DEFENSE INFORMATION SYSTEMS AGENCY

JOINT INTEROPERABILITY TEST COMMAND
FORT HUACHUCA, ARIZONA

MIL-STD-188-141B CONFORMANCE TEST PROCEDURES

NOVEMBER 2003

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CONFORMANCE
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INTRODUCTION

Military Standard (MIL-STD)-188-141B replaces MIL-STD-188-141A for establishing mandatory technical standards and design objectives that are necessary to ensure interoperability and to promote greater performance among High Frequency (HF) radios used in the voice frequency band of long haul and tactical communications systems.

This document contains the test procedures that will be used to determine the level of compliance of an HF radio transceiver to the requirements established in MIL-STD-188-141B. The test procedures are generic and can be used to test any HF radio transceiver requiring conformance to MIL-STD-188-141B. Tables and figures referenced in appendix B, appendix E, and the criteria sections of appendix C refer to tables and figures from MIL-STD-188-141B. All other tables and figures referenced in the text are contained within this document. If the Unit Under Test is an exciter and power amplifier, all test measurements will be taken with the exciter and power amplifier configured as in an operational environment, where possible.

The Joint Interoperability Test Command will conduct the standards and conformance test at Fort Huachuca, Arizona.

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APPENDIX A

ACRONYMS

Ω	ohm
≥	greater than or equal to
≤	less than or equal to
μA	microamperes
ACK	Acknowledge
AGC	Automatic Gain Control
AL	Application Level
ALC	Automatic Level Control
ALE	Automatic Link Establishment
AM	Amplitude Modulation
AMD	Automatic Message Display
ANSI	American National Standards Institute
AQC	Alternative Quick Call
ARQ	Automatic Repeat-Request
ASCII	American Standard Code for Information Interchange
AWGN	Additive White Gaussian Noise
BCD	binary coded decimal
Bd	baud
BER	Bit Error Rate
bps	bits per second
CCIR	International Radio Consultative Committee
CMD	Command
CRC	Cyclic Redundancy Check
dB	decibel
dBc	decibels referenced to full-peak envelope power
dBm	decibels referenced to one milliwatt
DBM	Data Block Messaging
dBW	a decibel measure to one watt
DC	Data Code
DCE	Data Circuit-Terminating Equipment
DO	Design Objective
DOD	Department of Defense
DTE	Data Terminal Equipment
DTM	Data Text Message
FDM	Frequency Division Multiplex
Fc	carrier frequency

ACRONYMS (continued)

FCS	Frame Check Sequence
FEC	Forward Error Correction
f_o	oscillator frequency
FSK	Frequency Shift Keying
HF	High Frequency
HFNC	High Frequency Node Controller
HP	Hewlett Packard
Hz	hertz
ICD	Interface Control Document
ICW	Interrupted Continuous Wave
ID	Identification
IF	Intermediate Frequency
IMD	Intermodulation Distortion
ISB	Independent Sideband
ISDN	Integrated Services Digital Network
kHz	kilohertz
LP	Linking Protection
LPCM	Linking Protecting Control Mechanism
LQA	Link Quality Analysis
LSB	Least Significant Bit
LSB	Lower Sideband
mA	milliamps
MF	Medium Frequency
MHz	megahertz
MIL-STD	Military Standard
MP	Multipath
MSB	Most Significant Bit
msec	millisecond
NAK	Non-Acknowledgment
NBFM	Narrowband Frequency Modulation
NSA	National Security Agency
NT	Not Tested
NTIA	National Telecommunications Information Agency
PC	Personal Computer
PEP	Peak Envelope Power
PI	Protection Interval

ACRONYMS (continued)

ppm	parts per million
PSK	Phase Shift Key
PTT	Push to Talk
QAM	Quadrature Amplitude Modulation
REP	Repeat
RF	Radio Frequency
SINAD	Signal-plus-noise-plus-distortion to noise-plus-distortion
SN	Slot Number
SNR	Signal to Noise Ratio
SSB	Single Sideband
STANAG	Standardization Agreement
Sync	synchronization
T	Time
TDMA	Time Division Multiple Access
TIMS	Transmission Impairment Measurement Set
TIS	This is
TOD	Time of Day
TWAS	This was
UI	Unique Index
USB	Upper Sideband
UUF	Unique User Function
UUT	Unit Under Test
V	Volt
VSWR	Voltage Standing Wave Ratio
WRTT	Wait-for-Response-and-Tune-Timeout

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APPENDIX B

REQUIREMENTS MATRIX

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Table B-1. MIL-STD-188-141B Requirements Matrix

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
1	4.2.1	Baseline mode. Frequency control of all new HF equipment, except manpack, shall be capable of being stabilized by an external standard. Should multiple-frequency (channel) storage be incorporated, it shall be of the programmable-memory type and be capable of storing/initializing the operational mode (see paragraphs 4.2.1.1 and 4.2.1.2 below, and paragraph A.4.3.1 of appendix A) associated with each particular channel.	1
2	4.2.1.1	Single-channel. All new single-channel HF equipment shall provide, as a minimum, the capability for the following one-at-a-time selectable operational modes: a. One nominal 3-kilohertz (kHz) channel upper sideband (USB) or lower sideband (LSB) (selectable). b. One (rate-dependent bandwidth) interrupted continuous wave (ICW) channel.* c. A narrowband frequency modulation (NBFM) channel capability should be included as a Design Objective (DO). *Not mandatory for radios designed for ALE.	1
3	4.2.1.2	Multichannel. All new multichannel HF equipment shall provide a single channel capability as set forth in paragraph 4.2.1.1, as a minimum, and one or more of the following modes, selectable one at a time: a. Two nominal 3-kHz channels in the USB and LSB (two independent channels in the same sideband-sideband selectable). b. One nominal 6-kHz channel in the USB or LSB (selectable). c. Two nominal 3-kHz channels in the USB and two in the LSB (four independent 3-kHz channels- two in each sideband). d. One nominal 6-kHz channel in the USB and one in the LSB (two independent 6-kHz channels-one in each sideband). e. One nominal 3-kHz channel in the USB and one in the LSB (two independent 3-kHz channels-one in each sideband).	1

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
4	4.2.2	Push-to-talk operation. Push-to-talk (PTT) operation is the most common form of interaction with MF/HF single sideband (SSB) radios, especially for tactical use by minimally trained, "noncommunicator" operators. Manual control with PTT shall be conventional; that is, the operator pushes the PTT button to talk and releases it to listen.	1
5	4.3.1	Electrical characteristics of digital interfaces. As a minimum, any incorporated interfaces for serial binary data shall be in accordance with the provisions of MIL-STD-188-114, and any other interfaces specified by the contracting agencies. Such interfaces shall include provisions for request-to-send and clear-to-send signaling. The capability to accept additional standard interfaces is not precluded.	2
6	4.3.3	Modulation and data signaling rates. The modulation rate (expressed in baud (Bd)) or the data signaling rate (expressed in bits per second (b/s)) at interface points A and A' in figure 2 shall include those contained in MIL-STD-188-110.	3
7	5.2.1	Displayed frequency. The displayed frequency shall be that of the carrier, whether suppressed or not.	4
8	5.2.2	Frequency coverage. The radio equipment shall be capable of operating over the frequency range of 2.0 MHz to 29.9999 MHz in a maximum of 100-Hz frequency increments (DO: 10-Hz) for single-channel equipment, and 10-Hz frequency increments (DO: 1-Hz) for multichannel equipment.	4
9	5.2.3	Frequency accuracy. The accuracy of the radio carrier frequency, including tolerance and long-term stability, but not any variation due to doppler shift, shall be within ±30 Hz for tactical application and within ±10 Hz for all others, during a period of not less than 30 days. If tactical system include long haul interoperability mission, tactical equipment must meet ±10° Hz radio carrier frequency specification.	4
10	5.2.4	Phase stability. The phase stability shall be such that the probability that the phase difference will exceed 5 degrees over any two successive 10 millisecond (msec) periods (13.33-msec periods may also be used) shall be less than 1 percent. Measurements shall be performed over a sufficient number of adjacent periods to establish the specified probability with a confidence of at least 95 percent.	5

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
11	5.2.5	Phase noise. The synthesizer and mixer phase-noise spectrum at the transmitter output shall not exceed those limits as depicted in figures 4 and 5 under continuous carrier single-tone output conditions. Figure 4 depicts the limits of phase noise for cosited and non-cosited fixed-site and transportable long-haul radio transmitters. Figure 5 depicts the limits for tactical radio transmitters. If tactical system include long haul interoperability mission, tactical equipment must meet ±10° Hz radio carrier frequency specification.	6
12	5.2.6	Bandwidths. The bandwidths for high frequency band emissions shall be as shown in table II. Use of other HF band emissions is optional; however, if selected, shall be as shown in table II. Other high frequency band emissions, which may be required to satisfy specific user requirements, can be found in the NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management.	7
13	5.2.7.1	Single-channel or dual-channel operation. The amplitude vs. frequency response between (f_0 + 300 Hz) and (f_0 + 3050 Hz) shall be within 3 dB (total) where f_0 is the carrier frequency. The attenuation shall be at least 20 dB from f_0 to (f_0 - 415 Hz), at least 40 dB from (f_0 - 415 Hz) to (f_0 - 1000 Hz), and at least 60 dB below (f_0 - 1000 Hz). Attenuation shall be at least 30 dB from (f_0 + 4000 Hz) to (f_0 + 5000 Hz) and at least 60 dB above (f_0 + 5000 Hz). See figure 6. Group delay time shall not vary by more than 1.0 msec over 80 percent of the passband of 300 Hz to 3050 Hz (575-2775 Hz). Measurements shall be performed end-to-end (transmitter audio input to receiver audio output) with the radio equipment configured in a back-to-back test setup. NOTE: Although the response values given are for single-channel USB operation, an identical shape, but inverted channel response, is required for LSB or the inverted channel of a dual-channel independent sideband operation.	7

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
14	5.2.7.2	Four-channel operation. When four-channel independent sideband operation is employed, the four individual 3-kHz channels shall be configured as shown in figure 7, which also shows the amplitude response for these four channels. Channels A2 and B2 shall be inverted and displaced with respect to channels A1 and B1 as shown on the figure. This can be accomplished by using subcarrier frequencies of 6290 Hz above and below the center carrier frequency, or by other suitable techniques that produce the required channel displacements and inversions. The suppression of any subcarriers used shall be at least 40 dB (DO: 50 dB) below the level of a single tone in the A2 or B2 channel modulating the transmitter to 25-percent of peak envelope power (PEP). See figure 7. The RF amplitude versus frequency response for each ISB channel shall be within 2 dB (DO: 1 dB) between 250 Hz and 3100 Hz, referenced to each channel's carrier (either actual or virtual). Referenced from each channel's carrier, the channel attenuation shall be at least 40 dB at 50 Hz and 3250 Hz, and at least 60 dB at 250 Hz and 3550 Hz. Group delay distortion shall not exceed 1500 microseconds over the ranges 370 Hz to 750 Hz and 3000 Hz to 3100 Hz. The distortion shall not exceed 1000 microseconds over the range 750 Hz to 3000 Hz. Group delay distortion shall not exceed 150 microseconds for any 100-Hz frequency increment between 570 Hz and 3000 Hz. Measurements shall be performed end-to-end (transmitter audio input to receiver audio output) with the radio equipment configured in a back-to-back test setup.	7
15	5.2.8	Absolute delay. The absolute delay shall not exceed 10 msec (DO: 5 msec) over the frequency range of 300 Hz to 3050 Hz. Measurements shall be performed back-to-back as in paragraph 5.2.7.1.	7
16	5.3.1.1	In-band noise. Broadband noise in a 1-Hz bandwidth within the selected sideband shall be at least 75 decibels referenced to full-rated peak envelope power (dBc) below the level of the rated PEP of the HF transmitter for fixed station application and 65 dBc below the level of the rated PEP of the HF transmitter for tactical application.	8

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
17	5.3.1.2	Intermodulation distortion (IMD). The IMD products of HF transmitters produced by any two equal-level signals within the 3 dB bandwidth (a single-frequency audio output) shall be at least 30 dB below either tone for fixed station application and 24 dB below either tone for tactical application when the transmitter is operating at rated PEP. The frequencies of the two audio test signals shall not be harmonically or subharmonically related and shall have a minimum separation of 300 Hz.	9
18	5.3.2.1	Broadband emissions. When the transmitter is driven with a single tone to the rated PEP, the power spectral density of the transmitter broadband emission shall not exceed the level established in table III and as shown in figure 8. Discrete spurs shall be excluded from the measurement, and the measurement bandwidth shall be 1 Hz.	10
19	5.3.2.2	Discrete frequency spurious emissions. For HF transmitters, when driven with a single tone to produce an RF output of 25-percent rated PEP, all discrete frequency spurious emissions shall be suppressed as follows: a. For fixed application Between the carrier frequency fc and fc ± 4B (where B = bandwidth), at least 40 dBc. Between fc ± 4B and ± 5-percent of fc removed from the carrier frequency, at least 60 dBc. Beyond ±5-percent removed from the carrier frequency, at least 80 dBc. Harmonic performance levels shall not exceed -63 dBc. See figure 10a. b. For tactical application Between the carrier frequency f_c and $f_c \pm 4B$ (where B = bandwidth), at least 40 dBc. Beyond $f_c \pm 4B$ at least 50 dBc. Harmonic performance levels shall not exceed -40 dBc. See figure 9.	10

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
20	5.3.3	Carrier suppression. The suppressed carrier for tactical applications shall be at least 40 dBc (DO: 60 dBc) below the output level of a single tone modulating the transmitter to rated PEP. The suppressed carrier for fixed site applications shall be at least 50 dBc (DO: 60 dBc) below the output level of a single tone modulating the transmitter to rated PEP.	11
21	5.3.4	Automatic level control (ALC). Starting at ALC threshold, an increase of 20 dB in audio input shall result in less than a 1 dB increase in average RF power output.	12
22	5.3.5.1	Attack-time delay. The time interval from keying-on a transmitter until the transmitted RF signal amplitude has increased to 90-percent of its steady-state value shall not exceed 25 msec (DO: 10 msec). This delay excludes any necessary time for automatic antenna tuning.	13
23	5.3.5.2	Release-time delay. The time interval from keying-off a transmitter until the transmitted RF signal amplitude has decreased to 10-percent of its key-on steady-state value shall be 10 msec or less.	13
24	5.3.6.1	Input signal power. Input signal power for microphone or handset input is not standardized. When a line-level input is provided (see paragraph 5.3.6.2), rated transmitter PEP shall be obtainable for single tone amplitudes from -17 dBm to +6 dBm (manual adjustment permitted).	14
25	5.3.6.2.1	Unbalanced interface. When an unbalanced interface is provided, it shall have an audio input impedance of a nominal 150 ohms, unbalanced with respect to ground, with a minimum return loss of 20 dB against a 150-ohm resistance over the nominal 3-kHz passband.	14
26	5.3.6.2.2	Balanced interface. When a balanced interface is provided, the audio input impedance shall be a nominal 600 ohms, balanced with respect to ground, with a minimum return loss of 26 dB against a 600-ohm resistance over the frequency range of 300 Hz to 3050 Hz. The electrical symmetry shall be sufficient to suppress longitudinal currents at least 40 dB below the reference signal level.	14

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
27	5.3.7	Transmitter output load impedance. Transmitters shall survive any voltage standing wave radio (VSWR) at point B, while derating the output power as a function of increasing VSWR. However, the transmitter shall deliver full rated forward power into a 1.3:1 VSWR load. Figure 11 is a design objective for the derating curve. The VSWR between an exciter and an amplifier shall be less than 1.5:1. The VSWR between an amplifier and an antenna coupler shall be less than 1.5:1 for fixed applications and less than 2.0:1 for tactical application.	15
28	5.4.1.1	Image rejection. The rejection of image signals shall be at least 70 dB for tactical HF receivers and 80 dB for all other HF receivers (DO: 100 dB).	16
29	5.4.1.2	Intermediate frequency (IF) rejection. Spurious signals at the IF (frequencies) shall be rejected by at least 70 dB for tactical HF receivers and 80 dB for all other HF receivers (DO: 100 dB).	16
30	5.4.1.3	Adjacent-channel rejection. The receiver shall reject any signal in the undesired sideband and adjacent channel in accordance with figure 6.	16
31	5.4.1.4	Other signal-frequency external spurious responses. Receiver rejection of spurious frequencies, other than IF and image, shall be at least 65 dB (55 dB for tactical application) for frequencies from +2.5-percent to +30-percent, and from -2.5-percent to –30-percent of the center frequency, and at least 80 dB (70 dB for tactical application) for frequencies beyond +30 percent of the center frequency.	16
32	5.4.1.5	Receiver protection. The receiver, with primary power on or off, shall be capable of survival without damage with applied signals of up to +43 dBm (DO: +53 dBm) available power delivered from a 50-ohm source for a duration of 5 minutes for fixed site applications and 1 minute for tactical applications.	17

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
33	5.4.1.6	Desensitization dynamic range. The following requirement shall apply to the receiver in an SSB mode of operation with an IF passband setting providing at least 2750 Hz (nominal 3 kHz bandwidth) at the 2 dB points. With the receiver tuning centered on a sinusoidal input test signal and with the test signal level adjusted to produce an output SINAD of 10 dB, a single interfering sinusoidal signal, offset from the test signal by an amount equal to ±5-percent of the carrier frequency, is injected into the receiver input. The output SINAD shall not be degraded by more than 1 dB as follows: a. For fixed site radios, the interfering signal is equal to or less than 100 dB above the test signal level. b. For tactical radios, the interfering signal is equal to or less than 90 dB above the test signal level.	18
34	5.4.1.7	Receiver sensitivity. The sensitivity of the receiver over the operating frequency range, in the sideband mode of operation (3-kHz bandwidth), shall be such that a -111 dBm (DO: -121 dBm) unmodulated signal at the antenna terminal, adjusted for a 1000-Hz audio output, produces an audio output with a SINAD of at least 10 dB over the operating frequency range.	19
35	5.4.1.8	Receiver out-of-band IMD. Second-order and higher-order responses shall require a two-tone signal amplitude with each tone at -30 dBm or greater (-36 dBm or greater for tactical applications), to produce an output SINAD equivalent to a single –110-dBm tone. This requirement is applicable for equal-amplitude input signals with the closest signal spaced 30 kHz or more from the operating frequency.	20
36	5.4.1.9	Third-order intercept point. Using test signals within the first IF passband, the worst-case third-order intercept point shall not be less than +10 dBm (+1 dBm for tactical applications).	21

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
37	5.4.2.1	Overall IMD (in-channel). The total of IMD products, with two equal-amplitude, in-channel tones spaced 110 Hz apart, present at the receiver RF input, shall meet the following requirements. However, for frequency division multiplex (FDM) service, the receiver shall meet the requirements for any tone spacing equal to or greater than the minimum between adjacent tones in any FDM library. The requirements shall be met for any RF input amplitude up to 0 dBm PEP (-6 dBm/tone) at rated audio output. All IMD products shall be at least 35 dB (DO: 45 dB) below the output level of either of the two tones.	22
38	5.4.2.2	Adjacent-channel IMD. For multiple-channel equipment, the overall adjacent-channel IMD in each 3-kHz channel being measured shall not be greater than -35 dBm at the 3-kHz channel output with all other channels equally loaded with 0 dBm unweighted white noise.	22
39	5.4.2.3	Audio frequency total harmonic distortion. The total harmonic distortion produced by any single-frequency RF test signal, which produces a frequency within the frequency bandwidth of 300 Hz to 3050 Hz shall be at least 25 dB (DO: 35 dB) below the reference tone level with the receiver at rated output level. The RF test signal shall be at least 35 dB above the receiver noise threshold.	22
40	5.4.2.4	Internally generated spurious outputs. For 99-percent of the available 3-kHz channels, internally generated spurious signals shall not exceed -112 dBm. For 0.8 percent of the available 3-kHz channels, spurious signals shall not exceed -100 dBm for tactical applications and -106 dBm for fixed applications. For 0.2-percent of the available 3-kHz channels, spurious signals may exceed these levels.	22
41	5.4.3	Automatic gain control (AGC) characteristic. The steady-state output level of the receiver (for a single tone) shall not vary by more than 3 dB over an RF input range from -103 dBm to +13 dBm for fixed application or -103 dBm to 0 dBm for tactical application.	23
42	5.4.3.1	AGC attack time (nondata modes). The receiver AGC attack time shall not exceed 30 msec.	23

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
43	5.4.3.2	AGC release time (nondata modes). The receiver AGC release time shall be between 800 and 1200 msec for SSB voice and ICW operation. This shall be the period from RF signal downward transition until audio output is within 3 dB of the steady-state output. The final steady-state audio output is simply receiver noise being amplified in the absence of any RF input signal.	23
44	5.4.3.3	AGC requirements for data service. In data service, the receiver AGC attack time shall not exceed 10 msec. The AGC release time shall not exceed 25 msec.	23
45	5.4.4	Receiver linearity. The following shall apply with the receiver operating at maximum sensitivity, and with a reference input signal that produces a SINAD of 10 dB at the receiver output. The output SINAD shall increase monotonically and linearly within ± 1.5 dB for a linear increase in input signal level until the output SINAD is equal to at least 30 dB (DO: 40 dB). When saturation occurs, the output SINAD may vary ±3 dB for additional increase in signal level. This requirement shall apply over the operating frequency range of the receiver.	24
46	5.4.5.1	Input impedance. The receiver RF input impedance shall be nominally 50 ohms, unbalanced with respect to ground. The input VSWR, with respect to 50 ohms, shall not exceed 2.5:1 over the operating frequency range.	25
47	5.4.5.2	Output impedance and power. When a balanced output is provided, the receiver output impedance shall be a nominal 600 ohms, balanced with respect to ground, capable of delivering 0 dBm to a 600-ohm load. Electrical symmetry shall be sufficient to suppress longitudinal currents at least 40 dB below reference signal level. The receiver output signal power for operation with a headset or handset shall be adjustable at least over the range from -30 dBm to 0 dBm. For operation with a speaker, the output level shall be adjustable at least over the range of 0 dBm to +30 dBm. As a DO, an additional interface can accommodate speakers ranging from 4 to 16 ohms impedance should be provided.	26

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
48	A.4.1.2	Scanning. The radio system shall be capable of repeatedly scanning selected channels stored in memory (in the radio or controller) under either manual control or under the direction of any associated automated controller. The radio shall stop scanning and wait on the most recent channel upon the occurrence of any of the following selectable events: Automatic controller decision to stop scan (the normal mode of operation) Manual input of stop scan Activation of external stop-scan line (if provided) The scanned channels should be selectable by groups (often called "scan lists") and also individually within the groups, to enable flexibility in channel and network scan management.	28
49	A.4.1.5	Channel quality display. If an operator display is provided, the display shall have a uniform scale, 0-30 with 31 being unknown all based on signal-plus-noise-plus-distortion to noise-plus-distortion (SINAD).	31
50	A.4.2.1	Scanning rate. Stations designed to this appendix shall incorporate selectable scan rates of two and five channels per second, and may also incorporate other scan rates (DO: 10 channels per second).	28
51	A.4.2.1.1	Alternative Quick Call (AQC) (NT). In the optional AQC-ALE protocol, the system shall be capable of variable dwell rates while scanning such that traffic can be detected in accordance with table A-II Probability of Linking.	49
52	A.4.2.1.2	Recommendation. Radios equipped with the optional AQC-ALE shall provide scanning at scan rates of two channels per second or five channels per second for backward compatibility to non-AQC-ALE networks.	49

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
53	A.4.2.2	Occupancy detection - not tested (NT). Stations designed to this appendix shall achieve at least the following probability of detecting the specified waveforms (see A.5.4.7) under the indicated conditions, with false alarm rates of no more than 1-percent. The channel simulator shall provide additive white gaussian noise (AWGN) without fading or multipath (MP). See table A-I.	45
54	A.4.2.3	Linking probability. Linking attempts made with a test setup configured as shown in figure A-3, using the specified ALE signal created in accordance with this appendix, shall produce a probability of linking as shown in table A-II. The receive audio input to the ALE controller shall be used to simulate the three channel conditions. The modified International Radio Consultative Committee (CCIR) good channel shall be characterized as having 0.52 millisecond (msec) (modified from 0.50ms) MP delay and a fading (two sigma) bandwidth of 0.1 hertz (Hz). The modified CCIR poor channel, normally characterized as consisting of a circuit having 2.0 msec MP delay with a fading (two sigma) bandwidth of 1.0 Hz, shall be modified to have 2.2 msec MP delay and a fading (two sigma) bandwidth of 1.0 Hz. Doppler shifts of ±60 Hz shall produce no more than a 1.0 decibel (dB) performance degradation from the requirements of table A-II for the modified CCIR good and poor channels. NOTE: This modification is necessary due to the fact that the constant 2-msec MP delay (an unrealistic fixed condition) of the CCIR poor channel results in a constant nulling of certain tones of the ALE tone library. Other tone libraries would also have some particular MP value, which would result in continuous tone cancellation during simulator testing. Each of the signal-to-noise (SNR) ratio values shall be measured in a nominal 3-kilohertz (kHz) bandwidth. Performance tests of this capability shall be conducted in accordance with ITU-R F.520-2 Use of High Frequency Ionospheric Channel Simulators employing the C.C. Watterson Model. This test shall use the individual scanning calling protocol described in A.5.5.3. The time for performance of each link attempt shall be measured from the initiation of the calling transmission until the successful establishment of the link. Performance testing shall include the following additional criteria:	30, 32

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
54	A4.2.3 (continued)	a. The protocol used shall be the individual scanning calling protocol with only TO and TIS preambles. b. Addresses used shall be alphanumeric, one word (three characters) in length from the 38-character basic American Standard Code for Information Interchange (ASCII) subset. c. Units under test (UUTs) shall be scanning 10 channels at two channels per second, and repeated at five channels per seconds. d. Call initiation shall be performed with the UUT transmitter stopped and tuned to the calling frequency. e. Maximum time from call initiation (measured from the start of UUT RF transmission -- not from activation of the ALE protocol) to link establishment shall not exceed 14.000 seconds, plus simulator delay time. The call shall not exceed 23 redundant words, the response three redundant words and the acknowledgment three redundant words. (See A.5.2.2.4 and Annex A). NOTE: Performance at the higher scan rates shall also meet the foregoing requirements and shall meet or exceed the probability of linking as shown in table A-II.	30

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
55	A.4.2.3.1	AQC-ALE linking probability. When the optional AQC-ALE protocol is implemented, the probability of linking shall conform to table A-II with the following additional criteria: a. The protocol used shall be quick AQC individual calling protocol with no message passing. b. Addresses shall be one to six characters in the 38-character basic ASCII subset. c. Units being called shall be scanning 10 channels. d. Call initiation shall be performed with the UUT transmitter stopped and tuned to the calling frequency. e. The initial call probe shall not exceed 10 T_{rw}, the call response shall not exceed 4T_{rw}, and the acknowledgment shall not exceed 2 T_{rw}.	46
56	A.4.2.3.2	AQC-ALE linking performance. AQC-ALE linking performance shall not be degraded in LP level 1 or 2. Scan rates of two or five channels per second may degrade performance because insufficient redundant words are emitted during the call probe.	46

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
57	A.4.3.1	Channel memory. The equipment shall be capable of storing, retrieving, and employing at least 100 different sets of information concerning channel data to include receive and transmit frequencies with associated mode information. See table A-III. The channel data storage shall be nonvolatile. The mode information normally includes: transmit power level traffic or channel use (voice, data, etc.) sounding data modulation type (associated with frequency) transmit/receive modes filter width (DO) automatic gain control (AGC) setting (DO) input/output antenna port selection (DO) input/output information port selection (DO) noise blanker setting (DO) security (DO) sounding self address(es) SA....n(DO) Any channel (a) shall be capable of being recalled manually or under the direction of any associated automated controller, and (b) shall be capable of having its information altered after recall without affecting the original stored information settings.	27

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
58	A.4.3.2	Self address memory. The radio shall be capable of storing, retrieving, and employing at least 20 different sets of information concerning self addressing. The self-address information storage shall be nonvolatile. These sets of information include self (its own personal) address(es), valid channels which are associated for use, and net addressing. Net addressing information shall include (for each "net member" self address, as necessary) the net address and the associated slot wait time (in multiples of T_w). See table A-IV and A.5.5.4.1. The slot wait time values are T_{swt}(slot number (SN)) from the formula, T_{swt} (SN) = T_{sw} x SN . Stations called by their net call address shall respond with their associated self (net member) address with the specified delay (T_{swt}(SN)). For example, the call is "GUY," thus the response is "BEN." Stations called individually by one of their self addresses (even if a net member address) shall respond immediately and with that address, as specified in the individual scanning calling protocol. Stations called by one of their self addresses (even if a net member address) within a group call shall respond in the derived slot, and with that address, as specified in the star group scanning protocol. If a station is called by one of its net addresses and has no associated net member address, it shall pause and listen but shall not respond (unless subsequently called separately with an available self or net member address), but shall enter the linked state.	27, 37
59	A.4.3.3	Other station table. The radio shall be capable of storing, retrieving, and employing at least 100 different sets of information concerning the addresses of other stations and nets, channel quality data to those stations and nets (measurements or predictions), and equipment settings specific to links with each station or net. DO: any excess capacity which is not programmed with preplanned other station information should be automatically filled with any addresses heard on any of the scanned or monitored channels. When the excess capacity is filled, it should be kept current by replacing the oldest heard addresses with the latest ones heard. This information should be used for call initiation to stations (if needed), and for activity evaluation.	27

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
60	A.4.3.3.1	Other station address storage. Individual station addresses shall be stored in distinct table entries, and shall be associated with a specific wait for reply time (T_{wr}) if not the default value. Net information shall include own net and net member associations, relative slot sequences, and own net wait for reply times (T_{wrn}) for use when calling. See figure A-4. The storage for addresses and settings shall be nonvolatile.	27
61	A.4.3.3.2	Link quality memory. The equipment shall be capable of storing, retrieving, and employing at least 4000 (DO: 10,000) sets of connectivity and LQA information associated with the channels and the other addresses in an LQA memory. The connectivity and LQA information storage shall be retained in memory for not less than one hour during power down or loss of primary power. The information in each address/channel "cell" shall include as a minimum, bilateral SINAD values of (a) the signals received at the station, and (b) the station's signals received at, and reported by, the other station. It shall also include either an indicator of the age of the information (for discounting old data), or an algorithm for automatically reducing the weight of data with time, to compensate for changing propagation conditions. (DO: the cells of the LQA memory should also include bilateral bit-error ratio (BER) and bilateral MP information derived by suitably equipped units.) The information within the LQA memory shall be used to select channels and manage networks as stated in this document. See figure A-4.	31

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
62	A.4.3.4	Operating parameters. The following ALE operating parameters shall be programmable by the operator or an external automated controller. Complete definitions of the parameters are provided in appendix H. ScanRate; RequestLQA MaxScanChan; AutoPowerAdj MaxTuneTime; SelfAddrTable; LqaAge TurnAroundTime; SelfAddrEntry; LqaMultipath ActivityTimeout; SelfAddr; LqaSINAD ListenTime; SelfAddrStatus; LqaBER AcceptAnyCall; NetAddr; ScanSet AcceptAllcall; SlotWaitTime AcceptAMD; SelfAddrValidChannels AcceptDTM; OtherAddrTable AcceptDBM; OtherAddrEntry OtherAddrValidChannels; OtherAddr OtherAddrAnt; OtherAddrStatus OtherAddrAntAzimuth; OtherAddrNetMembers OtherAddrPower; LqaStatus LqaMatrix; ConnectionTable LqaEntry; ConnectionEntry; ConnectedAddr LqaAddr; ConnectionStatus; LqaChannel	28
63	A.4.3.5	Message memory. Storage for preprogrammed, operator entered, and incoming messages shall be provided in the equipment. This storage shall be retained in memory for not less than one hour during power down or loss of primary power. Storage for at least 12 messages (DO: 100 messages), and a total capacity of at least 1000 characters (DO: 10,000 characters) shall be provided.	27

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
64	A.4.5.1	Introduction. This feature may be implemented in addition to the basic ALE functionality described in this appendix. The AQC-ALE provides a link establishment technique that requires significantly less time to link than the baseline ALE system. This is accomplished by some additional technology and trading-off some of the lesser used functions of the baseline system, for a faster linking process. The AQC-ALE shall always be listening for the baseline ALE call and shall automatically respond and operate in that mode when called.	40
65	A.5.1.2	Tones. The waveform shall be an 8-ary frequency shift-keying (FSK) modulation with eight orthogonal tones, one tone (or symbol) at a time. Each tone shall represent three bits of data as follows (least significant bit (LSB) to the right): 750 Hz 000 1000 Hz 001 1250 Hz 011 1500 Hz 010 1750 Hz 110 2000 Hz 111 2250 Hz 101 2500 Hz 100 The transmitted bits shall be encoded and interleaved data bits constituting a word, as described in paragraphs A.5.2.2 and A.5.2.3. The transitions between tones shall be phase continuous and shall be at waveform maxima or minima (slope zero).	29
66	A.5.1.3	Timing. The tones shall be transmitted at a rate of 125 tones (symbols) per second, with a resultant period of 8 msec per tone. Figure A-5 shows the frequency and time relationships. The transmitted bit rate shall be 375 bits per second (b/s). The transitions between adjacent redundant (tripled) transmitted words shall coincide with the transitions between tones, resulting in an integral 49 symbols (or tones) per redundant (tripled) word. The resultant single word period (T_w) shall be 130.66... msec (or 16.33... symbols), and the triple word (basic redundant format) period (3 T_w) shall be 392 msec.	29

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
67	A.5.1.4	Accuracy. At baseband audio, the generated tones shall be within ±1.0 Hz. At RF, all transmitted tones shall be within the range of 2.0 dB in amplitude. Transmitted symbol timing, and therefore, the bit and word rates shall be within ten parts per million.	29
68	A.5.2.2.2	Golay coding. The Golay (24, 12, 3) FEC code is prescribed for this standard. The FEC code generator polynomial shall be: $g(x) = x^{11} + x^9 + x^7 + x^6 + x^5 + x + 1$ The generator matrix G, derived from g(x), shall contain an identity matrix I_{12} and a parity matrix P as shown in figure A-6. The corresponding parity check matrix H shall contain a transposed matrix p^T and an identity matrix I_{12} as shown in figure A-7.	32
69	A.5.2.2.2.1	Encoding. Encoding shall use the fundamental formula x = uG, where the code word x shall be derived from the data word u and the generator matrix G. Encoding is performed using the G matrix by summing (modulo-2) the rows of G for which the corresponding information bit is a "1." See figures A-6, A-8, and A-9a.	32
70	A.5.2.2.3	Interleaving and deinterleaving. The basic word bits W1 (most significant bit (MSB)) through W24 (LSB), and resultant Golay FEC bits G1 through G24 (with G13 through G24 inverted), shall be interleaved, before transmission using the pattern shown in figure A-10. The 48 interleaved bits plus a 49th stuff bit S49, (value = 0) shall constitute a transmitted word and they shall be transmitted A1, B1, A2, B2... A24, B24, S49 using 16-1/3 symbols (tones) per word (T_w) as described in A.5.1.3. At the receiver, and after 2/3 voting (see A.5.2.2.4), the first 48 received bits of the majority word (including remaining errors) shall be deinterleaved as shown in figure A-10 and then Golay FEC decoded to produce a correct(ed) 24-bit basic word (or an uncorrected error flag). The 49th stuff bit (S49) is ignored.	32

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
71	A.5.2.2.4	Redundant words. Each of the transmitted 49-bit (or 16-1/3 symbol) (T_w) words shall be sent redundantly (times 3) to reduce the effects of fading, interference, and noise. An individual (or net) routing word (TO...), used for calling a scanning (multichannel) station (or net), shall be sent redundantly as long as required in the scan call (T_{sc}) to ensure receipt, as described in A.5.5.2. However, when the call is a non-net call to multiple scanning stations (a group call, using THRU and REPEAT (REP) alternately), the first individual routing word (THRU) and all the subsequent individual routing words (REP, THRU, REP,...) shall be sent three adjacent times (T_{rw}). These triple words for the individual stations shall be rotated in group sequence as described in A.5.5.3. See figure A-11. At bit time intervals (approximately T_w/49), the receiver shall examine the present bit and past bit stream and perform a 2/3 majority vote, on a bit-by-bit basis, over a span of three words. See tables A-VI and A-VII. The resultant 48 (ignoring the 49th bit) most recent majority bits constitute the latest majority word and shall be delivered to the deinterleaver and FEC decoder. In addition, the number of unanimous votes of the 48 possible votes associated with this majority word are temporarily retained for use as described in A.5.2.6.	32
72	A.5.2.3.1	ALE word format. The basic ALE word shall consist of 24 bits of information, designated W1 (MSB) through W24 (LSB). The bits shall be designated as shown in figure A-12.	32
73	A.5.2.3.1.1	Structure. The word shall be divided into two parts: a 3-bit preamble and a 21-bit data field (which often contains three 7-bit characters). The MSB for all parts, and the word, is to the left in figure A-12 and is sent earliest. Before transmission, the word shall be divided into two 12-bit halves (Golay code A and B in figure A-10) for FEC encoding as described in 5.2.2. The optional AQC-ALE word packs the address data. Details of this can be found in A.5.8.1.1, AQC-ALE Address Word Structure.	32
74	A.5.2.3.1.2	Word types. The leading three bits, W1 through W3, are designated preamble bits P3 through P1, respectively. These preamble bits shall be used to identify one of eight possible word types.	32

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
75	A.5.2.3.1.3	Preambles. The word types (and preambles) shall be as shown in table A-VIII and as described herein. Optional AQC-ALE preambles are defined in A.5.8.1.2.	32
76	A.5.2.3.2.1	TO. The TO word (010) shall be used as a routing designator which shall indicate the address of the present destination station(s) which is (are) to directly receive the call. TO shall be used in the individual call protocols for single stations and in the net call protocols for multiple net-member stations which are called using a single net address. The TO word itself shall contain the first three characters of an address. For extended addresses, the additional address words (and characters) shall be contained in alternating DATA and REP words, which shall immediately follow. The sequence shall be TO, DATA, REP, DATA, and REP, and shall be only long enough to contain the address, up to a maximum capacity of five address words (15 characters).	32
77	A.5.2.3.2.2	THIS IS (TIS). The TIS word (101) shall be used as a routing designator which shall indicate the address of the present calling (or sounding) station which is directly transmitting the call (or sound). Except for the use of TWAS, TIS shall be used in all ALE protocols to terminate the ALE frame and transmission. It shall indicate the continuation of the protocol or handshake, and shall direct, request, or invite (depending on the specific protocol) responses or acknowledgments from other called or receiving stations. The TIS shall be used to designate the call acceptance sound. The TIS word itself shall contain the first three characters of the calling stations address. For extended addresses, the additional address words (and characters) shall be contained in alternating DATA and REP words which shall immediately follow, exactly as described for whole addresses using the TO word and sequence. The entire address (and the required portion of the TIS, DATA, REP, DATA, REP sequence, as necessary) shall be used only in the conclusion section of the ALE frame (or shall constitute an entire sound). TWAS shall not be used in the same frame as TIS, as they are mutually exclusive.	32

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
78	A.5.2.3.2.3	THIS WAS (TWAS). The TWAS word (011) shall be used as a routing designator exactly as the TIS, with the following variations. It shall indicate the termination of the ALE protocol or handshake, and shall reject, discourage, or not invite (depending on the specific protocol) responses or acknowledgments from other called or receiving stations. The TWAS shall be used to designate the call rejection sound. TIS shall not be used in the same frame as TWAS, as they are mutually exclusive.	32
79	A.5.2.3.2.4	THRU. The THRU word (001) shall be used in the scanning call section of the calling cycle only with group call protocols. The THRU word shall be used alternately with REP, as routing designators, to indicate the address first word of stations that are to be directly called. Each address first word shall be limited to one basic address word (three characters) in length. A maximum of five different address first words shall be permitted in a group call. The sequence shall only be alternations of THRU, REP. The THRU shall not be used for extended addresses, as it will not be used within the leading call section of the calling cycle. When the leading call starts in the group call, the entire group of called stations shall be called with their whole addresses, which shall be sent using the TO preambles and structures, as described in A.5.2.3.2.1. NOTE: 1. The THRU word is also reserved for future implementation of indirect and relay protocols, in which cases it may be used elsewhere in the ALE frame and with whole addresses and other information. Stations designed in compliance with this nonrelay standard should ignore calls to them which employ their address in a THRU word in other than the scanning call. NOTE: 2. The THRU preamble value is also reserved for the AQC-ALE protocol.	32

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
80	A.5.2.3.2.5	FROM. The FROM word (100) is an optional designator which shall be used to identify the transmitting station without using an ALE frame termination, such as TIS or TWAS. It shall contain the whole address of the transmitting station, using the FROM, and if required, the DATA and REP words, exactly as described in the TO address structure in A.5.2.3.2.1. It should be used only once in each ALE frame, and it shall be used only immediately preceding a command (CMD) in the message section. Under direction of the operator or controller, it should be used to provide a "quick ID" of the transmitting station when the normal conclusion may be delayed, such as when a long message section is to be used in an ALE frame. NOTE: 1. The FROM word is also reserved for future implementation of indirect and relay protocols, in which cases it may be used elsewhere in the ALE frame and with multiple addresses and other information. Stations designed in compliance with this nonrelay standard should ignore sections of calls to them that employ FROM words in any other sequence than immediately before the CMD word. NOTE: 2. The FROM preamble value is also reserved for the AQC-ALE protocol.	32
81	A.5.2.3.3.1	CMD. The CMD word (110) is a special orderwire designator which shall be used for system-wide coordination, command, control, status, information, interoperation, and other special purposes. CMD shall be used in any combination between ALE stations and operators. CMD is an optional designator which is used only within the message section of the ALE frame, and it shall have (at some time in the frame) a preceding call and a following conclusion, to ensure designation of the intended receivers and identification of the sender. The first CMD terminates the calling cycle and indicates the start of the message section of the ALE frame. The orderwire functions are directed with the CMD itself, or when combined with the REP and DATA words. See A.5.6 for message words (orderwire messages) and functions.	32

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
82	A.5.2.3.4.1	DATA. The DATA word (000) is a special designator which shall be used to extend the data field of any previous word type (except DATA itself) or to convey information in a message. When used with the routing designators TO, FROM, TIS, or TWAS, DATA shall perform address extension from the basic three characters to six, nine, or more (in multiples of three) when alternated with REP words. The selected limit for address extension is a total of 15 characters. When used with CMD, its function is predefined as specified in A.5.6 for message words (orderwire messages) and functions.	32
83	A.5.2.3.4.2	REP. The REP word (111) is a special designator which shall be used to duplicate any previous preamble function or word meaning while changing the data field contents (bits W4 through W24). See table A-VIII. Any change of words or data field bits requires a change of preamble bits (P_3 through P_1) to preclude uncertainty and errors. If a word is to change, even if the data field is identical to that in the previous word, the preamble shall be changed, thereby clearly designating a word change. When used with the routing designator TO, REP performs address expansion, which enables more than one address to be specified. See A.5.2.3.2.4 for use with THRU. With DATA, REP may be used to extend and expand address, message, command, and status fields. REP shall be used to perform these functions, and it may directly follow any other word type except for itself, and except for TIS or TWAS, as there cannot be more than one transmitter for a specific call at a given time. NOTE 1. REP is used in T_{sc} of group calls directed to units with different first word addresses. NOTE 2. REP is not used in T_{sc} of calls directed to groups with same first word addresses. Also REP is not used in T_{sc} of calls directed to individuals and nets.	32

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
84	A.5.2.4.1	Introduction. The ALE system deploys a digital addressing structure based upon the standard 24-bit (three character) word and the Basic 38 character subset. As described below, ALE stations have the capability and flexibility to link or network with one or many prearranged or as-needed single or multiple stations. All ALE stations shall have the capacity to store and use at least 20 self addresses of up to 15 characters each in any combination of individual and net calls. There are three basic addressing methods which will be presented: Individual station Multiple station Special modes NOTE: Certain alphanumeric address combinations may be interpreted to have special meanings for emergency or specific functions, such as "SOS," "MAYDAY," "PANPAN," "SECURITY," "ALL," "ANY," and "NULL." These should be carefully controlled or restricted.	34
85	A.5.2.4.2	Basic 38 subset. The Basic 38 subset shall include all capital alphabetics (A-Z) and all digits (0-9), plus designated utility and wildcard symbols "@" and "?," as shown in figure A-13. The Basic 38 subset shall be used for all basic addressing functions. To be a valid basic address, the word shall contain a routing preamble from A.5.2.3.2 (such as TO...), plus three alphanumeric characters (A-Z, 0-9) from the Basic 38 subset in any combination. In addition, the "@" and "?" symbols shall be used for special functions. Digital discrimination of the Basic 38 subset shall not be limited to examination of only the three MSBs (b_7 through b_5), as a total of 48 digital bit combinations would be possible (including ten invalid symbols which would be improperly accepted).	32

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
86	A.5.2.4.3	Stuffing. The ALE basic address structure is based on single words which, in themselves, provide multiples of three characters. The quantity of available addresses within the system, and the flexibility of assigning addresses, are significantly increased by the use of address character stuffing. This technique allows address lengths that are not multiples of three to be compatibly contained in the standard (multiple of three characters) address fields by "stuffing" the empty trailing positions with the utility symbol "@." See table A-IX. "Stuff-1" and "Stuff-2" words shall only be used in the last word of an address, and therefore should appear only in the leading call (T_{lc}) of the calling cycle (T_{cc}). NOTE: As an example of proper usage, a call to the address "MIAMI" would be structured "TO MIA," "DATA MI@."	34

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
88	A.5.2.4.4.1	Basic size. The basic address word shall be composed of a routing preamble (TO, or possibly a REP which follows a TO, in T_{lc} of group call, or a TIS or TWAS) plus three address characters, all of which shall be alphanumeric numbers of the Basic 38 subset. The three characters in the basic individual address provide a Basic 38-address capacity of 46,656, using only the 36 alphanumerics. This three-character single word is the minimum structure. In addition, all ALE stations shall associate specific timing and control information with all own addresses, such as prearranged delays for slotted net responses. As described in A.5.5, the basic individual addresses of various station(s) may be combined to implement flexible linking and networking. NOTE: All ALE stations shall be assigned at least one (DO: several) single-word address for automatic use in one-word address protocols, such as slotted (multistation type) responses. This is a mandatory user requirement, not a design requirement. However, nothing in the design shall preclude using longer addresses.	34

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
89	A.5.2.4.4.2	Extended size. Extended addresses provide address fields which are longer than one word (three characters), up to a maximum system limit of five words (15 characters). See table A-X. This 15-character capacity enables Integrated Services Digital Network (ISDN) address capability. Specifically, the ALE extended address word structure shall be composed of an initial basic address word, such as TO or TIS, as described above, plus additional words as necessary to contain the additional characters in the sequence DATA, REP, DATA, REP, for a maximum total of five words. All address characters shall be the alphanumeric members of the Basic 38 subset. NOTE 1: All ALE stations shall be assigned at least one (DO: several) two-word address(es) for general use, plus an additional address(es) containing the station's assigned call sign(s). This is a mandatory user requirement, not a design requirement. However, nothing in the design shall preclude using longer addresses. NOTE 2: The recommended standard address size for intranet, internet, and general non-ISDN use is two words. Any requirement to operate with address sizes larger than six characters must be a network management decision. As examples of proper usage, a call to "EDWARD" would be "TO EDW," "DATA ARD," and a call to "MISSISSIPPI" would be "TO MIS," "DATA SIS," "REP SIP," "DATA PI@."	34
90	A.5.2.4.5	Net addresses. The purpose of a net call is to rapidly and efficiently establish contact with multiple prearranged (net) stations (simultaneously if possible) by the use of a single net address, which is an additional address assigned to all net members in common. When a net address type function is required, a calling ALE station shall use an address structure identical to the individual station address, basic or extended as necessary. For each net address at a net member's station, there shall be a response slot identifier, plus a slot width modifier if directed by the specific standard protocol. As described in paragraphs A.5.5.3 and A.5.5.4, additional information concerning the assigned response slots (and size) must be available, and the mixing of individual, net, and group addresses and calls is restricted.	32

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
91	A.5.2.4.6	Group addresses. The purpose of a group call is to establish contact with multiple nonprearranged (group) stations (simultaneously if possible) rapidly and efficiently by the use of a compact combination of their own addresses which are assigned individually. When a group address type function is required, a calling ALE station shall use a sequence of the actual individual station addresses of the called stations, in the manner directed by the specific standard protocol. A station's address shall not appear more than once in a group calling sequence, except as specifically permitted in the group calling protocols described in A.5.5.4. NOTE: The group feature is not available in the AQC-ALE protocol.	32
92	A.5.2.4.7	Allcall addresses. An "AllCall" is a general broadcast that does not request responses and does not designate any specific address. This mechanism is provided for emergencies ("HELP!"), broadcast data exchanges, and propagation and connectivity tracking. The global AllCall address is "@?@." The AllCall protocol is discussed in A.5.5.4.4. As a variation on the AllCall, the calling station can organize (or divide) the available but unspecified receiving stations into logical subsets, using a selective AllCall address. A selective AllCall is identical in structure, function, and protocol to the AllCall except that it specifies the last single character of the addresses of the desired subgroup of receiving stations (1/36 of all). By replacing the "?" with an alphanumeric, the selective AllCall special address pattern is "TO @A@" (or possibly "THRU @A@" and "REP @B@" if more than one subset is desired), where "A" (and "B," if applicable) in this notation represents any of the 36 alphanumerics in the Basic-38 subset. "A" and "B" may represent the same or different character from the subset, and specifically indicate which character(s) must be last in a station's address in order to stop scan and listen. NOTE: For ACQ-ALE, the Part2 address portion shall contain the same three characters used in the TO word of the call.	34

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
93	A.5.2.4.8	AnyCalls. An "AnyCall" is a general broadcast that requests responses without designating any specific addressee(s). It is required for emergencies, reconstitution of systems, and creation of new networks. An ALE station may use the AnyCall to generate responses from essentially unspecified stations, and it thereby can identify new stations and connectivities. The global AnyCall address is "@@?." The AnyCall protocol is discussed in A.5.5.4.5. If too many responses are received to an AnyCall, or if the caller must organize the available but unspecified responders into logical subsets, a selective AnyCall protocol is used. The selective AnyCall address is identical in structure, function, and protocol to the global AnyCall, except that it specifies the last single character of the addresses of the desired subset of receiving station (1/36 of all). By replacing the "?" with an alphanumeric, the global AnyCall becomes a selective AnyCall whose special address pattern is "TO @@A." If even narrower acceptance and response criteria are required, the double selective AnyCall should be used. The double selective AnyCall is an operator selected general broadcast which is identical to the selective AnyCall described above, except that its special address (using "@AB" format) specifies the last two characters that the desired subset of receiving stations must have to initiate a response. NOTE: For ACQ-ALE, the Part2 address portion shall contain the same three characters used in the TO word of the call.	34
94	A.5.2.4.9	Wildcards. A "wildcard" is a special character that the caller uses to address multiple-station addresses with a single-call address. The receivers shall accept the wildcard character as a substitute for any alphanumeric in their self addresses in the same position or positions. Therefore, each wildcard character shall substitute for any of 36 characters (A to Z, 0 to 9) in the Basic 38-character subset. The total lengths of the calling (wildcard) address, and the called addresses shall be the same. The special wildcard character shall be "?" (0111111). It shall substitute for any alphanumeric in the Basic 38-character subset. It shall substitute for only a single-address character position in an address, per wildcard character. See table A-XI for examples of acceptable patterns.	34

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
95	A.5.2.4.10	Self addresses. For self test, maintenance, and other purposes, stations shall be capable of using their own self addresses in calls. When a self-addressing type function is required, ALE stations shall use the following self-addressing structures and protocols. Any ALE calling structures and protocols permissible within this standard, and containing a specifically addressed calling cycle (such as "TO ABC," but not AllCall or AnyCall), shall be acceptable, except that the station may substitute (or add) any one (or several) of its own calling addresses into the calling cycle.	34
96	A.5.2.4.11	Null address. For test, maintenance, buffer times, and other purposes, the station shall use a null address that is not directed to, accepted by, or responded to by any station. When an ALE station requires a null address type function, it shall use the following null address protocol. The null address special address pattern shall be "TO @@@," (or "REP @@@"), if directly after another TO. The null address shall only use the TO (or REP), and only in the calling cycle (T_{cc}). Null addresses may be mixed with other addresses (group call), in which case they shall appear only in the leading call (T_{lc}), and not in the scanning call (T_{sc}). Nulls shall never be used in conclusion (terminator) (TIS or TWAS). If a null address appears in a group call, no station is designated to respond in the associated slot; therefore, it remains empty (and may be used as a buffer for tune-ups, or overflow from the previous slot's responder, etc.).	34
97	A.5.2.4.12	In-link address. The inlink address feature is used by a system to denote that all members in the established link are to act upon the information sent in the frame containing the inlink address. The inlink address shall be '?@?'. When a radio enters the linked condition with one or more stations, the radio shall expand the set of recognized self addresses to include the inlink address ('?@?'). When a frame is transmitted by any member of the link using the inlink address, all members are thus addressed publicly and are to use the frame information. Thus, if a linked member sent an AMD message, all members would present that message to their user. If the member sent a frame terminated with a TWAS preamble, then all members would note that the transmitting station just 'left' the link. Short messages of 'to-F?@?, to-?@?, tis-TALKINGMEMBER' would act as a keep-alive function and cause the receiving radio to extend any link termination timer.	34

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
98	A.5.2.5	Frame structure. All ALE transmissions are based on the tones, timing, bit, and word structures described in paragraphs A.5.1 and A.5.2.3. All calls shall be composed of a "frame," which shall be constructed of contiguous redundant words in valid sequence(s) as described in figure A-14, as limited in table A-VII, and in formats as described in A.5.5. There are three basic frame sections: calling cycle, message, and conclusion. See A.5.2.5.5 for basic frame structure examples.	33

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
99	A.5.2.5.1	Calling cycle. The initial section of all frames (except sounds) is termed a calling cycle (T_{cc}), and it is divided into two parts: a scanning call (T_{sc}) and a leading call (T_{lc}). The scanning call shall be composed of TO words if an individual or net call (or THRU and REP words, alternating, if a group call), which contain only the first word(s) of the called station(s) or net address. The leading call shall be composed of TO (and possibly DATA and REP) words containing the whole address(es) for the called station(s), from initiation of the leading call until the start of the message section or the conclusion (thus the end of the calling cycle). See figure A-15. The use of REP and DATA is described in A.5.2.4. The set of different address first words (T_{cl}) may be repeated as necessary for scanning calling (T_{sc}), to exceed the scan period (T_s). There is no unique "flag word" or "sync word" for frame synchronization (as discussed below). Therefore, stations may acquire and begin to read an ALE signal at any point after the start. The transmitter shall have reached at least 90 percent of the selected RF power within 2.5 msec of the first tone transmission following call initiation. The end of the calling cycle may be indicated by the start of the optional quick-ID, which occupies the first words in the message section, after the leading call and before the start of the rest of the message (or conclusion, if no message) section. NOTE 1: The frame time may need to be delayed (equipment manufacturer dependent) to avoid loss of the leading words if the transmitter attack time is significantly long. Alternatively, the modem may transmit repeated duplicates of the scanning cycle (set of) first word(s) to be sent (not to be counted in the frame) as the transmitter rises to full power (and may even use the ALE signal momentarily instead of a tuning tone for the tuner), and then start the frame when the power is up. NOTE 2: The 2.5-msec permissible delay of the first ALE tone, after the transmitter has reached 90 percent of selected power, is in addition to the allowable attack time delay specified in 5.3.5.1. NOTE 3: Non-compliance with the 90 percent of power parameter will impact the probability of linking. Compliance testing for this can be construed to be met if the probability of linking criteria is met (see table A-I).	33

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
100	A.5.2.5.2	Message section. The second and optional section of all frames (except sounds) is termed a "message." Except for the quick-ID, it shall be composed of CMD (and possibly REP and DATA) words from the end of the calling cycle until the start of the conclusion (thus the end of the message). The optional quick-ID shall be composed of FROM (and possibly REP and DATA) word(s), containing the transmitter's whole address. It shall only be used once at the start of the CMD message section sequences. The quick-ID enables prompt transmitter identification and should be used if the message section length is a concern. It is never used without a following (CMD...) message(s). The message section shall always start with the first CMD (or FROM with later CMD(s)) in the call. See figure A-16. The use of REP and DATA is described in A.5.7.3. The message section is not repeated within the call (although messages or information itself, within the message section, may be). For AQC-ALE, the message section in AQC-ALE is available when in a link. The acknowledgement leg (third leg) of a call may be used as an inlink entry condition. See A.5.8.2.3.	33
101	A.5.2.5.3	Conclusion. The third section of all frames is termed a "conclusion." It shall be composed of either TIS or TWAS (but not both) (and possibly DATA and REP) words, from the end of the message (or calling cycle sections, if no message) until the end of the call. See figure A-17. Sounds and exception shall start immediately with TIS (or TWAS) words as described in A.5.3. REP shall not immediately follow TIS or TWAS. Both conclusions and sounds contain the whole address of the transmitting station.	33
102	A.5.2.5.4	Valid sequences. The eight ALE words types that have been described shall be used to construct frames and messages only as permitted in figures A-18, A-19, and A-20. The size and duration of ALE frames, and their parts, shall be limited as described in table A-XII.	33

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
103	A.5.2.6.1	Transmit word phase. The ALE transmit modulator accepts digital data from the encoder and provides modulated baseband audio to the transmitter. The signal modulation is strictly timed as described in A.5.1.3 and A.5.1.4. After the start of the first transmission by a station, the ALE transmit modulator shall maintain a constant phase relationship, within the specified timing accuracy, among all transmitted triple redundant words at all times until the final frame in the transmission is terminated. Specifically, $T_{(later\ triple\ redundant\ word)} - T_{(early\ triple\ redundant\ word)} = n \times T_{rw}$ where $T_{(\ )}$ is the event time of a given triple redundant word within any frame, T_{rw} is the period of three words (392 msec), and n is any integer. NOTE: Word phase tracking will only be implemented within a transmission and not between transmissions. The internal word phase reference of the transmit modulator shall be independent of the receiver (which tracks incoming signals) and shall be self-timed (within its required accuracy). See A.5.1.4. NOTE: In some applications, a single transmission may contain several frames.	33
104	A.5.2.6.2	Receiver word sync. The receive demodulator accepts baseband audio from the receiver; acquires, tracks, and demodulates ALE signals; and provides the recovered digital data to the decoders. See figure A-11. In data block message (DBM) mode, the receive demodulator shall also be capable of reading single data bits for deep deinterleaving and decoding.	40

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
105	A.5.3.1	Introduction. The sounding signal is a unilateral, one-way transmission performed at periodic intervals on unoccupied channels. To implement, a timer is added to the controller to periodically initiate sounding signals (if the channel is clear). Sounding is not an interactive, bilateral technique, such as polling. However, the identification of connectivity from a station by hearing its sounding signal does indicate a high probability (but not guarantee) of bilateral connectivity and it may be done passively at the receiver. Sounding uses the standard ALE signaling, any station can receive sounding signals. As a minimum, the signal (address) information shall be displayed to the operator and, for stations equipped with connectivity and LQA memories, the information shall be stored and used later for linking. If a station has had recent transmissions on any channels that are to be sounded on, it may not be necessary to sound on those channels again until the sounding interval, as restarted from those last transmissions, has elapsed. In addition, if a net (or group) of stations is polled, their responses shall serve as sounding signals for the other net (or group) receiving stations. All stations shall be capable of performing periodic sounding on clear prearranged channels. The sounding capability may be selectively activated by, and the period between sounds shall be adjustable by the operator or controller, according to system requirements. When available, and not otherwise committed or directed by the operator or controller, all ALE stations shall automatically and temporarily display the addresses of all stations heard, with an operator selectable alert. The structure of the sound is virtually identical to that of the basic call; however, the calling cycle is not needed and there is no message section. It is only necessary to send the conclusion (terminator) that identifies the transmitting station. See figure A-22. The type of word, either TIS or TWAS (but never both), indicates whether potential callers are encouraged or ignored, respectively. The minimum redundant sound time (T_{rs}) is equal to the standard one-word address leading call time (T_{lc})=784 msec. Described below are both single-channel and multiple-channel protocols, plus detailed timing and control information, for designing stations.	31, 36

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
106	A.5.3.2	Single channel. The fundamental capability to automatically sound on a channel shall be in accordance with the sounding protocol as shown in figure A-22. As an option, stations may employ this protocol for single-channel sounding, connectivity tracking, and the broadcast of their availability for calls and traffic. The basic protocol consists of only one part: the sound. The sound contains its own address ("TIS A"). If "A" is encouraging calls and receives one, "A" shall follow the sound with the optional handshake protocol described in A.5.3.4. If "A" plans to ignore calls, it shall use the TWAS, which advises "B" and the others not to attempt calls, and then "A" shall immediately return to normal "available." In some systems it is necessary for a multichannel station "A" to periodically sound to a single-channel network, usually to inform them that he is active and available on that channel, although scanning. Upon receipt of "A's" sound, "B" (see figure A-23) and the other stations shall display "A's" address as a received sound and, if they have an LQA and connectivity memory, they shall store the connectivity information.	36
107	A.5.3.3	Multiple channels. Sounding must be compatible with the scanning timing. All stations shall be capable of performing the scanning sounding protocols described herein, even if operating on a fixed frequency. See figures A-22, A-23, and A-24. These protocols establish and positively confirm unilateral connectivity between stations on any available mutually scanned channel, and they assist in establishment of links between stations waiting for contact. Stations shall employ these protocols for multichannel sounding, connectivity tracking, and the broadcast of their availability for calls and traffic. All timing considerations and computations for individual scanning calling shall apply to scanning sounding, including sounding cycle times and (optional) handshake times. NOTE: The scanning sound is identical to the single-channel sound except for the extension of the redundant sound time (T_{rs}) by adding words to the scan sounding time (T_{ss}) to form a scanning redundant sound time (T_{srs}); that is $T_{srs} = T_{ss} + T_{rs}$. The scan sounding time (T_{ss}) is identical in purpose to the scan calling time (T_{sc}) for an equivalent scanning situation, but it only uses the whole address of the transmitter.	36

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
107	A.5.3.3 (continued)	The channel-scanning sequences and selection criteria for individual scanning calling shall also apply to scanning sounding. The channels to be sounded are termed a "sound set," and usually are identical to the "scan set" used for scanning. See figure A-23. In this illustration, station "A" is sounding and station "B" is scanning normally. If a station "A" plans to ignore calls (from "B"), which may follow "A's" sound, the following call rejection scanning sounding protocol shall be used. In a manner identical to the previously described individual scanning call, "A" lands on the first channel in the scan set (1), waits (T_{wt}) to see if the channel is clear (3), tunes (T_t) its coupler, comes to full power, and initiates the frame of the scanning redundant sound times (T_{srs}). This scanning sound is computed to exceed "B's" (and any others) scan period (T_s) by at least a redundant sound time (T_{rs}), which will ensure an available detection period exceeding T_{drw} = 784 msec. In this five-channel example, with "B" scanning at 5 chps, "A" sounds for at least 12 T_{rw} (4704 msec). "A" also uses "TWAS A," redundantly to indicate that calls are not invited. Upon completion of the scanning sounding frame transmission, "A" immediately leaves the channel and goes to the next channel in the sound set. This procedure repeats until all channels have been sounded, or skipped if occupied. When the calling ALE station has exhausted all the prearranged sound set channels, it shall automatically return to the normal "available" receive scan mode. As shown in figure A-23, the timing of both "A" and "B" have been prearranged to ensure that "B" has at least one opportunity, on each channel, to arrive and "capture" "A's" sound. Specifically, "B" arrives, detects sounds, waits for good words, reads at least three (redundant) "TWAS A" (in 3 to 4 T_w), stores the connectivity information (if capable), and departs immediately to resume scan.	36

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
107	A.5.3.3 (continued)	There are several specific protocol differences when station "A" plans to welcome calls after the sound. See figure A-24. In this illustration, "A" is sounding and "B" is scanning normally. If station "A" plans to welcome calls (from "B"), which may follow his sound, the following call acceptance scanning sounding protocol shall be used. In this protocol, "A" sounds for the same time period as before. However, since "A" is receptive to calls, he shall use his normal scanning dwell time (T_d) or his preset wait before transmit time (T_{wt}), whichever is longer, to listen for both channel activity and calls before sounding. If the channel is clear, "A" shall initiate the scanning sound identically to before, but with "TIS A." At the end of the sounding frame, "A" shall wait for calls identically to the wait for reply and tune time (T_{wrt}) in the individual scanning calling protocol, in this case shown to be 6 T_w (for fast-tuning stations). During this wait, "A" shall (as always) be listening for calls that may coincidentally arrive even though unassociated with "A's" sound, plus any other sound heard, which "A" shall store as connectivity information if polling-capable. If no calls are received, "A" shall leave the channel.	36
108	A.5.4	Channel selection. Channel selection is based on the information stored within the LQA memory (such as BER, SINAD, and MP) and this information is used to speed connectivity and to optimize the choice of quality channels. When initiating scanning (multichannel) calling attempts, the sequence of channels to be tried shall be derived from information in the LQA memory with the channel(s) with the "best score(s)" being tried first (unless otherwise directed by the operator or controller) until all the LQA scored channels are tried. However, if LQA or other such information is unavailable (or it has been exhausted and other valid channels remain available and untried) the station shall continue calling on those channels until successful or until all the remaining (untried valid) channels have been tried.	31

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
109	A.5.4.1	LQA. LQA data shall be used to score the channels and to support selection of a "best" (or an acceptable) channel for calling and communication. LQA shall also be used for continual monitoring of the link(s) quality during communications that use ALE signaling. The stored values shall be available to be transmitted upon request, or as the network manager shall direct. Unless specifically and otherwise directed by the operator or controller, all ALE stations shall automatically insert the CMD LQA word (t) in the message section of their signals and handshakes when requested by the handshaking station(s), when prearranged in a network, or when specified by the protocol. See A.5.4.2. If an ALE station requires, and is capable of using LQA information (polling-capable), it may request the data from another station by setting the control bit KA1 to "1" in the CMD LQA word. If an ALE station, which is sending CMD LQA in response to a request is incapable of using such information itself (not polling-capable), it shall set the control bit KA1 to "0." It will be a network management decision to determine if the LQA is to be active or passive. For human factor considerations, LQA scores that may be presented to the operator should have higher (number) scores for better channels.	31

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
110	A.5.4.1.1	BER. Analysis of the BER on RF channels, with respect to poor channels and the 8-ary modulation, plus the design and use of both redundancy and Golay FEC, shows that a coarse estimate of BER may be obtained by counting the number of non-unanimous (2/3) votes (out of 48) in the majority vote decoder. The range of this measure is 0 through 48. Correspondence to actual BER values is shown in table A-XIII. After an ALE receiver achieves word synchronization (see A.5.2.6.2), all received words in a frame shall be measured, and a linear average BER/LQA shall be computed as follows: If the Golay decoder reports no uncorrectable errors in both halves of the ALE word, the number of non-unanimous votes detected in the word shall be added to the total. If at least one half of the ALE word contained uncorrectable errors, the number of non-unanimous votes detected shall be discarded, and 48 (the maximum value) shall be added to the total. At the end of the transmission, the total shall be divided by the number of words received, and the total shall be stored in the Link Quality Memory as the most current BER code for the station sending the measured transmission and the channel that carried it.	31
111	A.5.4.1.2	SINAD. The signal to noise and distortion measurement shall be a SINAD measurement ((S+N+D)/(N+D)) averaged over the duration of each received ALE signal. The SINAD values shall be measured on all ALE signals.	31
112	A.5.4.1.4	Operator display (optional). Display of SINAD values shall be in dB.	31

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
113	A.5.4.2	Current channel quality report (LQA CMD). This mandatory function is designed to support the exchange of current LQA information among ALE stations. The CMD LQA word shall be constructed as shown in table A-XIV The preamble shall be CMD (110) in bits P3 through P1 (W1 through W3). The first character shall be "a" (1100001) in bits C1-7 through C1-1 (W4 through W10), which shall identify the LQA function "analysis." It carries three types of analysis information (BER, SINAD, and MP) which are separately generated by the ALE analysis capability. Note that when the control bit KA1 (W11) is set to "1," the receiving station shall respond with an LQA report in the handshake. If KA1 is set to "0," the report is not required.	31
114	A.5.4.2.1	BER field in LQA CMD. Measurement and reporting of BER is mandatory. The BER field in the LQA CMD shall contain five bits of information, BE5 through BE1 (W20 through W24). Refer to table A-XIII for the assigned values.	31
115	A.5.4.2.2	SINAD. SINAD shall be reported in the CMD LQA word as follows. The SINAD is represented as five bits of information SN5 through SN1 (W15 through W19). The range is 0 to 30 dB in 1-dB steps. 00000 is 0 dB or less, and 11111 is no measurement.	31
116	A.5.4.2.3	MP. If implemented, MP measurements shall be reported in CMD LQA words in the three bits, MP3 through MP1 (W12 through W14). The measured value in msec shall be reported rounded to the nearest integer, except that values greater than 6 msec shall be reported as 6 (110). When MP is not measured, the reported MP value shall be 7 (111).	31

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
117	A.5.4.4	Local noise report CMD (optional). The Local Noise Report CMD provides a broadcast alternative to sounding that permits receiving stations to approximately predict the bilateral link quality for the channel carrying the report. An example application of this optional technique is networks in which most stations are silent but need to have a high probability of linking on the first attempt with a base station. A station receiving a Local Noise Report can compare the noise level at the transmitter to its own local noise level, and thereby estimate the bilateral link quality from its own LQA measurement of the received noise report transmission. The CMD reports the mean and maximum noise power measured on the channel in the past 60 minutes. The Local Noise Report CMD shall be formatted as shown in figure A-26. Units for the Max and Mean fields are dB relative to 0.1 µV 3 KHz noise. If the local noise measurement to be reported is 0 dB or less, a 0 is sent. For measured noise ratios of 0 dB to +126 dB, the ratio in dB is rounded to an integer and sent. For noise ratios greater than +126 dB, 126 is sent. The code 127 (all 1s) is sent when no report is available for a field. By comparing the noise levels reported by a distant station on several channels, the station receiving the noise reports can select a channel for linking attempts based upon knowledge of both the propagation characteristics and the interference situation at that destination.	31
118	A.5.4.5	Single-station channel selection. All stations shall be capable of selecting the (recent) best channel for calling or listening for a single station based on the values in the LQA memory.	31

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
119	A.5.4.6	Multiple-station channel selection. A station shall also be capable of selecting the (recent) best channel to call or listen for multiple stations, based on the values in the LQA memory. NOTE: In the example shown in figure A-27, if a multiple-station handshake is required with stations “B” and “C,” C5 is the best choice as the total score is 12 (2+5+3+2), followed by C4 (20) and C3 (35). Next would be C2 (34+) and C6 (36+), this ranking being due to their unknown handshake capability (which had not been tried). C1(x) is the last to be tried because recent handshake attempts had failed for both “B” and “C.” To call the three stations “A,” “B,” and “C,” the sequence would be C5 (24), C3 (38), C2 (46+), C6 (62+), C4 (one x) (recently failed attempt), and finally C1 (two x). If an additional selection factor is used, it will change the channel selection sequence. NOTE: In the example, to call “D” and “E,” the sequence would be C2, C3, C4, C5, C1, and C6. If a maximum limit of LQA $\leq$ 14 is imposed on any path (to achieve a minimum circuit quality), only C2 and C3 would be initially selected for the linking attempt. Further, if the LQA limit was “lowered” to 10, C3 would be selected before C2 for the linking attempt. If a broadcast to multiple stations is required, the TO section (“to” the station) scores are given priority. NOTE: In the example, to broadcast to “B” and “C,” the sequence would be C5(7), C4(9), C3(21), C2(7+), C6(12+), and C1(two x). To select channels for listening for multiple stations, the FROM section (“from” the station) scores are given priority. NOTE: In the example, to listen for “A” and “B,” channel C2 (2) would be best, and if only four channels could be scanned, they should be C2, C3, C4, and C5.	31

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
120	A.5.4.7	Listen before transmit. Before initiating a call or a sound on a channel, an ALE controller shall listen for a programmable time (T_{wt}) for other traffic, and shall not transmit on that channel if traffic is detected. Normally, a sound aborted due to detected traffic will be rescheduled, while for a call another channel shall be selected.	45
121	A.5.4.7.1	Listen-before-transmit duration. The duration of the listen-before-transmit pause shall be programmable by the network manager. When the selected channel is known to be used only for ALE transmissions, the listen-before-transmit delay need be no longer than 2 T_{rw}. For other channels, at least 2 seconds shall be used. When an ALE controller was already listening on the channel selected for a transmission, the time spent listening on the channel may be included in the listen-before-transmit time.	45
122	A.5.4.7.2	Modulations to be detected. The listen-before-transmit function shall detect traffic on a channel in accordance with A.4.2.2. This may be accomplished using any combination of internal signal detection and external devices that provide a channel busy signal to the ALE controller.	45
123	A.5.4.7.3	Listen before transmit override. The operator shall be able to override both the listen-before-transmit pause and the transmit lockout (for emergency use).	45
124	A.5.5	Link establishment protocols. An ALE controller shall control an attached HF SSB radio to support both manual and automatic link operation as described in the following paragraphs.	35
125	A.5.5.1	Manual operation. The ALE controller shall support emergency control by the operator. Each ALE controller shall provide a manual control capability to permit an operator to directly operate the basic SSB radio in emergency situations. At all other times, the radio shall be under automated control, and the operator should operate the radio through its associated controller. The ALE controller's receiving and passive collection capability to be "always listening," such as monitoring for sounding signals or alerting the operator, shall not be impaired. NOTE: This does not abrogate the manual push-to-talk operation required by 4.2.2.	35

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
126	A.5.5.2	ALE. The fundamental protocol exchange for link establishment shall be the three-way handshake (see appendix I for overview of Selective Calling). A three-way handshake is sufficient to establish a link between a calling station and a responding station. With the addition of slotted responses (described in A.5.5.4.2), the same call/response/acknowledgment sequence can also link a single calling station to multiple responding stations.	35
127	A.5.5.2.3	ALE channel selection. A scanning calling station shall send ALE calls on its scanned channels in the order dictated by its channel selection algorithm. It shall link on the first channel it tries that supports a handshake with the called station(s).	35
128	A.5.5.2.3.1	Rejected channel. If a channel is rejected after linking by the operator or controller as unsuitable, the ALE controller shall terminate the link in accordance with A.5.5.3.5 and shall update LQA data using measurements obtained during linking.	35
129	A.5.5.2.3.3	Exhausted channel list. If a calling station has exhausted all of its prearranged scan set channels and failed to establish a link, it shall immediately return to normal receive scanning (the available state). It shall also alert the operator (and networking controller if present) that the calling attempt was unsuccessful.	35
130	A.5.5.2.4	End of frame detection. ALE controllers shall identify the end of a received ALE signal by the following methods. The controller shall search for a valid conclusion (TIS or TWAS, possibly followed by DATA and REP for a maximum of five words, or $T_{x\ max}$). The conclusion must maintain constant redundant word phase within itself (if a sound) and with associated previous words. The controller shall examine each successive redundant word phase (T_{rw}) following the TIS (or TWAS) for the first (of up to four) non-readable or invalid word(s). Failure to detect a proper word (or detection of an improper word) or detection of the last REP, plus the last word wait delay time, (T_{lww} or T_{rw}), shall indicate the end of the received transmission. The maximal acceptable terminator sequence is TIS (or TWAS), DATA, REP, DATA, REP.	35

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
131	A.5.5.3	One-to-one calling. The protocol for establishing a link between two individual stations shall consist of three ALE frames: a call, a response, and an acknowledgment. The sequence of events, and the timeouts involved, are discussed in the following paragraphs using a calling station SAM and a called station JOE.	35

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
132	A.5.5.3.1	Sending an individual call. After selecting a channel for calling, the calling station (SAM) shall begin the protocol by first listening on the channel to avoid "disturbing active channels," and then tuning. If the called station (JOE) is known to be listening on the chosen channel (not scanning), the calling station shall transmit a single-channel call that contains only a leading call and a conclusion (see upper frame in figure A-29). Otherwise, it shall send a longer calling cycle that precedes the leading call with a scanning call of sufficient length to capture the called station's receiver as it scans (lower frame in figure A-29). The duration of this scanning call shall be 2 T_{rw} for each channel that the called station is scanning. The scanning call section shall contain only the first word of the called station address, using a TO preamble, and repeated as necessary until the end of the scanning call section. The entire called station address shall be used in the leading call section, and shall be sent twice (see figure A-29) using a TO preamble each time the first word is sent and DATA and REP as required for additional words. Any message section CMDs shall be sent immediately following the leading call, followed by a conclusion containing the complete calling station address ("TIS SAM"). The calling station shall then wait a preset reply time to start to receive the called station's response. In the single-channel case, the wait for reply time shall be T_{wr}, which includes anticipated round trip propagation delay and the called station's turnaround time. In the multi-channel case, the calling station shall wait through a wait for reply and tune time (T_{wrt}), which also includes time for the called station to tune up on the chosen channel. If the expected reply from the called station does not start to arrive within the preset wait for reply time (T_{wr}) or wait for reply and tune time (T_{wrt}), the linking attempt on this channel has failed. At this point, if other channels in the scan set have not been tried, the linking attempt will normally start over on a new channel. Otherwise, the ALE controller shall return to the available state, and the calling station's operator or networking controller shall be notified of the failed linking attempt.	35

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
133	A.5.5.3.2	Receiving an individual call. When the called station (JOE) arrives on channel, sometime during its scan period T_s, and therefore during the calling station SAM's longer scan calling time T_{sc}, the called station shall attempt to detect ALE signaling within its dwell time. If ALE signaling is detected, and the controller achieves word sync, it shall examine the received word to determine the appropriate action. If JOE reads "TO JOE" (or an acceptable equivalent according to protocols), the ALE controller shall stop scan, enter the linking state, and continue to read ALE words while waiting a preset, limited time T_{wce} for the calling cycle to end and the message or conclusion to begin. If the received word is potentially from a sound or some other protocol, the ALE controller shall process the word in accordance with that protocol. Otherwise, the ALE controller shall resume its previous state (e.g., available if it was scanning, linked if it was linked to another station). While reading a call in the linking state, the called station shall evaluate each new received word. The controller shall immediately abort the handshake and return to its previous state upon the occurrence of any of the following: It does not receive the start of a quick-ID, message, or frame conclusion within T_{wce}, or the start of a conclusion within T_{mmax} after the start of the message section; Any invalid sequence of ALE word preambles is received, except that during receipt of a scanning call, up to three contiguous words containing uncorrectable errors shall be tolerated without causing rejection of the frame; The end of the conclusion is not detected within T_{lww}, (plus the additional multiples of T_{rw} if an extended address) after the first word of the conclusion. If a quick-ID or a message section starts within T_{wce}, the called station, (JOE) shall attempt to read one or more complete messages within a new preset, limited time T_{mmax}. If a frame conclusion starts "TIS SAM," the called station shall wait and attempt to read the calling station's address (SAM) within a new preset, limited time T_{xmax}.	35

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
133	A.5.5.3.2 (continued)	If an acceptable conclusion sequence with TIS is read, the called station shall start a "last word wait" timeout $T_{lww} = T_{rw}$ while searching for additional address words (if any) and the end of the frame (absence of a detected word), which shall trigger its response. The called station will also expect the calling station to continue the handshake (with an acknowledgment) within the called station's reply window, T_{wr}, after its response. If TWAS is read instead, the called station shall not respond but shall return to its previous state immediately after reading the entire calling station address. If all of the above criteria for responding are satisfied, the called station shall initiate an ALE response immediately after detecting the end of the call, unless otherwise directed by the operator or controller.	35

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
134	A.5.5.3.3	Response. Upon receipt of a call that is addressed to one of its own self addresses (JOE), and which contains a valid calling station address in a TIS conclusion (SAM), the called station shall listen for other traffic on the channel. If the channel is not in use, the station shall tune up, send a response (figure A-30), and start its own reply timer T_{wr}. (The longer T_{wrt} timeout is not necessary unless the calling station will send its acknowledgment on a different channel than the one carrying the call, requiring re-tuning.) If the channel is in use, the ALE controller shall ignore the call and return to its previous state unless otherwise programmed. If the calling station (SAM) successfully reads the beginning of an appropriate response ("TO SAM") starting within its timeout (either T_{wr} or T_{wrt}), it shall process the rest of the frame in accordance with the checks and timeouts described above for the call until it either aborts the handshake or receives the appropriate conclusion, which in this example is "TIS JOE." Specifically, the calling station shall immediately abort the handshake upon the occurrence of any of the following: It does not receive an appropriate response calling cycle ("TO SAM") starting within the timeout; An invalid sequence of ALE word preambles occurs; It does not receive the appropriate conclusion ("TIS JOE") starting within T_{lc} (plus $T_{m\ max}$, if message included); The end of the conclusion is not detected within T_{lww}, (plus the additional multiples of T_{rw} if an extended address). After aborting a handshake for any of the above reasons, the calling station will normally restart the calling protocol, usually on another channel. If the calling station receives the proper conclusion from the called station ("TIS JOE") starting within T_{lc} (plus $T_{m\ max}$, if message included), it shall set a last word wait timeout as above and prepare to send an acknowledgment. If, instead, "TWAS JOE" is received, the called station has rejected the linking attempt, the calling station ALE controller shall abort the linking attempt and inform the operator of the rejected attempt.	35

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
135	A.5.5.3.4	Acknowledgment. If all of the above criteria for an acceptable response are satisfied, and if not otherwise directed by the operator or networking controller, the calling station ALE controller shall alert its operator that a correct response has been received, send an ALE acknowledgment (see figure A-31), enter the linked state with the called station (JOE), and unmute the speaker. A "wait for activity" timer T_{wa} shall be started (with a typical timeout of 30 seconds) that shall cause the link to be dropped if the link remains unused for extended periods (see A.5.5.3.5). If the called station (JOE) successfully reads the beginning of an appropriate acknowledgment ("TO JOE") starting within its T_{wr} timeout, it shall process the rest of the frame in accordance with the checks and timeouts described above for the response until it either aborts the handshake or receives the appropriate conclusion, which in this example is "TIS SAM" or "TWAS SAM." Specifically, the calling station shall immediately abort the handshake upon the occurrence of any of the following: It does not receive an appropriate response calling cycle ("TO JOE") starting within its T_{wr} timeout; An invalid sequence of ALE word preambles occurs; It does not receive the appropriate conclusion starting within T_{lc} after the start of the frame (plus $T_{m\ max}$, if message included); The end of the conclusion is not detected within T_{lww}, (plus the additional multiples of T_{rw} if an extended address). If the handshake is aborted for any of the above reasons, the handshake has failed, and the called station ALE controller shall return to its pre-linking state. The called station shall notify the operator or controller of the failed linking attempt. Otherwise, the called station shall enter the linked state with the calling station ("SAM"), alert the operator (and network controller if present), unmute the speaker, and set a wait-for-activity timeout T_{wa} between 9 and 14 seconds.	35

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
135	A.5.5.3.4 (continued)	NOTE 1: Although SAM's acknowledgment to JOE appears identical to a single-channel individual call from SAM to JOE, it does not cause JOE to provide another response to the acknowledgment (resulting in an endless "ping-pong" handshake) because SAM's acknowledgment arrives within a narrow time window (T_{wr}) after JOE's response, and an acknowledge (ACK) from SAM is expected within this window. If SAM's acknowledgment arrives late (after T_{wr}), however, then JOE must treat it as a new individual call (and shall therefore send a new response, if SAM concludes the frame with TIS). NOTE 2: A typical one-to-one scanning call three-way handshake takes	35
136	A.5.5.3.5	Link termination. Termination of a link after a successful linking handshake shall be accomplished by sending a frame concluded with TWAS to any linked station(s) which is (are) to be terminated. For example, "TO JOE, TO JOE, TWAS SAM" (when sent by SAM) shall terminate the link between stations SAM and JOE. JOE shall immediately mute and return to the available state, unless it still retains a link with any other stations on the channel. Likewise, SAM shall also immediately mute and return to the available state, unless it retains a link with any other stations on the channel.	35
137	A.5.5.3.5.1	Manual termination. A means shall be provided for operators to manually reset a station, which shall mute the speaker(s), return the ALE controller to the available state, and send a link terminating (TWAS) transmission, as specified above, to all linked stations, unless this latter feature is overridden by the operator. (DO: provide a manual disconnect feature that drops individual links while leaving others in place.)	35

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
138	A.5.5.3.5.2	Automatic termination. If no voice, data, or control traffic is sent or received by a station within a preset time limit for activity (T_{wa}), the ALE controller shall automatically mute the speaker, terminate the linked state with any linked stations, and return to the available state. The wait for the activity timer is mandatory, but shall also be capable of being disabled by the operator or network manager. This timed reset is not required to cause a termination (TWAS) transmission, as specified above. However, it is recommended that a termination be sent to reset the other linked stations(s) to immediately return them to the available state. Termination during a handshake or protocol by the use of TWAS (or a timer) should cause the receiving (or timed-out) station to end the handshake or protocol, terminate the link with that station, re-mute, and immediately return to the available state unless it still retains a link with another station.	35
139	A.5.5.3.6	Collision detection. While receiving an ALE signal, it is possible for the continuity of the received signal to be lost (due to such factors as interference or fading) as indicated by failure to detect a good ALE word at a T_{rw} boundary. When one or both Golay words of a received ALE word contain uncorrectable errors, the ALE controller shall attempt to regain word sync, with a bias in favor of words that arrive with the same word phase as the interrupted frame. If word sync is reacquired but at a new word phase, this indicates that a collision has occurred. The interrupted frame shall be discarded, and the interrupting signal processed as a new ALE frame. NOTE: Stations should be able to read interfering ALE signals, as they may contain useful (or critical) information, for which the station is "always listening."	34

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
140	A.5.5.4.1	Slotted responses. The simple three-way handshake used for individual links cannot be used for one-to-many calling because the responses from the called stations would collide with each other. Instead, a time-division multiple access (TDMA) scheme is used. Each responding station shall send its response in an assigned or computed time slot as described later for the particular one-to-many protocol. At the end of a one-to-many call frame, the following events shall take place: The calling station shall set a wait-for-response-and-tune timeout (WRTT) that shall trigger its acknowledgment after the last response slot time has expired. The time allowed is denoted T_{wrn}. The value of T_{wrn} is described later for each one-to-many protocol. The called stations shall set their own WRTTs that bound their waiting times for an acknowledgment. To allow time for acquiring word sync during the leading call of the acknowledgment, the waiting time shall be set to $T_{wan} = T_{wrn} + 2\ T_{rw}$. Each called station shall also set a slot wait timeout T_{swt} that shall trigger its response. The called stations shall tune as required during the slot immediately following the end of the call frame, called slot 0. As each station's slot wait timer expires, it shall send its response and continue to await the expiration of its WRTT. Should that timer expire before the start of an acknowledgment from the calling station, the called station shall abort the linking attempt, and return to its pre-linking state.	37
141	A.5.5.4.1.1	Slotted response frames. Slotted response frames shall be formatted identically to responses in the one-to-one calling protocol (see figure A-32), including a leading call, an optional message section, and a frame conclusion. A responding station shall conclude its response with TIS to accept the call, or TWAS to reject it. When the calling and responding addresses are one-word (as shown), slots are each 14 T_w, or about 1.8 seconds.	37

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
142	A.5.5.4.1.2	Slot widths. Unless otherwise specified, all slots shall be 14 T_w in duration, which allows response frames with single-word addresses to propagate to and from the other side of the globe and use commonly available HF transceivers and tuners. When any slot is extended, all following slots shall be delayed commensurately. When the calling station address is longer than one word, every slot shall be extended by two T_{rw} (six T_w) per additional address word. When a called station address is longer than one word, its slot shall be extended by one T_{rw} (three T_w) per additional address word. Slots shall be extended by one T_{rw} (three T_w) for each ALE word to be sent in the message section of responses (including LQA CMD).	37
143	A.5.5.4.2.1	Star net call. A star net call is identical to a one-to-one call, except that the called station address is a net address, as shown in figure A-34. The calling station address shall be an individual station address (not a net or other collective address).	37
144	A.5.5.4.2.2	Star net response. When an ALE controller receives a call that is addressed to a net address that appears in its self address memory (see A.4.3.2), it shall process the call using the same checks and timeouts as an individual call (see A.5.5.3.2). If the call is acceptable, it shall respond in accordance with A.5.5.4.1 using its assigned net member address and slot number for the net address that was called.	37
145	A.5.5.4.2.3	Star net acknowledgment. A star net acknowledgment is identical to a one-to-one acknowledgment, except that the called station address is a net address. An ALE controller that has responded to a net call shall process the acknowledgment from the calling station in accordance with A.5.5.3.4, except that the wait-for-response timeout value shall be the T_{wan} timeout from A.5.5.4.1.3. A TWAS acknowledgment from the calling station shall return the called ALE controller to its pre-linking state. If a TIS acknowledgment is received from the calling station, the called ALE controller shall enter the linked state with the calling station (SAM in this example), alert the operator (and network controller if present), unmute the speaker, and set a wait-for-activity timeout T_{wa}.	37

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
146	A.5.5.4.3.1	Star group scanning call. A group address is produced by combining individual addresses of the stations that are to form the group. During a scanning call, only the first word(s) of addresses shall be sent, just as for individual or net calls. The set of unique first address words for the group members shall be sent repeatedly in rotation until the end of T_{sc}. These address words shall alternate between THRU and REP preambles (see figure A-35 for a sample group consisting of BOB, EDGAR, and SAM). When group member addresses share a common first word, that word shall be sent only once during T_{sc}. A limit of five unique first words may be sent in rotation during T_{sc}.	37
147	A.5.5.4.3.2	Star group leading call. During T_{lc}, the complete addresses of the prospective group members shall be sent, using TO preambles as usual. Up to 12 address words total are allowed for the full addresses of group members, so T_{lc} in a group call may last up to 24 T_{rw}. Note in figure A-34 that when a TO word would follow another TO word, a REP preamble must be used, but when a TO follows any other word it shall remain a TO.	37
148	A.5.5.4.3.3	Star group call conclusion. The optional message section and the conclusion of a star group call shall be in accordance with A.5.2.5.	37

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
149	A.5.5.4.3.4	Receiving a star group call. Slots shall be derived for group call responses by noting the order in which individual addresses appear in the call. a. When an ALE controller pauses on a channel carrying a group scanning call, it will read either a THRU or a REP preamble. If the address word in this first received word matches the first word of one of its individual addresses, the ALE controller shall stay to read the leading call. Otherwise, it shall continue to read first address words until it finds: a match with the first word of a self address, or a repetition of a word it has already seen, or five unique words. (In the latter two cases, the station is not being called and the ALE controller shall return to the available or linked state as appropriate.) b. When T_{lc} starts, an ALE controller potentially addressed in the scanning call shall watch for its complete address. If found, a slot counter shall be set to 1 and incremented for each address that follows it. If that address is found again (as it should be, because the address list is repeated in T_{lc}), the counter shall be then reset to 1, and incremented for each following address as before. The number of words in each following address shall also be noted for use in computing T_{swt}. c. The message section (if any) and the frame conclusion shall processed in accordance with A.5.5.3.2. In the event that an addressed ALE controller arrives on channel too late to identify the size of the called group, it will be unable to compute the correct T_{wan}. In this situation, it shall use a default value for T_{wan}, which is equal to the longest possible group call of twelve one-word addresses. It will, however, have computed its correct slot number because to have received its own address it must also have received the addresses that followed that self address in the leading call.	37

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
150	A.5.5.4.3.5	Star group slotted responses. Slotted responses shall be sent and checked in accordance with A.5.5.4.1, using the derived slot numbers and the self address contained in the leading call.	37
151	A.5.5.4.3.6	Star group acknowledgment. The acknowledgment in a group call handshake shall be addressed to any subset of the members originally called, and is usually limited to those whose responses were heard by the calling station. The leading call of the acknowledgment shall include the full addresses of the stations addressed, sent twice, using the same syntax as in the call (A.5.5.4.3.2). An ALE controller that responded to a group call shall await acknowledgment and process an incoming acknowledgment in accordance with A.5.5.3.4, with the following exceptions: The wait-for-response timeout value shall be the T_{wan} timeout from A.5.5.4.1.3, not T_{wr}. Self address detection shall search through the entire leading call group address. An ALE controller that responded but was not named in the acknowledgment shall return to its pre-linking state. An ALE controller that is addressed in the acknowledgment shall proceed as follows: A TWAS acknowledgment from the calling station shall return the called ALE controller to its pre-linking state. If a TIS acknowledgment is received from the calling station, the called ALE controller shall enter the linked state with the calling station (SAM in this example), alert the operator (and network controller if present), unmute the speaker, and set a wait-for-activity timeout T_{wa}.	37
152	A.5.5.4.3.7	Star group call example. In the example group call in figure A-35, SAMUEL will respond in slot 1, with T_{swt} = 14 T_w (the one-word address JOE causes slot 0 to be 14 T_w). EDGAR will respond in slot 2, with T_{swt} = 14 + 17 T_w = 31 T_w (slot 1 is 17 T_w because of SAMUEL's two-word address). BOB will respond in slot 3, with T_{swt} = 48 T_w. JOE will send an acknowledgment after 62 T_w.	37

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
153	A.5.5.4.3.8	Multiple self addresses in group call. If a station is addressed multiple times in a group call, even by different addresses, it shall properly respond to at least one address. NOTE: The fact that the called station has multiple addresses may not be known to the caller. In some cases, it would be confusing or inappropriate to respond to one but not another address. Redundant calling address conflicts can be resolved after successful linking, if there is a problem.	37
154	A.5.5.4.4	Allcall protocol. An AllCall requests all stations hearing it to stop and listen, but not respond. The AllCall special address structure(s) (see A.5.2.4.7) shall be the exclusive member(s) of the scanning call and the leading call, and shall not be used in any other address field or any other part of the handshake. The global AllCall address shall appear only in TO words. Selective AllCalls with more than one selective AllCall address, however, shall be sent using group addressing, using THRU during the scanning call and TO during the leading call. An AllCall pertains to an ALE controller when it is a global AllCall, or when a selective AllCall specifies a character that matches the last character of any self address assigned to that station. Upon receipt of a pertinent AllCall, an ALE controller shall temporarily stop scanning and listen for a preset limited time, $T_{cc\ max}$. If a message section or frame conclusion does not arrive within $T_{cc\ max}$, the controller shall automatically resume scanning. If a quick-ID (an address beginning with a FROM word immediately after the calling cycle) arrives, the pause for the message section shall be extended for no more than five words (5 T_{rw}), and if a CMD does not arrive, the controller shall resume scanning. If a message arrives (indicated by receipt of a CMD), the controller shall pause for a preset limited time, $T_{m\ max}$ to read the message. If the frame conclusion does not arrive within $T_{m\ max}$, the controller shall automatically resume scanning. If a conclusion arrives (indicated by receipt of a TIS or TWAS), the controller shall pause (for a preset limited time, $T_{x\ max}$) to read the caller's address. If the end of the signal does not arrive within $T_{x\ max}$, the controller shall automatically resume scanning.	35

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
154	A.5.5.4.4 (continued)	If a pertinent AllCall frame is successfully received and is concluded with a TIS, the controller shall enter the linked state, alert the operator, unmute its speaker and start a wait-for-activity timeout. If an AllCall is successfully received with a TWAS conclusion, the called controller shall automatically resume scanning and not respond (unless otherwise directed by the operator or controller). If a station receiving an AllCall desires to attempt to link with the calling station, the operator may initiate a handshake within the pause after a TIS conclusion. Note that in all handshakes (the initial AllCall does not constitute a handshake), the AllCall address shall not be used. To minimize possible adverse effects resulting from overuse or abuse of AllCalls, controllers shall have the capability to ignore AllCalls. Normally AllCall processing should be enabled.	35

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
155	A.5.5.4.5	AnyCall protocol. An AnyCall is similar to an AllCall, but it instead requests responses. Use of the AnyCall special address structures is identical to that for the AllCall special address structures. Upon receipt of a pertinent AnyCall, an ALE controller shall temporarily stop scanning and examine the call identically to the procedure for AllCalls, including the $T_{cc\ max}$, $T_{m\ max}$, and $T_{x\ max}$ limits. If the AnyCall is successfully received, and is concluded with TIS, the controller shall enter the linking state and automatically generate a slotted response in accordance with A.5.5.4.1 and the following special procedure: Because neither preprogrammed nor derived slot data are available, the controller shall randomly select a slot number, 1 through 16. Each slot shall be 20 T_w (2613.33...msec) wide, unless the calling station requests LQA responses, in which case the slots shall expand by 3 T_w to 23 T_w to accommodate the CMD LQA message section. The controller shall compute values for T_{swt} and T_{wan} using this slot width and its random slot number. Slot 0 shall be used for tuning, as usual for slotted response protocols. Upon expiration of its T_{swt} timeout, the controller shall send a standard star net response consisting of TO (with the address of the caller) and TIS (with the address of the responder), with the LQA CMD included if requested. Responders shall use a self address no longer than five words minus twice the caller address length. (For example, if the caller address is two words, the responder shall use a one-word address.) The AnyCall special address shall not be sent. In this protocol, collisions are expected and tolerated. The station sending the AnyCall shall attempt to read the best response in each slot. Upon receipt of the slotted responses, the calling station shall transmit an ACK to any subset of stations whose responses were read, using an individual or group address. The AnyCall special address shall not be used in the acknowledgment. The caller selects the conclusion of its ACK to either maintain the link for additional interoperation and traffic with the responders (TIS), or return everyone to scan (TWAS), as appropriate to the caller's original purpose.	35

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
155	A.5.5.4.5 (continued)	An ALE controller that responded to an AnyCall shall await and process the acknowledgment in accordance with A.5.5.4.3.6. To minimize possible adverse effects resulting from overuse or abuse of AnyCalls, controllers shall have the capability to ignore AnyCalls. Normally AnyCall processing should be enabled.	35
156	A.5.5.4.6	Wildcard calling protocol. Wildcard addresses shall be the exclusive members of a calling cycle in a call, and shall not be used in any other address sequence in the ALE frame or handshake. The span (number of cases possible) of the wildcard(s) used should be minimized to only the essential needs of the user(s). Calls to wildcard addresses that conclude with TWAS shall be processed identically to the AllCall protocol. Responses to wildcard calls that conclude with TIS shall be sent in pseudorandomly-selected slots in accordance with the AnyCall protocol. As in both the AllCall and AnyCall, the controller shall be programmable to ignore wildcard calls, but wildcard call processing should normally be enabled.	35

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
157	A.5.6.1	CRC. This special error-checking function is available to provide data integrity assurance for any form of message in an ALE call. NOTE: The CRC function is optional, but mandatory when used with the DTM or DBM modes. The 16-bit frame check sequence (FCS) and method as specified by FED-STD 1003 shall be used herein. The FCS provides a probability of undetected error of 2^{-16}, independent of the number of bits checked. The generator polynomial is $X^{16} + X^{12} + X^5 + 1$ and the sixteen FCS bits are designated (MSB) $X^{15}, X^{14}, X^{13}, X^{12} \ldots X^1, X^0$ (LSB) The ALE CRC is employed two ways: within the DTM data words, and following the DBM data field, described in paragraphs A.5.7.3 and A.5.7.4, respectively. The first, and the standard, usages are described in this section. The CMD CRC word shall be constructed as shown in table A-XVII. The preamble shall be CMD (110) in bits P3 through P1 (W1 through W3). The first character shall be "x" (1111000), "y" (1111001), "z" (1111010), or "{" (1111011) in bits C1-7 through C1-1 (W4 through W10). Note that four identifying characters result from FCS bits X^{15} and X^{14} which occupy C1-2 and C1-1 (W9 and W10) in the first character field respectively. The conversion of FCS bits to and from ALE CRC format bits shall be as described in table A-XVII where X^{15} through X^0 correspond to W9 through W24.	41

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
157	A.5.6.1 (continued)	The CMD CRC message should normally appear at the end of the message section of a transmission, but it may be inserted within the message section (but not within the message being checked) any number of times for any number of separately checked messages, and at any point except the first word (except as noted below). The CRC analysis shall be performed on all ALE words in the message section that precede the CMD CRC word bearing the FCS information, and which are bounded by the end of the calling cycle, or the previous CMD CRC word, whichever is closest. The selected ALE words shall be analyzed in their non-redundant and unencoded (or FEC decoded) basic ALE word (24-bit) form in the bit sequence (MSB) W1, W2, W3, W4...W24 (LSB), followed by the unencoded bits W1 through W24 from the next word sent (or received), followed by the bits of the next word, until the first CMD CRC is inserted (or found). Therefore, each CMD CRC inserted and sent in the message section ensures the data integrity of all the bits in the previous checked ALE words, including their preambles. If it is necessary to check the ALE words in the calling cycle (TO) preceding the message section, an optional calling cycle CMD CRC shall be used as the calling cycle terminator (first FROM or CMD), shall therefore appear first in the message section, and shall analyze the calling cycle words in their simplest (T_c), nonredundant and nonrotated form. If it is necessary to check the words in a conclusion (TIS or TWAS), an optional conclusion CRC shall directly precede the conclusion portion of the call, shall be at the end of the message section, and shall itself be directly preceded by a separate CMD CRC (which may be used to check the message section or calling cycle, as described herein). Stations shall perform CRC analysis on all received ALE transmissions and shall be prepared to compare analytical FCS values with any CMD CRC words which may be received. If a CRC FCS comparison fails, an ARC (or operator initiated) or other appropriate procedure may be used to correct the message.	41

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
158	A.5.6.2	Power control (optional). The power control orderwire function is used to advise parties to a link that they should raise or lower their RF power for optimum system performance. The power control CMD word format shall be as shown in figure A-36. The KP control bits shall be used as shown in table XVIII. The procedure shall be: a. When KP_3 is set to 1, the power control command is a request to adjust the power from the transmitter. If KP_2 is 1, the adjustment is relative to the current operating power, i.e., to raise (KP_1 = 1) or lower (KP_1 = 0) power by the number of dB indicated in the relative power field. If KP_2 is 0, the requested power is specified as an absolute power in dBW. b. When KP_3 is set to 0, the power control command reports the current power output of the transmitter, in dB relative to nominal power if KP_2 is 1, or in absolute dBW if KP_2 is 0. c. KP_1 shall be set to 0 whenever KP_2 is 0. d. Normally, a station receiving a power control request (KP_3 = 1) should approximate the requested effect as closely as possible, and respond with a power report (KP_3 = 0) indicating the result of its power adjustment.	44
159	A.5.6.3.1	Channel designation. When two or more stations need to explicitly refer to channels or frequencies other than the one(s) in use for a link, the following encodings shall be used. A frequency is designated using binary-coded-decimal (BCD). The standard frequency designator is a five-digit string (20 bits), in which the first digit is the 10-megahertz (MHz) digit, followed by 1-MHz, 100-kilohertz (kHz), 10-kHz, and 1-kHz digits. A frequency designator is normally used to indicate an absolute frequency. When a bit in the command associated with a frequency designator indicates that a frequency offset is specified instead, the command shall also contain a bit to select either a positive or a negative frequency offset.	44

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
160	A.5.6.3.2	Frequency designation. A channel differs from a frequency in that a channel is a logical entity that implies not only a frequency (or two frequencies for a full-duplex channel), but also various operating mode characteristics, as defined in A.4.3.1. As in the case of frequency designators, channels may be specified either absolutely or relatively. In either case, a 7-bit binary integer shall be used that is interpreted as an unsigned integer in the range 0 through 127. Bits in the associated command shall indicate whether the channel designator represents an absolute channel number, a positive offset, or a negative offset. a. The frequency select CMD word shall be formatted as shown in figure A-37. A frequency designator (in accordance with A.5.6.3.1) is sent in a DATA word immediately following the frequency select CMD; bit W4 of this DATA word shall be set to 0, as shown. b. The 100-Hz and 10-Hz fields in the frequency select CMD word contain BCD digits that extend the precision of the standard frequency designator. These digits shall be set to 0 except when it is necessary to specify a frequency that is not an even multiple of 1 kHz (e.g., when many narrowband modem channels are allocated within a 3-kHz voice channel). c. The control field shall be set to 000000 to specify a frequency absolutely, to 100000 to specify a positive offset, or to 110000 to specify a negative offset. d. A station receiving a frequency select CMD word shall make whatever response is required by an active protocol on the indicated frequency.	44

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
161	A.5.6.3.3	Full-duplex independent link establishment (optional). Full duplex independent link establishment is an optional feature; however, if this option is selected the transmit and receive frequencies for use on a link shall be negotiated independently as follows: a. The caller shall select a frequency believed to be propagating to the distant station (the prospective responder) and places a call on that frequency. The caller embeds a frequency select CMD word in the call to ask the responder to respond on a frequency chosen for good responder-to-caller propagation (probably from sounding data in the caller's LQA matrix). b. If the responder hears the call, it shall respond on the second frequency, asking the caller to switch to a better caller-to-responder frequency by embedding a frequency select CMD word in its response (also based upon sounding data). c. The caller shall send an acknowledgment on the frequency chosen by the responder (the original frequency by default), and the full duplex independent link is established.	44

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
162	A.5.6.4.1	Tune and wait. The CMD tune and wait special control function directs the receiving station(s) to perform the initial parts of the handshake, up through tune-up, and wait on channel for further instructions during the specified time limit. The time limit timer is essentially the WRTT as used in net slotted responses where its value T_{wrn} is set by the timing information in the special control instruction, and it starts from the detected end of the call. The CMD tune and wait instruction shall suppress any normal or preset responses. Except for the tune-up itself, the receiving station(s) shall make no additional emissions, and they shall quit the channel and resume scan if no further instructions are received. NOTE: This special control function enables very slow tuning stations, or stations that must wait for manual operator interaction, to effectively interface with automated networks. The CMD tune and wait shall be constructed as follows and as shown in table A-XIX. The preamble shall be CMD (110) in bits P3 through P1 (W1 through W3). The first character (C1) shall be "t" (1110100) in bits C1-7 through C1-1 (W4 through W10) and "t" (1110100) in bits C2-7 through C2-1 (W11 through W17), for "time, tune-up." The "T" time bits TB7 through TB1 (W18 through W24) shall be values selected from table A-XX, and limited as shown in table A-XXI. The lowest value (00000) shall cause the tuning to be performed immediately, with zero waiting time, resulting in immediate return to normal scan after tuning.	42

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
163	A.5.6.4.2	Scheduling commands. These special control functions permit the manipulation of timing in the ALE system. They are based on the standard "T" time values, presented in table A-XX, which have the following ranges based on exact multiples of T_w (130.66...msec) or T_{rw} (392 msec). 0 to 4 seconds in 1/8 second (T_w) increments 0 to 36 seconds in 1 second (3 T_{rw}) increments 0 to 31 minutes in 1 minute (153 T_{rw}) increments 0 to 29 hours in 1 hour (9184 T_{rw}) increments There are several specific functions that utilize these special timing controls. All shall use the CMD (110) preamble in bits P3 through P1 (W1 through W3). The first character is "t" (1110100) for "time." The second character indicates the function as shown in table A-XXI. The basic structure is the same as in table A-XIX.	42
164	A.5.6.4.3.1	Command words. Time exchange command words Time Is and Time Request that are used to request and to provide time of day (TOD) data, shall be formatted as shown in figure A-38. The three most-significant bits (W1-3) shall contain the standard CMD preamble (110). The next seven bits (W4-10) shall contain the ASCII character '~'(1111110), indicating the magnitude of time uncertainty at the sending station in accordance with A.5.6.4.6.	42
165	A.5.6.4.3.2	Time Is command. The Time Is command word carries the fine time current at the sending station as of the start of transmission of the word following the Time Is command word, and is used in protected time requests and all responses. In a Time Is command word, the seconds field shall be set to the current number of seconds elapsed in the current minute intervals which have elapsed in the current second (0-24). The time quality shall reflect the sum of the uncertainty of the local time and the uncertainty of the time of transmission of the Time Is command, in accordance with table A-XXII and A.5.6.4.6. When a protocol requires transmission of the Time Is command word, but no time value is available, a NULL Time Is command word shall be sent, containing a time quality of 7 and the seconds and ticks fields both set to all 1s.	42

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
166	A.5.6.4.3.3	Time Request command. The Time Request command word shall be used to request time when no local time value is available, and is used only in non-protected transmissions. In a Time Request command word, time quality shall be set to 7, the seconds field to all 1s, and the ticks field set to 30 (11110).	42
167	A.5.6.4.3.4	Other encodings. All encodings of the seconds and ticks fields not specified here are reserved, and shall not be used until standardized.	42
168	A.5.6.4.4	Coarse time word. Coarse time words shall be formatted as shown in figure A-39, and shall contain the coarse time current as of the beginning of that word.	42
169	A.5.6.4.5	Authentication word. Authentication words, formatted as shown in figure A-39, shall be used to authenticate the times exchanged using the time protocols. The 21-bit authenticator shall be generated by the sender as follows: a. All 24-bit words in the time exchange message preceding the authentication word (starting with the Time Is or Time Request command word which begins the message) shall be exclusive-or'd. b. If the message to be authenticated is in response to a previous time exchange message, the authenticator from that message shall be exclusive-or'd with the result of (1). c. The 21 least significant bits of the final result shall be used as the authenticator.	42

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
170	A.5.6.4.6	Time quality. Every time exchange command word transmitted shall report the current uncertainty in TOD at the sending station, whether or not time is transmitted in the command word. The codes listed in table A-XXII shall be employed for this purpose. The time uncertainty windows on the table are upper bounds on total uncertainty (with respect to coordinated universal time). For example, an uncertainty of ±6 seconds is 12 seconds total and requires a transmitted time quality value of 6. Stations shall power up from a cold start with a time quality of 7. Time uncertainty is initialized when time is entered (see B.5.2.2.1) and shall be maintained thereafter as follows: a. The uncertainty increases at a rate set by oscillator stability (e.g., 72 msec per hour with a ±10 parts per million (ppm) time base). b. Until the uncertainty is reduced upon the acceptance of time with less uncertainty from an external source after which the uncertainty resumes increasing at the above rate. A station accepting time from another station shall add its own uncertainty due to processing and propagation delays to determine its new internal time uncertainty. For example, if a station receives time of quality 2, it adds to the received uncertainty of 100 msec (±50 msec) its own processing delay uncertainty of, say ±100 msec, and a propagation delay bound of ±35 msec, to obtain a new time uncertainty of ±185 msec, or 370 msec total, for a time quality of 3. With a ±10 ppm time source, this uncertainty window would grow by 72 msec per hour, so after two hours, the uncertainty becomes 514 msec, and the time quality has dropped to 4. If a low-power clock is used to maintain time while the rest of the unit is powered off, the quality of this clock shall be used to assign time quality upon resumption of normal operation. For example, if the backup clock maintains an accuracy of ±100 ppm under the conditions expected while the station is powered off, the time uncertainty window shall be increased by 17 seconds per day. Therefore, such a radio, which has been powered-off for much over three days, shall not be presumed to retain even coarse sync, despite its backup clock, and may require manual entry of time.	42

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
171	A.5.6.5	Mode control functions (optional). If any of these features are selected, however, they shall be implemented in accordance with this standard. Many of the advanced features of an ALE controller are "modal" in the sense that when a particular option setting is selected, that selection remains in effect until changed or reset by some protocol event. The mode control CMD is used to select many of these operating modes, as described in the following paragraphs. The CMD word shall be formatted as shown in figure A-40. The first character shall be 'm' to identify the mode control command; the second character identifies the type of mode selection being made; the remaining bits specify the new setting for that mode.	44
172	A.5.6.5.1	Modem negotiation and handoff. An ALE data link can be used to negotiate a modem to be used for data traffic by exchanging modem negotiation messages. A modem negotiation message shall contain one modem selection command. NOTE: This function may best be implemented in a high frequency node controller (HFNC) to avoid retrofit to existing ALE controllers, and for the greater flexibility inherent in network management information bases.	44
173	A.5.6.5.1.1	Modem selection CMD. The modem selection CMD word shall be formatted as shown in figure A-41, and may be followed by one or more DATA words, as described below. The defined modem codes are listed in table A-XXIII. Codes not defined are reserved, and shall not be used until standardized.	44

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
174	A.5.6.5.1.2	Modem negotiating. Modem negotiating shall employ modem negotiation messages in the following protocol: a. The station initiating the negotiation will send a modem selection CMD word containing the code of the modem it wants to use. b. The responding station(s) may either accept this modem selection or suggest alternatives. A station accepting a suggested modem shall send a modem selection CMD word containing the code of that modem. c. A station may negotiate by sending a modem selection CMD word containing all 1s in the modem code field, followed by one or more DATA words containing the codes of one or more suggested modems. Modem codes shall be listed in order of preference in the DATA word(s). Unused positions in the DATA word(s) shall be filled with the all 1s code. d. The negotiation is concluded when the most recent modem negotiation message from all participating stations contains an identical modem selection CMD word with the same modem code (not all 1s). When this occurs, the station that initiated the negotiation will normally begin sending traffic using the selected modem.	44
175	A.5.6.5.2	Crypto negotiation and handoff. When crypto negotiation and handoff are required, the following applies: a. An ALE data link can also be used to negotiate an encryption device to be used for voice or data traffic by exchanging crypto negotiation messages. The crypto selection CMD word is formatted as shown in figure A-42. The defined crypto codes are listed in table A-XXIV. Codes not defined are reserved, and shall not be used until standardized. NOTE: This function may best be implemented in an HFNC to avoid retrofit to existing ALE controllers, and for the greater flexibility inherent in network management information bases. b. Crypto negotiation shall employ crypto negotiation messages in the protocol described above for modem negotiation.	44

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
176	A.5.6.6.1	Version CMD (mandatory). The version CMD function is used to request ALE controller version identification. The first character is 'v' to indicate the version family of ALE CMD word functions. The second character shall be set to 's' to select a summary report. NOTE: The capabilities function in A.5.6.6.2 is a variant of this function that provides more detailed information. a. The response to a version CMD is a printable ASCII message in manufacturer-specific format that indicates a manufacturers' identification, the version(s) of hardware, operating firmware and software, and/or management firmware and software of the responding ALE controller, as requested by control bits $KVC_{1\text{-}3}$ of the version CMD format (see figure A-43 and table A- XXV). b. The requesting station specifies acceptable formats for the response in control bits $KVF_{1\text{-}4}$ in accordance with table A-XXVI. A controller responding to a version function shall attempt to maximize the utility of its response and: (1) Shall report the version(s) of all of the components requested by the KVC control bits that are present in the controller. (2) Shall use the ALE message format that represents the highest level of mutual capability of itself and the requesting station by comparing the message types that it can generate with those desired by the requesting station, and selecting the message type in the intersection of these two sets that correspond to the highest-numbered KFV bit.	44

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
177	A.5.6.6.2.1	Capabilities query. The capabilities query, shown in figure A-44, consists of a single ALE CMD word. The second character position shall be set to ‘c’ to select a full capabilities report (rather than a summary as in the version CMD). The third character position shall be set to ‘q’ in a capabilities query to request a capabilities report.	44
178	A.5.6.6.2.2	Capabilities report CMD. The capabilities report shall consist of a CMD word followed by five DATA words, as shown in figure A-45. The second character position of the capabilities report CMD word shall be set to ‘c’ and the third character position shall be set to ‘r’. (The DATA preamble in the second and fourth DATA words shall be replaced by REP for transmission, as required by the ALE protocol.)	44
179	A.5.6.6.2.3	Data format. The format of the DATA words in a capabilities report is constant, regardless of the capabilities reported, to simplify the software that implements the capabilities command. The data fields of the capabilities report shall be encoded in accordance with tables A-XXVII, A-XXVIII, and A-XXIX. The values encoded shall represent the current operational capabilities of the responding ALE controller, i.e., the timing or functions currently programmed. All timing fields shall be encoded as unsigned integers.	44
180	A.5.6.7	Do not respond CMD. When an ALE controller receives this CMD in a transmission, it shall not respond unless a response is specifically required by some other CMD in the transmission (e.g., an LQA request or a DTM or DBM with ARQ requested). In a Do Not Responds CMD, no three-way ALE handshake needs to be completed.	44

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
181	A.5.6.9	User unique functions (UUFs). UUFs are for special uses, as coordinated with specific users or manufacturers, which use the ALE system in conjunction with unique, nonstandard, or non-ALE, purposes. There are 16384 specific types of CMD UUF codes available, as indicated by a 14-bit (or two-character) unique index (UI). Each unique type of special function that employees a UUF shall have a specific UI assigned to it to ensure interoperability, compatibility, and identification. The UI shall be assigned for use before any transmission of the UUF or the associated unique activity, and the ALE UUF shall always include the appropriate UI when sent. The UUF shall be used only among stations that are specifically addressed and included within the protocol, and shall be used only with stations specifically capable of participating in the UUF activity, and all other (non-participating) stations should be terminated. There are two exceptions for stations that are not capable of participating in the UUF and are required to be retained in the protocol until concluded. They shall be handled using either of the two following procedures. First, the calling station shall direct all the addressed and included stations to stay linked for the duration of the UUF, to read and use anything that they are capable of during that time, and to resume acquisition and tracking of the ALE frame and protocol after the UUF ends. To accomplish this, and immediately before the CMD UUF, the sending station shall send the CMD STAY, which shall indicate the time period (T) for which the receiving stations shall wait for resumption of the frame and protocol. Second, the sending station shall use any standard CMD function to direct the non-participating stations to wait or return later, or do anything else appropriate and controllable through the standard orderwire functions.	43

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
181	A.5.6.9 (continued)	If a CMD UUF is included within an ALE frame, it shall only be within the message section. The UUF activity itself should be conducted completely outside of the frame and should not interfere with the protocols. If the UUF activity itself must be conducted within the message section, will occupy time on the channel, and is incompatible with the ALE system, that activity shall be conducted immediately after the CMD UUF and it shall be for a limited amount of time (T). A CMD STAY shall precede the UUF instruction, as described herein, to indicate that time (T). The sending station shall resume the same previous redundant word phase when the frame and protocol resumes, to ensure synchronization. The STAY function preserves maintenance of the frame and link. It instructs the stations to wait, because the amount of time occupied by the UUF activity or its signaling may conflict with functions such as the wait-for-activity timer (T_{wa}). This may interfere with the protocols or maintenance of the link. In any case, the users of the UUF shall be responsible for noninterference with other stations and users, and also for controlling their own stations and link management functions to avoid these conflicts. *The UUF shall be constructed as follows and as shown in table A-XXX. The UUF word shall use the CMD (110) preamble in bits P3 through P1 (W1 through W3). The character in the first position shall be the pipe "¦" or vertical bar "|" (1111100) in bits C1-7 through C1-1 (W4 through W10), which shall identify the "unique" function. The user or manufacturer-specific UI shall be a 14-bit (or two-character, 7-bit ASCII) code using bits UI-14 through UI-1 (W11 through W24). All unassigned UI codes shall be reserved and shall not be used until assigned for a specific use.*	43
182	A.5.7.1	Overview. Three message protocols are available for carrying user data using the ALE waveform and signal structure. The characteristics of these three protocols are summarized in the table A-XXXI. All ALE controllers complying with this appendix shall implement the AMD protocol.	38
183	A.5.7.2	AMD mode (mandatory). The operators and controllers shall be able to send and receive simple ASCII text messages using only the existing station equipment.	38

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
184	A.5.7.2.1	Expanded 64-channel subset. The expanded 64 ASCII subset shall include all capital alphabetics (A-Z), all digits (0-9), the utility symbols "@" and "?," plus 26 other commonly used symbols. See figure A-46. The expanded 64 subset shall be used for all basic orderwire message functions, plus special functions as may be standardized. For orderwire message use, the subset members shall be enclosed within a sequence of DATA (and REP) words and shall be preceded by an associated CMD (such as DTM). The CMD designates the usage of the information that follows, and shall also be preceded by a valid and appropriate calling cycle using the Basic 38 ASCII subset addressing. Digital discrimination of the expanded 64 ASCII subset may be accomplished by examination of the two MSBs (b_7 and b_6), as all of the members within the "01" and "10" MSBs are acceptable. No parity bits are transmitted because the integrity of the information is protected by the basic ALE FEC and redundancy and may be ensured by optional use of the CMD CRC as described in A.5.6.1. The station shall have the capability to both send and receive AMD messages from and to both the operator and the controller. The station shall also have the capability to display any received AMD messages directly to the operator and controller upon arrival, and to alert them. The operator and controller shall have the capability to disable the display and the alarm when their functions would be operationally inappropriate.	38

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
185	A.5.7.2.2	AMD protocol. When an ASCII short orderwire AMD type function is required, the following CMD AMD protocol shall be used, unless another protocol in this standard is substituted. An AMD message shall be constructed in the standard word format, as described herein, and the AMD message shall be inserted in the message section of the frame. The receiving station shall be capable of receiving an AMD message contained in any ALE frame, including calls, responses, and acknowledgments. Within the AMD structure, the first word shall be a CMD AMD word, which shall contain the first three characters of the message. It shall be followed by a sequence of alternating DATA and REP words that shall contain the remainder of the message. The CMD, DATA, and REP words shall all contain only characters from the expanded ASCII 64 subset, which shall identify them as an AMD transmission. Each separate AMD message shall be kept intact and shall only be sent in a single frame, and in the exact sequence of the message itself. If one or two additional characters are required to fill the triplet in the last word sent, the position(s) shall be "stuffed" with the "space" character (0100000) automatically by the controller, without operator action. The end of the AMD message shall be indicated by the start of the frame conclusion, or by the receipt of another CMD. Multiple AMD messages may be sent within a frame, but they each shall start with their own CMD AMD with the first three characters.	38

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
186	A.5.7.2.3	Maximum AMD message size. Receipt of the CMD AMD word shall warn the receiving station that an AMD message is arriving and shall instruct it to alert the operator and controller and display the message, unless they disable these outputs. The station shall have the capability to distinguish among, and separately display, multiple separate AMD messages that were in one or several transmissions. The AMD word format shall consist of a CMD (110) in bits P3 through P1 (W1 through W3), followed by the three standard character fields C1, C2, and C3. In each character field, each character shall have its most significant bits (MSBs) bit 7 and bit 6 (C1-7 and C1-6, C2-7 and C2-6, and C3-7 and C3-6) set to the values of “01” or “10” (that is, all three characters are members of the expanded ASCII 64 subset). The rest of the AMD message shall be constructed identically, except for the alternating use of the DATA and REP preambles. Any quantity of AMD words may be sent within the message section of the frame within the $T_{m\ max}$ limitation of 30 words (90 characters). $T_{m\ max}$ shall be expanded from 30 words, to a maximum of 59 words, with the inclusion of CMD words within the message section. The maximum AMD message shall remain 30 words, exclusive of additional CMD words included within the message section of the frame. The maximum number of CMD words within the message section shall be 30. The message characters within the AMD structure shall be displayed verbatim as received. If a detectable information loss or error occurs, the station shall warn of this by the substitution of a unique and distinct error indication, such as all display elements activated (like a “block”). The display shall have a capacity of at least 20 characters (DO: at least 40). The AMD message storage capacity, for recall of the most recently received message(s), shall be at least 90 characters plus sending station address (DO: at least 400). By operator or controller direction, the display shall be capable of reviewing all messages in the AMD memory and shall also be capable of identifying the originating station’s address. If words are received that have the proper AMD format but are within a portion of the message section under the control of another message protocol (such as DTM), the other protocol shall take precedence and the words shall be ignored by the station’s AMD function. NOTE: If higher data integrity or reliability is required, the CMD DTM and DBM protocols should be used.	38

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
187	A.5.7.3	DTM mode. The DTM ALE (orderwire) message protocol function enables stations to communicate (full ASCII or unformatted binary bits) messages to and from any selected station(s) for direct output to and input from associated data terminals or other date terminal equipment (DTE) devices through their standard data circuit-terminating equipment (DCE) ports. The DTM data transfer function is a standard speed mode (like AMD) with improved robustness, especially against weak signals and short noise bursts. When used over medium frequency (MF)/HF by the ALE system, DTM orderwire messages may be unilateral or bilateral, and broadcast or acknowledged. As the DTM data blocks are of moderate sizes, this special orderwire message function enables utilization of the inherent redundancy and FEC techniques to detect weak HF signals and tolerate short noise bursts. The DTM data blocks shall be fully buffered at each station and should appear transparent to the using DTEs or data terminals. As a DO, and under the direction of the operator or controller, the stations should have the capability of using the DTM data traffic mode (ASCII or binary bits) to control switching of the DTM data traffic to the appropriate DCE port or associated DTE equipment, such as to printers and terminals (if ASCII mode), or computers and cryptographic devices (if binary bits mode). As an operator or controller selected option, the received DTM message may also be presented on the operator display similar to the method for AMD in A.5.7.2. There are four CMD DTM modes: BASIC, EXTENDED, NULL, and ARQ. The DTM BASIC block ranges over a moderate size and contains a variable quantity of data, from zero to full as required, which is exactly measured to ensure integrity of the data during transfer. The DTM EXTENDED blocks are variable over a larger range of sizes, in integral multiples of the ALE basic word, and are filled with integral multiples of message data. The DTM NULL and ARQ modes are used for both link management, and error and flow control. The characteristics of the CMD DTM orderwire message functions are listed in table A-XXXII and are summarized below:	39

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
187	A.5.7.3 (continued)	When an ASCII, or binary bit, digital data message function is required, the following CMD DTM orderwire structures and protocols shall be used as specified herein, unless another standardized protocol is substituted. The DTM structure shall be inserted within the message section of the standard ALE frame. A CMD DTM word shall be constructed in the standard 24-bit format, using the CMD preamble (see table A-XXXIII). The message data to be transferred shall also be inserted in words, using the DATA and REP preambles. The words shall then be Golay FEC encoded and interleaved, and then shall be transmitted immediately following the CMD DTM word. A CMD CRC shall immediately follow the data block words, and it shall carry the error control CRC FCS. When the DTM structure transmission time exceeds the maximum limit for the message section ($T_{m\ max}$), the DTM protocol shall take precedence and shall extend the T_m limit to accommodate the DTM. The DTM mode preserves the required consistency of redundant word phase during the transmission. The message expansion due to the DTM is always a multiple of one T_{rw}, as the basic ALE word structure is used. The transmission time of the DTM data block (DTM words x 392 msec) does not include the T_{rw} for the preceding CMD DTM word or the following CMD CRC. Figure A-47 shows an example of a DTM message structure.	39

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
187	A.5.7.3 (continued)	The DTM protocol shall be as described herein. The CMD DTM BASIC and EXTENDED formats (herein referred to as DTM data blocks) shall be used to transfer messages and information among stations. The CMD DTM ARQ format shall be used to acknowledge other CMD DTM formats and for error and flow control, except for non-ARQ and one-way broadcasts. The CMD DTM NULL format shall be used to (a) interrupt ("break") the DTM and message flow, (b) to interrogate station to confirm DTM capability before initiation of the DTM message transfer protocols, and (c) to terminate the DTM protocols while remaining linked. When used in ALE handshakes and subsequent exchanges, the protocol frame terminations for all involved stations shall be TIS until all the DTM messages are successfully transferred, and all are acknowledged if ARQ error control is required. The only exceptions shall be when the protocol is a one-way broadcast or the station is forced to abandon the exchange by the operator or controller, in which cases the termination should be TWAS. Once a CMD DTM word of any type has been received by a called (addressed) or linked station, the station shall remain on channel for the entire specified DTM data block time (if any), unless forced to abandon the protocol by the operator or controller. The start of the DTM data block itself shall be exactly indicated by the end of the CMD DTM BASIC or EXTENDED word itself. The station shall attempt to read the entire DTM data block information in the DATA and REP words, and the following CMD CRC, plus the expected frame continuation, which shall contain a conclusion (possibly preceded by additional functions in the message section, as indicated by additional CMD words). With or without ARQ, identification of each DTM data block and its associated orderwire message (if segmented into sequential DTM data blocks) shall be achieved by use of the sequence and message control bits, KD1 and KD2, (as shown in table A-XXXIII), which shall alternate with each DTM transmission and message, respectively. The type of data contained within the data block (ASCII or binary bits) shall be indicated by KD3 as a data identification bit. Activation of the ARQ error control protocol shall use the ARQ control bit KD4. If no ARQ is required, such as in one-way broadcasts, multiple DTM data blocks may be sent in the same frame, but they shall be in proper sequential order if they are transferring a segmented message.	39

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
187	A.5.7.3 (continued)	When ARQ error or flow control is required, the CMD DTM ARQ shall identify the acknowledged DTM data block by the use of the sequence and message control bits KD1 and KD2, which shall be set to the same values as the immediately preceding and referenced DTM data block transmission. Control bit KD3 shall be used as the DTM flow control to pause or continue (or resume) the flow of the DTM data blocks. The ACK and request-for-repeat (NAK) functions shall use the ARQ control bit KD4. If no ARQ has been required by the sending station, but the receiving station needs to control the flow of the DTM data blocks, it shall use the DTM ARQ to request a pause in, and resumption of, the flow. When data transfer ARQ error and flow control is required, the DTM data blocks shall be sent individually, in sequence, and each DTM data block shall be acknowledged before the next DTM data block is sent. Therefore, with ARQ there shall be only one DTM data block transmission in each ALE frame. If the transmitted DTM data block causes a NAK in the returned DTM ARQ, as described below, or if ACK or DTM ARQ is detected in the returned frame, or if no ALE frame is detected at all, the sending station shall resend an exact duplicate of the unacknowledged DTM data block. It shall send and continue to resend duplicates (which should be up to at least seven) one at a time and with appropriate pauses for responses, until the involved DTM data block is specifically acknowledged by a correct DTM ARQ. Only then shall the next DTM data block in the sequence be sent. If the sending station is frequently or totally unable to detect ALE frame or DTM ARQ responses, it should abort the DTM transfer protocol, terminate the link, and relink and reinitiate the DTM protocol on a better channel, under operator or controller direction.	39

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
187	A.5.7.3 (continued)	Before initiation of the DTM data transfer protocols, the sending stations should confirm the existence of the DTM capability in the intended receiving stations, if not already known. When a DTM interrogation function is required, the following protocol shall be used. Within any standard protocol frame (using TIS), the sending station shall transmit a CMD DTM NULL, with ARQ required, to the intended station(s). These receiving stations shall respond with the appropriate standard frame and protocol, with the following variations. They shall include a CMD DTM ARQ if they are DTM capable, and they shall omit it if they are not DTM capable. The sending station shall examine the ALE and DTM ARQ responses for existence, correctness, and the status of the DTM KD control bits, as described herein. The transmitted CMD DTM NULL shall have its control bits set as follows: KD1 and KD2 set opposite of any subsequent and sequential CMD DTM BASIC or EXTENDED data blocks, which will be transmitted next; KD3 set to indicate the intended type of traffic, and KD4 set to require ARQ. The returned CMD DTM ARQ shall have its control bits set as follows: KD1 and KD2 set to match the interrogating DTM NULL; KD3 set to indicate if the station is ready for DTM data exchanges, or if a pause is requested; and KD4 set to ACK if the station is ready to accept DTM data transmissions with the specified traffic type, and NAK if it cannot or will not participate, or it failed to read the DTM NULL. The sending (interrogating) station shall handle any and all stations that return a NAK, or do not return a DTM ARQ at all, or do not respond at all, in any combination of the following three ways, and for any combination of these stations. The specific actions and stations shall be selected by the operator or controller. The sending station shall: (a) terminate the link with them, using an appropriate and specific call and the TWAS terminator; or (b) direct them to remain and stay linked during the transmissions, using the CMD STAY protocol in each frame immediately before each CMD DTM word and data block sent; or (c) redirect them to do anything else that is controllable using the CMD functions described within this standard.	39

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
187	A.5.7.3 (continued)	Each received DTM data block shall be examined using the CRC data integrity test included within the mandatory associated CMD CRC that immediately follows the DTM data block structure. If the data block passes the CRC test, the data shall be passed through to the appropriate DCE port (or normal output as directed by the operator or controller). If the data block is part of a larger message segmented before DTM transfer, it shall be recombined before output. If any DTM data blocks are received and do not pass the CRC data integrity test, any detectable but uncorrectable errors or areas likely to contain errors and should be tagged for further analysis, error control, or inspection by the operator or controller. If ARQ is required, the received but unacceptable data block shall be temporarily stored, and a DTM ARQ NAK shall be returned to sender, who shall retransmit an exact duplicate DTM data block. Upon receipt of the duplicate, the receiving station shall again test the CRC. If the CRC is successful, the data block shall be passed through as described before, the previously unacceptable data block should be deleted, and a DTM ARQ ACK shall be returned. If the CRC fails again, both the duplicate and the previously stored data blocks shall be used to correct, as possible, errors and to create an "improved" data block. See figure A-48 for an example of data block reconstruction. The "improved" data block shall then be CRC tested. If the CRC is successful, the "improved" data block is passed through, the previously unacceptable data blocks should be deleted, and a DTM ARQ ACK shall be returned. If the CRC test fails, the "improved" data block shall be stored and a DTM ARQ NAK shall be returned. This process shall be repeated until: (a) a received duplicate, or an "improved" data block passes the CRC test (the data block is passed through, and a DTM ARQ ACK is returned); (b) the maximum number of duplicates (such as seven or more) have been sent without success (with actions by the sender as described above); or (c) the operators or controllers terminate or redirect the DTM protocol.	39

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
187	A.5.7.3 (continued)	During reception of ALE frames and DTM data blocks, it is expected that fades, interferences, and collisions will occur. The receiving station shall have the capability to maintain synchronization with the frame and the DTM data block transmission, once initiated. It shall also have the capability to read and process any colliding and significantly stronger (that is, readable) ALE signals without confusing them with the DTM signal (basic ALE reception in parallel, and always listening). Therefore, useful information that may be derived from readable collisions of ALE signals should not be arbitrarily rejected or wasted. The DTM structures, especially the DTM EXTENDED, can tolerate weak signals, short fades, and short noise bursts. For these cases and for collisions, the DTM protocol can detect DTM words that have been damaged and "tag" them for error correction or repeats. The DTM constructions are described herein. Within the DTM data block structure, the CMD DTM word shall be placed ahead of the DTM data block itself. The DTM word shall alert the receiving station that a DTM data block is arriving, how long it is, what type of traffic it contains, what its message and block sequence is, and if ARQ is required. It shall also indicate the exact start of the data block (the end of the CMD DTM word), and shall initiate the reception, tracking, decoding, reading, and checking of the message data contained within the data block, which itself is within the DATA and REP words. The message data itself shall be either one of two types, binary bits or ASCII. The ASCII characters (typically used for text) shall be the standard 7-bit length, and the start, stop, and parity bits shall be removed at the sending (and restored at the receiving) station. The binary bits (typically used for other character formats, computer files, and cryptographic devices) may have any (or no) pattern or format, and they shall be transferred transparently (that is, exactly as they were input to the sending station) with the same length and without modification.	39

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
187	A.5.7.3 (continued)	The size of the DTM BASIC or EXTENDED data block shall be the smallest multiple of DATA and REP words that will accommodate the quantity of the ASCII or binary bits message data to be transferred in the DTM data block. If the message data to be transferred does not exactly fit the unencoded data field of the DTM block size selected, the available empty positions shall be "stuffed" with ASCII "DEL" (1111111) characters or all "1" bits. The combined message and "stuff" data in the uncoded DTM data field shall then be checked by the CRC for error control in the DTM protocol. The resulting 16-bit CRC word shall always be inserted into the CMD CRC word that immediately follows the DTM data block words themselves. All the bits in the data field shall then be inserted into standard DATA and REP words on a 21-bit or three-character basis and Golay FEC encoded, interleaved, and tripled for redundancy. Immediately after the CMD DTM word, the DTM DATA and REP words shall follow standard word format, and the CMD CRC shall be at the end. The DTM BASIC data block has a relatively compact range of sizes from 0 to 31 words and shall be used to transfer any quantity of message data between zero and the maximum limits for the DTM BASIC structure, which is up to 651 bits or 93 ASCII characters. It is capable of counting the exact quantity of message data it contains, on a bit-by-bit basis. It should be used as a single DTM for any message data within this range. It shall also be used to transfer any message data in this size range that is an "overflow" from the larger size (and increments) DTM EXTENDED data blocks, which shall immediately precede the DTM BASIC in the DTM sequence of sending. The DTM EXTENDED data blocks are also variable in size in increments of single ALE words up to 351. They should be used as a single, large DTM to maximize the advantages of DTM throughput. The size of the data block should be selected to provide the largest data field size that can be totally filled by the message data to be transferred. Any "overflow" shall be in a message data segment sent within an immediately following and appropriately sized DTM EXTENDED or BASIC data block. Under operator or controller direction, multiple DTM EXTENDED data blocks, with smaller than the maximum appropriate ID sizes, should be selected if they will optimize DTM data transfer throughput and reliability. However, these multiple data blocks will require that the message data be divided into multiple segments at the sending station, that they be sent only in the exact order of the segments in the message, and that the receiving stations recombine the segments into a complete received message.	39

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
187	A.5.7.3 (continued)	When binary bits are being transferred, the message data segment sent within an immediately following and appropriately sized DTM EXTENDED or BASIC data block. Under operator or controller direction, multiple DTM EXTENDED data blocks, with smaller than the maximum appropriate ID sizes, should be selected if they will optimize DTM data transfer throughput and reliability. However, these multiple data blocks will require that the message data be divided into multiple segments at the sending station, that they be sent only in the exact order of the segments in the message, and that the receiving stations recombine the segments into a complete received message. When binary bits are being transferred, the EXTENDED data field shall be filled exactly to the last bit. When ASCII characters are being transferred, there are no stuff bits as the 7-bit characters fit the ALE word 21-bit data field exactly. If stations are exchanging DTM data blocks and DTM ARQs, they may combine both functions in the same frames, and they shall discriminate based on the direction of transmission and the sending and destination addressing. If ARQ is required in a given direction, only one DTM data block shall be allowed within any frame in that direction, and only one DTM ARQ shall be allowed in each frame in the return direction. If no ARQ is required in a given direction, multiple DTM data blocks may be included in frames in that direction, and multiple DTM ARQ's may be included in the return direction. As always throughout the DTM protocol, any sequence of DTM data blocks to be transferred shall have the KD1 sequence control bits alternating with the preceding and following DTM data blocks (except duplicates for ARQ, which shall be exactly the same as the originally transmitted DTM data block).	39

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
187	A.5.7.3 (continued)	Also, all multiple DTM data blocks transferring multiple segments of a larger data message shall all have their KD2 message control bits set to the same value, and opposite of the preceding and following messages. If a sequence of multiple but unrelated DTM data blocks are sent (such as several independent and short messages within several DTM BASIC data blocks), they may be sent in any sequence. However, the KD1 or KD2 sequence and message control bits shall alternate with those in the adjacent DTM data blocks. The CMD DTM words shall be constructed as shown in table A-XXXIII. The preamble shall be CMD (110) in bits P3 through P1 (W1 through W3). The first character shall be "d" (1100100) in bits C1-7 through C1-1) (W4 through W10), which shall identify the DTM "data" function. For DTM BASIC, EXTENDED, and NULL, when the "ARQ" control bit KD4 (W11) is set to "0," no correct data receipt acknowledgment is required; and when set to "1," it is required. For DTM ARQ, "ARQ" control bit KD4 is set to "0" to indicate acknowledgment or correct data block receipt (ACK); and when set to "1," it indicates a failure to receive the data and is therefore a request-for-repeat (NAK). For DTM ARQ responding to a DTM NULL interrogation, KD4 "0" indicates non-participation in the DTM protocol or traffic type, and KD4 "1" indicates affirmative participation in both the DTM protocol and traffic type. For DTM BASIC, EXTENDED, and NULL, when the "data type" control bit KD3 (W12) is set to "0," the message data contained within the DTM data block shall be binary bits with no required format or pattern; and when KD3 is set to "1" the message data is 7-bit ASCII characters. For DTM ARQ, "flow" control bit KD3 is set to indicate that the DTM transfer flow should continue, or resume; and when KD3 is set to "1" it indicates that the sending station should pause (until another and identical DTM ARQ is returned, except that KD3 shall be "0").	39

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
187	A.5.7.3 (continued)	For DTM BASIC, EXTENDED, and NULL, when the "message" control bit KD2 (W13) is set to the same value as the KD2 in any sequentially adjacent DTM data block, the message data contained within those adjacent blocks (after individual error control) shall be recombined with the message data within the present DTM data block segment-by-segment to reconstitute the original whole message, and when KD2 is set opposite to any sequentially adjacent DTM data blocks, those data blocks contain separate message data and shall not be combined. For DTM ARQ, "message" control bit KD2 shall be set to match the referenced DTM data block KD2 value to provide message confirmation. For DTM BASIC, EXTENDED, and NULL, the "sequence" control bit KD1 (W14) shall be set opposite to the KD1 value in the sequentially adjacent DTM BASIC, EXTENDED, or NULLs to be sent (the KD1 values therefore alternate, regardless of their message dependencies). When KD1 is set to the same value as any sequentially adjacent DTM sent, it indicates that it is a duplicate (which shall be exactly the same). For DTM ARQ, "sequence" control bit KD1 shall be set to match the referenced DTM data block or NULL KD1 value to provide sequence confirmation. When used for the DTM protocols, the ten DTM data code (DC) bits DC10 through DC1 (W15 through W24) shall indicate the DTM mode (BASIC, EXTENDED, ARQ, or NULL). They shall also indicate the size of the message data and the length of the data block. The DTM NULL DC value shall be "0" (0000000000), and it shall designate the single CMD DTM NULL word.	39

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
187	A.5.7.3 (continued)	The DTM EXTENDED DC values shall range from “1” (0000000001) to “351” (0101011111), and they designate the CMD DTM EXTENDED word and the data block multiple of DATA and REP words that define the variable data block sizes. The EXTENDED sizes shall range from 1 to 351 words, with a range of 21 to 7371 binary bits, in increments of 21; or three to 1053 ASCII characters, in increments of three. The DTM BASIC DC values shall range from “353” (0101100001) to “1023” (1111111111), and they shall designate the CMD DTM BASIC word and the exact size of the message data in compact and variable size data blocks, with up to 651 binary bits or 93 ASCII characters. The DTM ARQ DC value shall be “352” (0101100000), and it shall designate the single CMD DTM ARQ word. The DC values “384” (0110000000) and all higher multiples of “32m” (m x 100000) shall be reserved until standardized. See table A-XXXII for DC values and DTM block sizes and other characteristics.	39

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
188	A.5.7.4	DBM mode. The DBM ALE (orderwire) message protocol function enables ALE stations to communicate either full ASCII, or unformatted binary bit messages to and from any selected ALE station(s) for direct output to and input from associated data terminal or other DTE devices through their standard DCE ports. This DBM data transfer function is a high-speed mode (relative to DTM and AMD) with improved robustness, especially against long fades and noise bursts. When used over MF/HF by the ALE system, DBM orderwire messages may be unilateral or bilateral, and broadcast or acknowledged. As the DBM data blocks can be very large, this special orderwire message function enables exploitation of deep interleaving and FEC techniques to penetrate HF-channel long fades and large noise bursts. The DBM data blocks shall be fully buffered at each station and should appear transparent to the using DTEs or data terminals. As a design objective and under the direction of the operator or controller, the stations should have the capability of using the DBM data traffic mode (ASCII or binary bits) to control switching of the DBM data traffic to the appropriate DCE port or associated DTE equipment, such as to printers and terminals (if ASCII mode) or computers and cryptographic devices (if binary bits mode). As an operator or controller-selected option, the received DBM message may also be presented on the operator display, similar to the method for AMD in table A.5.7.2. There are four CMD DBM modes: BASIC, EXTENDED, NULL, and ARQ. The DBM BASIC block is a fixed size and contains a variable quantity of data, from zero to full as required, which is exactly measured to ensure integrity of the data during transfer. The DBM EXTENDED blocks are variable in size in integral multiples of the BASIC block, and are filled with integral multiples of message data. The DBM NULL and ARQ modes are used for both link management, and error and flow control. The characteristics of the CMD DBM orderwire message functions are listed in table A-XXXIV, and they are summarized below:	40

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
188	A.5.7.4 (continued)	When an ASCII, or binary bit, digital data message function is required, the following CMD DBM orderwire structures and protocols shall be used as specified herein, unless another standardized protocol is substituted. The DBM structure shall be inserted within the message section of the standard frame. A CMD DBM word shall be constructed in the standard format. The data to be transferred shall be Golay FEC encoded, interleaved (for error spreading during decoding), and transmitted immediately following the CMD DBM word. When the DBM structure transmission time exceeds the maximum for the message section ($T_{m\ max}$), the DBM protocol shall take precedence and shall extend the T_m limit to accommodate the DBM. The DBM mode preserves the required consistency of redundant word phase during the transmission. The message expansion due to the DBM is always a multiple of 8 T_{rw}, as the interleaver depth is always a multiple of 49. The transmission time of the DBM data block (T_{dbm}) itself is equal to (interleaver depth x 64ms), not including the T_{rw} for the preceding CMD DBM word. Figure A-49 shows an example of an exchange using the DBM orderwire to transfer and acknowledge messages. Figure A-50 shows an example of a DBM data interleaver, and figure A-51 shows the transmitted DBM bit-stream sequence. The DBM protocol shall be as described herein. The CMD DBM BASIC and EXTENDED formats (herein referred to as DBM data blocks) shall be used to transfer messages in information among ALE stations. The CMD DBM ARQ format shall be used to acknowledge other CMD DBM formats and for error and flow control, except for non-ARQ and one-way broadcasts. The CMD DBM NULL format shall be used to: (a) interrupt ("break") the DBM and message flow; (b) to interrogate stations to confirm DBM capability before initiation of the DBM message transfer protocols; and (c) to terminate the DBM protocols while remaining linked.	40

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
188	A.5.7.4 (continued)	When used in handshakes and subsequent exchanges, the protocol frame terminations for all involved stations shall be TIS until all the DBM messages are successfully transferred, and all are acknowledged if ARQ error control is required. The only exceptions shall be when the protocol is a one-way broadcast or the station is forced to abandon the exchange by the operator or controller, in which cases the termination should be TWAS. Once a CMD DBM word of any type has been received by a called (addressed) or linked station, the station shall remain on channel for the entire specified DBM data block time (if any), unless forced to abandon the protocol by the operator or controller. The start of the DBM data block itself shall be exactly indicated by the end of the CMD DBM BASIC or EXTENDED word itself. The station shall attempt to read the entire DBM data block information, plus the expected frame continuation, which shall contain a conclusion (possibly preceded by additional functions in the message section, as indicated by additional CMD words). With or without ARQ, identification of each DBM data block and its associated orderwire message (if segmented into sequential DBM data blocks) shall be achieved by use of the sequence and message control bits, KB1 and KB2, (see table A-XXXV) which shall alternate with each DBM transmission and message, respectively. The type of data contained within the data block (ASCII or binary bits) shall be indicated by KB3 as a data identification bit. Activation of the ARQ error-control protocol shall use the ARQ control bit KB4. If no ARQ is required, such as in one-way broadcasts, multiple DBM data blocks may be sent in the same frame, but they shall be in proper sequence if they are transferring a segmented message. When ARQ error or flow control is required, the CMD DBM ARQ shall identify the acknowledged DBM data block by the use of the sequence and message control bits KB1 and KB2, which shall be set to the same values as the immediately preceding and referenced DBM data block transmission.	40

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
188	A.5.7.4 (continued)	Control bit KB3 shall be used as the DBM flow control to pause or continue (or resume) the flow of the DBM data blocks. The ACK and NAK functions shall use the ARQ control bit KB4. If no ARQ has been required by the sending station, but the receiving station needs to control the flow of the DBM data blocks, it shall use the DBM ARQ to request a pause in, and resumption of, the flow. When data transfer ARQ error and flow control is required, the DBM data blocks shall be sent individually and in sequence. Each DBM data block shall be individually acknowledged before the next DBM data block is sent. Therefore, with ARQ there shall be only one DBM data block transmission in each frame. If the transmitted DBM data block causes a NAK in the returned DBM ARQ, as described below, or if no ACK or DBM ARQ is detected in the returned frame, or if no frame is detected at all, the sending station shall resend an exact duplicate of the unacknowledged DBM data block. It shall continue to resend duplicates (which should be at least seven), one at a time and with appropriate pauses for responses, until the involved DBM data block is specifically acknowledged by a correct DBM ARQ. Only then shall the next DBM data block in the sequence be sent. If the sending station is frequently or totally unable to detect frame or DBM ARQ responses, it should abort the DBM transfer protocol, terminate the link and relink and reinitiate the DBM protocol on a better channel (under operator or controller direction). Before initiation of the DBM data transfer protocols, the sending stations should confirm the existence of the DBM capability in the intended receiving stations, if not already known. When a DBM interrogation function is required, the following protocol shall be used. Within any standard protocol frame (using TIS), the sending station shall transmit a CMD DBM NULL, with ARQ required, to the intended station(s). These receiving stations shall respond with the appropriate standard frame and protocol, with the following variations. They shall include a CMD DBM ARQ if they are DBM capable, and they shall omit it if they are not DBM capable. The sending station shall examine the ALE and DBM ARQ responses for existence, correctness, and the status of the DBM KB control bits, as described herein. The transmitted CMD DBM NULL shall have its control bits set as follows:	40

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
188	A.5.7.4 (continued)	KB1 and KB2 set opposite of any subsequent and sequential CMD DBM BASIC or EXTENDED data blocks which will be transmitted next; KB3 set to indicate the intended type of traffic; and KB4 set to require ARQ. The returned CMD DBM ARQ shall have its control bits set as follows: KB1 and KB2 set to match the interrogating DBM NULL; KB3 set to indicate if the station is ready for DBM data exchanges, or if a pause is requested; and KB4 set to ACK if the station is ready to accept DBM data transmissions with the specified traffic type, and NAK if it cannot or will not participate, or if it failed to read the DBM NULL. The sending (interrogating) station shall handle any stations which return a NAK, or do not return a DBM ARQ, or do not respond, in any combination of the following, and for any combination of these stations. The specific actions and stations shall be selected by the operator or controller. The sending station shall: (a) terminate the link with these stations, using an appropriate and specific call and the TWAS terminator; (b) direct the stations to remain and stay linked during the transmissions, using the CMD STAY protocol in each frame immediately before each CMD DBM word and data block sent; or (c) redirect them to do anything else which is controllable using the CMD functions described within this standard. Each received DBM data block shall be examined using the CRC data integrity test which is embedded within the DBM structure and protocol. If the data block passes the CRC test, the data shall be passed through to the appropriate DCE port (or normal output as directed by the operator or controller). If the data block is part of a larger message which was segmented before DBM transfer, it shall be recombined before output. If any DBM data blocks are received and do not pass the CRC data integrity test, any detectable but uncorrectable errors; or areas likely to contain errors, should be tagged for further analysis, error control, or inspection by the operator or controller.	40

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
188	A.5.7.4 (continued)	If ARQ is required, the received but unacceptable data block shall be temporarily stored, and a DBM ARQ NAK shall be returned to the sender, who shall retransmit an exact duplicate DBM data block. Upon receipt of the duplicate, the receiving station shall again test the CRC. If the CRC is successful, the data block shall be passed through as described before, the previously unacceptable data block should be deleted, and a DBM ARQ ACK shall be returned. If the CRC fails again, both the duplicate and the previously stored data blocks shall be used to correct, as possible, errors and to create an “improved” data block. See figure A-48 for an example of data block reconstruction. The “improved” data block shall then be CRC tested. If the CRC is successful, the “improved” data block is passed through, the previously unacceptable data blocks should be deleted, and a DBM ARQ ACK shall be returned. If the CRC test fails, the “improved” data block shall also be stored and a DBM ARQ NAK shall be returned. This process shall be repeated until: (a) a received duplicate, or an “improved” data block passes the CRC test (and the data block is passed through, and a DBM ARQ ACK is returned); (b) the maximum number of duplicates (such as seven or more) have been sent without success (with actions by the sender as described above); or (c) the operators or controllers terminate or redirect the DBM protocol. During reception of frames and DBM data blocks, it is expected that fades, interferences, and collisions will occur. The receiving station shall have the capability to maintain synchronization with the frame and the DBM data block transmission, once initiated. It shall also have the capability to read and process any colliding and significantly stronger (that is, readable) ALE signals without confusing them with the DBM signal (basic ALE reception in parallel, and always listening). The DBM structures, especially the DBM EXTENDED, can tolerate significant fades, noise bursts, and collisions. Therefore, useful information which may be derived from readable collisions of ALE signals should not be arbitrarily rejected or wasted.	40

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
188	A.5.7.4 (continued)	The DBM constructions shall be as described herein. Within the DBM data block structure, a CMD DBM word shall be placed ahead of the encoded and interleaved data block itself. The DBM word shall alert the receiving station that a DBM data block is arriving, how long it is, what type of traffic it contains, what its interleaver depth is, what its message and block sequence is, and if ARQ is required. It shall also indicate the exact start of the data block itself (the end of the CMD DBM word itself) and shall initiate the reception, tracking, deinterleaving, decoding, and checking of the data contained within the block. The message data itself shall be either one of two types, binary bits or ASCII. The ASCII characters (typically used for text) shall be the standard 7-bit length, and the start, stop, and parity bits shall be removed at the sending (and restored at the receiving) station. The binary bits (typically used for other character formats, computer files, and cryptographic devices) may have any (or no) pattern or format, and they shall be transferred transparently, that is, exactly as they were input to the sending station, with the same length and without modification. The value of the interleaver depth shall be the smallest (multiple of 49) which will accommodate the quantity of ASCII or binary bits message data to be transferred in the DBM data block. If the message data to be transferred does not exactly fit the uncoded data field of the DBM block size selected (except for the last 16 bits, which are reserved for the CRC), the available empty positions shall be "stuffed" with ASCII "DEL" characters or all "1" bits. The combined message and "stuff" data in the uncoded DBM data field shall then be checked by the CRC for error control in the DBM protocol. The resulting 16-bit CRC word shall always occupy the last 16 bits in the data field. All the bits in the field shall then be Golay FEC encoded, on a 12-bit basis, to produce rows of 24-bit code words, arranged from top to bottom in the interleaver matrix (or equivalent), as shown in figure A-50. The bits in the matrix are then read out by columns (of length equal to the interleaver depth) for transmission. Immediately after the CMD DBM word, the encoded and interleaved data blocks bits shall follow in bit format, three bits per symbol (tone).	40

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
188	A.5.7.4 (continued)	The DBM BASIC data block has a fixed size (interleaver depth 49) and shall be used to transfer any quantity of message data between zero and the maximum limits for the DBM BASIC structure, which is up to 572 bits or 81 ASCII characters. It is capable of counting the exact quantity of message data which it contains, on a bit-by-bit basis. It should be used as a single DBM for any message data within this range. It shall also be used to transfer any message data in this size range which is an "overflow" from the larger size (and increments) DBM EXTENDED data blocks (which shall immediately precede the DBM BASIC in the DBM sequence of sending). The DBM EXTENDED data blocks are variable in size, in increments of 49 times the interleaver depth. They should be used as a single, large DBM to maximize the advantages of DBM deep interleaving, FEC techniques, and higher speed (than DTM or AMD) transfer of data. The interleaver depth of the EXTENDED data block should be selected to provide the largest data field size which can be totally filled by the message data to be transferred. Any "overflow" shall be in a message data segment sent within an immediately following DBM EXTENDED or BASIC data block. Under operator or controller direction, multiple DBM EXTENDED data blocks, with smaller than the maximum appropriate interleaver depth sizes, should be selected if they will optimize DBM data transfer throughput and reliability. However, these multiple data blocks will require that the message data be divided into multiple segments at the sending station and sent only in the exact order of the segments in the message. The receiving stations must recombine the segments into a complete received message. When binary bits are being transferred, the EXTENDED data field shall be filled exactly to the last bit. When ASCII characters are being transferred, the EXTENDED data field may have 0 to 6 "stuff" bits inserted. Individual ASCII characters shall not be split between DBM data blocks and the receiving station shall read the decoded data field on a 7-bit basis, and it shall discard any remaining "stuff" bits (modulo-7 remainder). If stations are exchanging DBM data blocks and DBM ARQs, they may combine both functions in the same frames. They shall discriminate based on the direction of transmission and the sending and destination addressing. If ARQ is required in a given direction, only one DBM data block shall be allowed within any frame in that direction, and only one DBM ARQ shall be allowed in each frame in the return direction. If no ARQ is required in a given direction, multiple DBM data blocks may be included in frames in that direction, and multiple DBM ARQs may be included in the return direction.	40

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
188	A.5.7.4 (continued)	As always throughout the DBM protocol, any sequence of DBM data blocks to be transferred shall have their KB1 sequence control bits alternating with the preceding and following DBM data blocks (except duplicates for ARQ, which shall be exactly the same as their originally transmitted DBM data block). Also, all multiple DBM data blocks transferring multiple segments of a large data message shall all have their KB2 message control bits set to the same value, and opposite of the preceding and following messages. If a sequence of multiple but unrelated DBM data blocks are sent (such as several independent and short messages within several DBM BASIC data blocks), they may be sent in any sequence. However, when sent, the associated KB1 and KB2 sequence and message control bits shall alternate with those in the adjacent DBM data blocks. The CMD DBM words shall be constructed as shown in table A-XXXV. The preamble shall be CMD (110) in bits P3 through P1 (W1 through W3). The first character shall be “b” (1100010) in bits C1-7 through C1-1 (W4 through W10), which shall identify the DBM “block” function. For DBM BASIC, EXTENDED, and NULL, when the ARQ control bit KB4 (W11) is set to “0,” no correct data receipt acknowledgment is required; and when set to “1,” it is required. For DBM ARQ, ARQ control bit KB4 is set to “0” to indicate acknowledgment or correct data block receipt (ACK); and when set to “1,” it indicates a failure to receive the data and is therefore a request-for-repeat (NAK). For DBM ARQ responding to a DBM NULL interrogation, KB4 “0” indicates non-participation in the DBM protocol or traffic type, and KB4 “1” indicates affirmative participation in both the DBM protocol and traffic type. For DBM BASIC, EXTENDED, and NULL, when the data type control bit KB3 (W12) is set to “0,” the message data contained within the DBM data block shall be binary bits with no required format or pattern; and when KB3 is set to “1” the message data is 7-bit ASCII characters. For DBM ARQ, flow control bit KB3 is set to “0” to indicate that the DBM transfer flow should continue or resume; and when KB3 is set to “1” it indicates that the sending station should pause (until another and identical DBM ARQ is returned, except that KB3 shall be “0”).	40

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
188	A.5.7.4 (continued)	For DBM BASIC, EXTENDED, and NULL, when the "message" control bit KB2 (W13) is set to the same value as the KB2 in any sequentially adjacent DBM data block, the message data contained within those adjacent blocks (after individual error control) shall be recombined with the message data within the present DBM data block to reconstitute (segment-by-segment) the original whole message; and when KB2 is set opposite to any sequentially adjacent DBM data blocks, those data blocks contain separate message data and shall not be combined. For DBM ARQ, "message" control bit KB2 shall be set to match the referenced DBM data block KB2 value to provide message confirmation. For DBM BASIC, EXTENDED, and NULL, the sequence control bit KB1 (W14) shall be set opposite to the KB1 value in the sequentially adjacent DBM BASIC, EXTENDED, or NULLs be sent (the KB1 values therefore alternate, regardless of their message dependencies). When KB1 is set the same as any sequentially adjacent DBM sent, it indicates a duplicate. For DBM ARQ, sequence control bit KB1 shall be set to match the referenced DBM data block or NULL KB1 value to provide sequence confirmation. When used for the DBM protocols, the ten DBM data code (BC) bits BC10 through BC1 (W15 through W24) shall indicate the DBM mode (BASIC, EXTENDED, ARQ, or NULL). They shall also indicate the size of the message data and the length of the data block. The DBM NULL BC value shall be "0" (0000000000), and it shall designate the single CMD DBM NULL word. The DBM EXTENDED BC values shall range from "1" (0000000001) to "445" (0110111101), and they shall designate the CMD DBM EXTENDED word and the data block multiple (of 49 INTERLEAVER DEPTH) which defines the variable data block sizes, in increments of 588 binary bits or 84 ASCII characters. The DBM BASIC BC values shall range from "448" (0111000000) to "1020" (1111111100), and they shall designate the CMD DBM BASIC word and the exact size of the message data in a fixed size (INTERLEAVER DEPTH = 49) data block, with up to 572 binary bits or 81 ASCII characters. The DBM ARQ BC value shall be "1021" (1111111101), and it shall designate the single CMD DBM ARQ word. NOTES: 1. The values "446" (0110111110) and "447" (0110111111) are reserved. 2. The values "1022" (1111111110) and "1023" (1111111111) are reserved until standardized (see table A-XXXIV).	40

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
189	A.5.8.1	Signaling structure (NT). The AQC-ALE signaling structure is identical to that described previously in this appendix, except as provided below and in the remaining subsections of this section: The AQC-ALE word is encoded differently (see A.5.8.1.1). A PSK tone sequence may optionally be inserted between AQC-ALE words during calling handshakes or sounds (see A.5.8.1.6). All compliant implementation of AQC-ALE shall correctly process the AQC-ALE words in calling handshakes and sounds whether or not such PSK tone sequences are present, and whether or not the implementation can extract useful channel data from such PSK tone sequences.	49
190	A.5.8.1.1	AQC-ALE word structure (NT). The AQC-ALE word shall consist of a three-bit preamble, an address differentiation flag, a 16-bit packed address field, and a 4-bit Data Exchange field. These fields shall be formatted and used as described in the following paragraphs. Every AQC-ALE word shall have the form shown in figure A-52, AQC-ALE Word. The data values associated with a particular AQC-ALE word are defined by the context of the frame transmission (see A.5.8.2).	49
191	A.5.8.1.1.1	Packed address (NT). AQC-ALE packs the 21 bits representing three address characters in the 38-character ASCII subset into 16 bits. This is performed by assigning an ordinal value between 0 and 39 to each member of the 38-character subset. Base 40 arithmetic is used to pack the mapped data into a 16-bit number. The ASCII characters used for addressing shall be mapped to the values defined in table A-XXXVI, Address Character Ordinal Values, with character 1's value multiplied by 1600, Character 2's value multiplied by 40, and Character 3's value multiplied by 1. The sum of the three values shall be used as the 16-bit packed address (see example below).	49
192	A.5.8.1.1.2	Address differentiation flag (NT). Bit 4 of the AQC-ALE word shall be a copy of the most significant bit of the 16-bit packed address. This combination results in no legal address in AQC-ALE being legal in baseline 2G ALE and vice versa. The packed address shall occupy the next 16 bits of the 21-bit data portion of the address.	49
193	A.5.8.1.2	Preambles (NT). The preambles shall be as shown in table A-XXXVII AQC-ALE word types (and preambles).	49

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
194	A.5.8.1.2.1	TO (NT). This preamble shall have a binary value of 010 and is functionally identical to the TO preamble in A.5.2.3.2.1. The AQC-ALE TO preamble shall represent the first of two words identifying the address of the station or net.	49
195	A.5.8.1.2.2	THIS IS (TIS) (NT). This preamble shall have a binary value of 101. The preamble is functionally identical to the TIS preamble in A.5.2.3.2.2. The AQC-ALE TIS preamble identifies the AQC-ALE word as containing the first three characters of the of the calling or sounding station address.	49
196	A.5.8.1.2.3	THIS WAS (TWAS) (NT). This preamble shall have a binary value of 011. This preamble is functionally identical to the TWAS preamble in A.5.2.3.2.3. The AQC-ALE TWAS preamble identifies the AQC-ALE word as containing the first three characters of the of the calling or sounding station address.	49
197	A.5.8.1.2.4	PART2 (NT). This preamble shall have a binary value of 100. This preamble is shared with the baseline 2G ALE preamble of FROM. This preamble identifies the second set of three characters in an AQC-ALE address. This preamble shall be used for the second word of every AQC-ALE packed address transmission.	49

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
198	A.5.8.1.2.5	INLINK (NT). This preamble shall have a binary value of 001. This preamble is shared with the baseline 2G ALE preamble of THRU. This preamble shall be used by AQC-ALE whenever a transmission to stations already in an established link is required. This preamble identifies the AQC-ALE word as containing the first three characters of the transmitting station address. This preamble may also be used in the acknowledgement frame of a three-way handshake as described in A.5.8.2.3.	49
199	A.5.8.1.3.1	Address size (NT). Addresses shall be from 1 to 6 characters.	49
200	A.5.8.1.3.2	Address character set (NT). The address character set shall be the same ASCII-38 character set as for baseline 2G ALE.	49
201	A.5.8.1.3.3	Support of ISDN (option) (NT). To support an ISDN address requirement, the station shall be capable of mapping any 15 character address to and from a 6 character address for displaying or calling. This optional mapping shall be available for at least one Self Address and all programmed Other Addresses in the radio.	49
202	A.5.8.1.3.4	Over-the-air address format (NT). A two AQC-ALE word sequence shall be broadcast for any AQC-ALE address. The "@" shall be used as the stuff character to complete an address that contains fewer than six characters. The sequence shall be an AQC-ALE word with the preamble TO, TIS, TWAS, or INLINK for the first three characters of the address followed by an AQC-ALE word with the preamble PART2 for the last three address characters.	49
203	A.5.8.1.4.1	Unit addresses (NT). A unit or other address shall be from one to six characters.	49
204	A.5.8.1.4.2	StarNet addresses (NT). A StarNet address shall be from one to six characters.	49

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
205	A.5.8.1.4.4	AllCall address (NT). AQC-ALE AllCall address shall be six characters. The second three characters of the AllCall address shall be the same as the first three characters. Thus, a global AllCall sequence would look like: TO-@?@|PART2-@?@.	49
206	A.5.8.1.4.5	AnyCall address (NT). AQC-ALE AnyCall address shall be six characters. The second three characters of the AnyCall address shall be the same as the first three characters. Thus, a global AnyCall sequence would look like: TO-@@?|PART2-@@?.	49
207	A.5.8.1.5	Data exchange field (NT). The 4-bit data exchange field shall be encoded as described in table A_XXXVIII and the following paragraphs. The use of the various encodings DE(1) through (9) shall be as shown in the figures for the Sound, Unit call, Starnet call, All call, and Any call in the respective subsections of A.5.8.2. NOTE: A station may use the contents of the data exchange field to further validate the correctness of a given frame.	52
208	A.5.8.1.5.1	DE(1) no data available (NT). DE(1) shall be sent in the TIS word in the conclusion of a Call frame. All data bits shall be set to 1s.	52
209	A.5.8.1.5.2	DE(2) number of to's left in calling cycle (NT). DE(2) shall be sent in every AQC-ALE word that contains a TO preamble. In a Call frame, the DE(2) field shall indicate the remaining number of TO preambles that remain in the frame. This is an inclusive number and when set to a value of 1 the next address shall be the caller's address using a TIS or TWAS preamble. When the remaining call duration would require a count greater than 15, a count of 15 shall be used. A value of 0 shall be used in in the Response frame and Acknowledgement frame when a single address in required. DE(2) shall count down to 1 whenever multiple addresses are transmitted in an address section.	52

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
210	A.5.8.1.5.3	DE(3) Inlink resource list (NT). DE(3) shall be sent in the PART 2 word that follows each TO word. The DE(3) field shall indicate the type of traffic to be conveyed during the Inlink state, using the encodings in table AXXXIX. Values not specified in the table are reserved, and shall not be used until standardized. Upon receipt of the INLINK Resource List in the Call, the called station shall determine whether the station can operate with the desired resource. When responding to the call, the called station shall honor the requested resource whenever possible. If the resource requested is unavailable, the called unit shall respond with an alternate resource that is the best possible alternative resource available to the receiver. This information is provided in the Response frame of a handshake. By definition, when the calling station enters an Inlink state with the called station, the calling station accepted the Inlink resource that the called station can provide.	52

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
211	A.5.8.1.5.4	DE(4) local noise report (NT). DE(4) shall be sent in the PART 2 word that concludes a Call frame and in every PART 2 word in a Sounding frame. The Local Noise Report contains information which describes the type of local noise at the sender's location. The Local Noise Report provides a broadcast alternative to sounding that permits receiving stations to approximately predict the bilateral link quality for the channel carrying the report. An example application of this technique is networks in which most stations are silent but which need to have a high probability of linking on the first attempt with a base station. A station receiving a Local Noise Report can compare the noise level at the transmitter to its own local noise level, and thereby estimate the bilateral link quality from its own LQA measurement of the received noise report transmission. The report includes a mean and maximum noise power measured on the channel in the past 60 minutes with measurement intervals at least once per minute. The Local Noise Report shall be formatted as shown in figure A.5.8-5. Units for the Max and Mean fields are dB relative to 0.1 µV 3 kHz noise. The Max noise level shall be the amount of distance from the Mean that the local noise was measured against. When averaging is used, standard rounding rules to the integer shall apply. By comparing the noise levels reported by a distant station on several channels, the station receiving the noise reports can select a channel for linking attempts based upon knowledge of both the propagation characteristics and the interference situation at that destination. For a more detailed local noise report, a station may broadcast the ALE Local Noise Report command in the message section. When deriving the average noise floor, signals which can be recognized shall be excluded from the power measurement.	52

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
212	A.5.8.1.5.5	DE(5) LQA variation (NT). DE(5) shall be sent in the TIS or TWAS word in the conclusion of AQC-ALE Response and Acknowledgement frames. It shall report the signal quality variation measured on the immediately preceding transmission of the handshake. Whenever an AQC-ALE or ALE word is received, a signal noise ratio (SNR) sample shall be computed. This measurement can be used to determine the capacity of the channel to handle traffic. Because several types of signaling protocols may be used while in the linked state, it is important that this measurement be applicable to a wide variety of signaling structures. The DE(5) LQA Data Exchange word provides feedback as to the value of the measured signal. During receipt of a AQC-ALE or ALE signal, an SNR measurement shall be taken at least every Tw (non-redundant word period). Three characteristics shall be collected: A Mean SNR signal shall be derived A Minimum SNR value during the frame shall be recorded Rapid Change Boolean, when set 1, shall indicate more than 40 percent of the measurements varied greater than ±3 dB from the mean SNR. Items 2 and 3 of the LQA calculation are reported in this data exchange field. This field shall be set to all 1's when the LQA measurement value in DE(6) indicates that no SNR value was taken. Table A-XLT shall be used to encode the magnitude of lowest value SNR difference from the Mean.	52

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
213	A.5.8.1.5.6	DE(6) LQA measurement (NT). DE(6) shall be sent in the PART 2 word in the conclusion of AQC-ALE Response and Acknowledgement frames. The Link Quality Measurement contains the predicted quality of the channel to handle traffic. This value may be used as a first approximation to setting data rates for data transmission, determining that propagation conditions could carry voice traffic, or directing the station to continue to search for a better channel. (See A.5.8.1.5.5 for a description of the LQA.) This can also be used to determine which channels are more likely to provide sufficient propagation characteristics for the intended Inlink state traffic. Table A-XLII shall be used to encode the measured mean SNR value. An additional column is provided suggesting possible channel usage for the given SNR value.	52
214	A.5.8.1.5.7	DE(7) number of Tis/Twas left in sounding cycle (NT). While transmitting the sounding frame, DE(7) shall be sent in each TIS/TWAS word to identify the remaining number of TIS/TWAS words that will be transmitted in the frame. This is an inclusive number and when set to a value of 1, only one PART2 word remains in the frame. When the sound duration would require an initial count greater than 15, a count of 15 shall be used until the count can correctly decrement to 14. From this point, DE(7) shall count down to 1.	52
215	A.5.8.1.5.8	DE(8) inlink data definition from INLINK (NT). Inlink Event transaction definitions are defined by 2 data exchange words. DE(8) shall be used when the INLINK preamble is used, while DE(9) shall be used for the second half of the address begun with the INLINK preamble.	52
216	A.5.8.1.5.8.1	Acknowledge this frame (NT). Data Bit3, ACK-THIS, when set to 1, shall indicate that the stations which are linked to the transmitting station are to generate an ACK Inlink message in response to this frame. If the address section of an Inlink transaction is present, then only the addressed stations in the link are to respond. The responding station Inlink event shall return a NAK if any CRC in the received message fails, otherwise the Inlink event shall be an ACK. When Data Bit3 is set to 0, the transmitting station is broadcasting the information and no response by the receiving stations is required.	52

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
217	A.5.8.1.5.8.2	Identify command section count (NT). Data Bits 0-2 represent the number of command sections that are present in the frame. A value of 0 indicates no command sections are present, i.e., the frame is complete when the immediately following PART2 address word is received. A value of 1 indicates that 1 command section is present. Up to seven command sections can be transmitted in one Inlink event transaction.	52
218	A.5.8.1.5.9.1	I AM remaining in a link state (NT). Data Bit3, I'mInlink, when set to 1, shall indicate that the transmitting station will continue to be available for Inlink transactions. When set to 0, the station is departing the linked state with all associated stations. It shall be the receiver 's decision to return to scan or perform other overhead functions when a station departs from a link state. All Inlink event transactions should set this to '1' when the members of the link are to remain in the linked state. Valid combinations of data bit ACK-THIS and I'mInlink are defined in table A-XLIII.	52
219	A.5.8.1.5.9.2	Inlink event transaction code (NT). Data Bits 0-2 represent the type of Inlink event that is being transmitted. Table A-XLIV shall be used to encode the types of Inlink events. The Operator ACK/NAK and AQC-ALE Control Message sections are described in A.5.8.3.	52
220	A.5.8.1.6.1	PSK tone sequence placement (NT). The optional PSK tone sequence for link quality may be inserted after the last tone associated with any PART2 AQC-ALE word and prior to the first FSK tone of the following AQC-ALE word (if any). The 26.67 msec PSK tone sequence shall be preceded by 8 msec of guard time and followed by 21.33 msec of guard time, for a total duration of 56 msec (seven symbol periods of the 2G ALE FSK waveform).	52
221	A.5.8.1.6.2	PSK tone sequence generation (NT). The PSK tone sequence shall be identical to the 26.67 msec preamble for Burst Waveform 2 (see C.5.1.5).	52

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
222	A.5.8.2.1	Calling cycle (NT). The calling cycle frame is used when the caller is attempting to reach a station that is scanning. Sufficient address words are repeated continuously until the scanning radio has had ample opportunity to stop on the channel. Other receivers, upon hearing an address, may recognize the presence of an ongoing call and skip processing the channel until the handshake is completed. The calling cycle shall be composed of the target address broadcast for at least the period defined as the call duration for the radio, followed by the target address followed by the caller's (source) address. Data exchange values shall be per the specific type of call being attempted. When the call duration is not evenly divisible by 2 Trw, then an additional full address may be transmitted. When an entire address is not used to complete a fractional portion of the call duration, the caller shall begin the transmission with the second half of the target address using the PART2 preamble. In this case, the LP word number shall be 1. When the radio is programmed to automatically derive the call duration, the equation shall be: Number of Channels * 0.196 Table A-XLV specifies minimum and maximum number of words used for the scanning cycle section of a call. The total number of words used for calling is four additional words. The unit call time column presents the maximum time to complete a unit call as measured from the first tone transmitted by the caller to the last tone transmitted by the caller in the Acknowledgement frame. Users will see times greater than these due to call setup time, caller tune time, listen before call, and link notification delay; these may add several seconds to the response time seen by a user.	51

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
223	A.5.8.2.2	Unit call structure (NT). A unit call in AQC-ALE follows the same principles as a standard ALE unit call with the following changes. In the Leading Call section of the Call and Response, the address shall appears once instead of twice. In the Acknowledgement frame, only the conclusion section shall be sent. See figure A-53 for an example of a unit call sequence from SOURCE to TARGET. See A.5.8.2.1, Calling Cycle to determine the maximum number of words to send during the scanning call portion of the Call. The optional PSK tone sequence shall be available during any leg of the handshake. An Inlink Event Transaction shall be used in lieu of the Acknowledgement frame when ALE data traffic is available for the Inlink State in AQC-ALE.	47
224	A.5.8.2.3	Star net call structure (NT). The call probe shall be identical to a Unit call where the star net address replaces the unit address. The Slotted Response portion shall always use a two word address for the TO and TIS addresses. Just as in Baseline 2G ALE, the slotted response shall be 5 Tw wider than the 6 Tw needed to transmit the TIS/TWAS address. Slot 0 shall be 17 Tw to accommodate a non-net member participating in the call. Slot 1 and all remaining slots shall be 11 Tw wide. No LQA information shall be emitted in the Acknowledgement portion of the Start Net Call except as provided through the data exchange bits. The optional PSK tone sequence shall be available during any frame of the handshake. The slot width does not change, even when the optional PSK tone sequence is used. The Data Exchange values shall be per figure A-54. An Inlink Event frame may be used for the Acknowledgement frame. Slots 1 and beyond may be expanded by fixed number of Trw for certain types of AQC-ALE Inlink Messages.	47
225	A.5.8.2.4	AllCall frame formats (NT). A station placing an AllCall shall issue the call using the calling cycle definition in A.5.8.2.1. The actions taken shall be as described for baseline 2G ALE AllCalls. The Data Exchange values shall be per figure A.-55, AllCall Frame Format. Selective AllCall shall be supported.	47

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
226	A.5.8.2.5	AnyCall frame formats (NT). A station placing an AnyCall shall issue the call using the calling cycle definition in A.5.8.2.1. The actions taken shall be a described for baseline 2G ALE AnyCalls except that the Slot width shall be fixed at 17 Tw. The leading address section and conclusion shall be used for each slotted response. The Data Exchange values shall be per figure A-56. Selective AnyCall and Double Selective AnyCall shall be supported. An Inlink Event frame shall not be used for the Acknowledgement frame.	47
227	A.5.8.2.6	Sounding (NT). The sounding cycle shall be composed of the station's address broadcast for at least the period defined as the sound duration for the radio. Data exchange values shall be as denoted in figure A-57. When the call duration is not evenly divisible by 2 triple-redundant word times, then the an additional full address may be transmitted. When an entire address is not used to complete a fractional portion of the sound duration, the caller shall begin the transmission with the second half of the target address using the PART2 preamble. In this case, the LP word number shall be 1. As shown in figure A-57, the LP word number shall toggle between 0 and 1. When the radio is programmed to automatically derive the sound duration, the equation shall be: Number of Channels * 0.196 + 0.784 See table A-58 for the minimum and maximum number of Trw to broadcast automatically.	47

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
228	A.5.8.2.7	Inlink transactions (NT). AQC-ALE stations shall have the capability to transfer information within the Inlink state of the radio. A special purpose frame is defined for the purpose of separating link establishment transactions from transactions that occur during the Inlink state. Two types of Inlink transactions are defined, Inlink Event and Inlink Event Sequence. Either transaction can have an optional address section appended to the beginning of the frame. This optional address section indicates that the transaction is targeted at the addresses defined in this section of the frame. The Inlink frame uses Data Exchange DE(8) and DE(9). DE(8) informs the recipient of the type of transaction and whether this frame needs to be acknowledged. See A.5.8.3.8. DE(9) data content indicates to the caller the exact form of the data and identifies if the sender intends to remain in the linked state with all those represented in the address section of the frame. When the address section is omitted, the frame shall be targeted to all stations currently linked with the transmitting station. See A.5.8.3.9. The data Exchange values shall be per figure A-58. This figure outlines the general format of both types of Inlink transaction events.	48
229	A.5.8.2.7.1	Inlink transaction as an acknowledgement (NT). The Inlink Event or the Inlink Event Sequence shall be used as the Acknowledgement frame of a handshake whenever the calling radio has a message for the radios entering the Inlink state. If the INLINK preamble is replacing a TIS preamble indicating that the radios were to remain in an Inlink state, then the I'M LINKED bit shall be set to 1. If a TWAS preamble would normally be used for this transmission, the I'M LINKED bit shall be set to 0. Thus, the calling station can minimize over the air time for any transaction by judicious use of Inlink state and associated control bits.	48

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
230	A.5.8.2.7.2	CRC for Inlink event sequences (NT). As seen in figure A-58, a command section of an Inlink event sequence shall consist of the COMMAND preamble, followed by the data associated with the command using the preambles DATA and REPEAT. The Inlink event sequence frame shall be terminated with a COMMAND preamble containing the CRC of the data contained in all words starting with the first COMMAND preamble. This CRC shall be computed exactly as the CRC for a standard ALE DTM (See A.5.6.1). The receiver shall maintain a history of failed CRC. The history may be displayed to the operator or used in channel selection algorithms for follow-on traffic.	48
231	A.5.8.2.7.3	Use of address section (NT). The address section of a Inlink transaction, when present, shall indicate that the addressed stations in the link are to react to the information contained in the message section.	48
232	A.5.8.2.7.4	Slotted responses in an Inlink state (NT). When an acknowledgement has been requested, each radio in the address section shall be assigned a response slot in the same manner as a standard ALE group call. The slot width shall be as specified for AQC-ALE StarNet call, A.5.8.2.4. When the address section contains a StarNet address, the slot assignments shall be per the StarNet definition. When no slot assignment can be determined and an acknowledgement is requested, the receiving radio shall respond as quickly as possible. Slotted responses shall use an Inlink transaction frame beginning with the INLINK preamble. The address section shall not be permitted in the slotted response. When a the transmitting station issues a message that requires a responding message, such as time-request to Time-is, the slot widths for slot 1 and greater shall automatically expand by a fixed number of Trw to satisfy the response. When a response could be variable in length, the maximum slot width shall be used. The maximum width in Tw for an Inlink transaction shall be 44 Tw. This could represent an AMD message of up to 27 characters.	48

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
233	A.5.8.3.1	Operator ACK/NAK transaction command section (optional) (NT). This optional message section is a means to poll every station to determine if a site is currently manned. The operator must respond to the request for acknowledgement in a timely manner. AMD messages formatted in accordance with table A.5.8-11 Operator ACK/NAK shall be used to define the values and meaning of the message. When a request for ACK is received, the operator shall have 15 seconds to respond. The ACK message shall be sent immediately as an Inlink Event if the operator responds. If no response from the operator occurs the receiving station shall emit an Operator NAK response Inlink Event.	50
234	A.5.8.3.2	AQC-ALE control message section (optional) (NT). Table A-XLVII defines the values used to declare a AQC-ALE control message. When sending these commands, all commands in the frame shall be AQC-ALE control messages. Table A-XLVI defines which message types in an AQC-ALE message section are mandatory for all implementations of AQC-ALE and which messages are optional for AQC-ALE implementations. As seen in figure A-59, each word with a COMMAND preamble contains a 5-bit MsfID field to define the type of control message present. Because ALE orderwire functions are still allowed, MsgID values greater than 7 are not allowed, as these would overlap with existing ALE orderwire commands.	50

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
235	A.5.8.3.2.1	AMD dictionary message (NT). When a message section can be translated into a dictionary and all stations linked are using AQC-ALE, an AMD message may use the dictionary word as provided in table A-XLVIII. Each character in the AMD message will represent itself or a word/phrase found in one of three look up tables. Because messages are short, when a transmission word is lost, the complete message could be rendered meaningless if a bit packing approach was used. This method shall consist of a series of 7-bit values. This is the same size as currently used for an AMD message. At a minimum, a radio shall provide lookups for values 2 through 95. A mapped entry can be of any length. Every radio communicating with packed AMD formats must use the same programmed values for words or confusion in the message will result. Messages should be displayed in their unpacked form as looked up or optionally with curly braces around the numeric value of the lookup, i.e. {2.5} would indicate word is in Dictionary Set 2 at index position 5. (See figure A-60 for the format of an AQC-ALE Packed AMD message.) The two dictionaries sets provide a means to identify the most frequently used words communication for a mission. Dictionary Set 1 shall be the initial dictionary used for values 96 through 127. When a character with value 1 is received in a Packed AMD Message, then Dictionary Set 2 shall be the word list for character values 96 through 127 until the end of that message or receipt of a character with value 0 in that message, after which Dictionary Set 1 shall again be used, and so on. A network manager might choose to minimize air time and provide some unique information using Dictionary Set 1 by placing tactical user phrases in the dictionary, such as "AT WAY POINT". To identify where the a unit is, the AMD message "AT WAY POINT 1" would be entered. What would be transmitted in the Packed AMD message would be a 4 TRW Inlink event transmission consisting of INLINK, PART2, COMMAND, REPEAT preambles. That is the entire message would fit in one COMMAND TRW as: Message Type = AQC-ALE Packed AMD Message Look-up 1 = Index into Dictionary Set 1 for "AT WAY POINT" Look-up 2 = The character "1" No spaces are needed because the lookup table transform shall place spaces into the expanded message as defined in table A-IL.	50

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
236	A.5.8.3.2.2	Channel definition (NT). The channel definition provides a system to reprogram the radio with a different frequency or to cause stations in a link to move to a traffic channel. This allows the radios to listen for general propagation characteristics in a common area and then move to a nearby channel to manage the inlink state transactions. By allowing a channel to be reprogrammed, the radio can adapt to a wide variety of conditions that may occur on a mission. If congestion is experienced on the assigned frequency, the stations shall return to the normal scan list and reestablish the call. The channel index number is specified from a range of 0 to 255. A radio shall have at least 100 channels available for reprogramming. A channel index of 0 shall indicate that the receive and transmit frequencies are to be used for the remainder of this link. Other channel index numbers indicate that the new assignment shall be entered into the channel table. Frequencies shall be specified as a 21-bit values with each step being 100 Hz. See figure A-61 for an example format of this message. A 2-bit value 0 for emission mode shall indicate upper side band and a value of 1 shall indicate a value of lower side band. Bits 17-18 refer to the receive frequency, bits 19-20 to the transmit frequency.	50
237	A.5.8.3.2.3	Slot assignment (NT). The slot assignment feature allows a control station to dynamically assign response slots for stations with which it is linked. In this manner, when a response is required from several stations in an inlink state, orderly responses can be generated. The slot width shall be in Tw. When set to 11 or less, the radio shall respond with the shortest form possible allowing for 5 Tw as timing error. Figure A-62 depicts the format of a slot assignment. Examples of this usage would be setting up a link to several stations and then periodically polling them with an operator ACK/NAK request or a position report request. Each radio would respond at a specified time following that transmission. This form of time division multiplexing is self-synchronizing to minimize the need for time of day clock synchronization. If more traffic is required on a channel, slot widths can be expanded.	50

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
238	A.5.8.3.2.4	List content of database (NT). The list content of database (FIGURE a-63) shall display the programmable values of a scanning radio such that the receiver can inter-operate with that station in the best possible manner. This command requests the contents to be displayed. The Database identifier shall be the ASCII36 character set plus the characters "*" and "_".	50
239	A.5.8.3.2.5	List database activation time (NT). This function requests the time stamp of a database. Its format is identical to that shown in figure A-64.	50
240	A.5.8.3.2.6	Set database activation time (NT). This function (figure A-64) sets or displays the time stamp of a database. The first word format of the command is identical to the List Content of Database. The second word contains the time of day that the database is to be active. Only one database shall be active at a time. When the SET bit=1, the command represents the time to assert when the database becomes active. When the SET bit=0, this is a report of the current time set value. A network control station can program or select preprogrammed channel sets and then cause all mission participants to switch to a new set of channels to operate upon. Other uses would include moving from one area of the world to another may cause the user to move into a different set of allocated frequencies.	50

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
241	A.5.8.3.2.7	Define database content (NT). This function defines a database over the air. The first TRW format of the command is identical to the List Content of Database. Subsequent words contain association of existing information into a dataset that the radio may operate against. As shown in figure A-65. Word 2 of the message shall consists of: 3 bits of LP Level number. Values range from 0 through 4. 1 bit for Lower Level Linking. When set to 1, the radio shall honor lower level link attempts. 3 bits for LP Key number identification. A value of 0 indicates no key assignment. When an LP level greater than 0 exists, this would be an non-operational condition. If more than one type of key is used between LP levels, they must use the same key index. When a radio does not have a key present for a given LP Key, a value of NOKEY shall be used. 5 bits for the number of channels. Immediately following this word shall be (number_of_Channels/2) words containing the channel numbers to use. Earlier commands defining channel numbers or a preprogrammed value define the actual frequencies used. 6 bits for defining the words from a dictionary into the 64 words. The mapping of a dictionary into a database dictionary allows a specific set of words that yield a higher frequency hit rate to the dictionary. A value of 0 indicates using the orginal programmed dictionary. The mapping of the dictionary is contained in the Trw that follow the channel association.	50
242	A.5.8.3.2.8	Database content listing (NT) This command shall have the same format as the Define Database Content.	50

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
243	A.5.8.4	AQC-ALE linking protection (NT). When operating in LP with AQC-ALE, every 24-bit AQC-ALE word shall be scrambled in accordance with appendix B. The same rules for LP in baseline 2G ALE shall be applied to AQC-ALE with the following exceptions: The word number for all TO AQC-ALE words during the scanning call shall be 0, and the word number for all PART 2 AQC-ALE words during the scanning call shall be 1. The TIS or TWAS word that concludes a scanning call shall use word number 2 and the following PART 2 word shall use word number 3. The AQC-ALE response frame shall use word numbers 0, 1, 2, and 3. A 2-word AQC-ALE acknowledgement shall use word numbers 0 and 1. The TOD shall be later than that used at the end of the scanning call.	53
244	B.4.1	LP overview. The LP procedures specified herein shall be implemented as distinct functional entities for control functions and bit randomization functions. (Unless otherwise indicated, distinct hardware for each function is not required.) Figure B-1 shows a conceptual model of the MIL-STD-188-141 data link layer functions, showing the placement within the data link layer at which LP shall be implemented. The linking protection control module (LPCM) shall perform all control functions specified herein and interface to the ALE controller as shown on figure B-2. Scrambler(s) shall perform all cryptographic operations on ALE words, under the control of the LPCM. Use of LP shall neither increase the time to establish a link compared to the non-protected radio, nor degrade the probability of linking below the standard set for non-protected linking in appendix A, table A-II. A means shall be provided to disable the LP functions and operate the radio in the clear unprotected application level (AL-0). Hardware scramblers shall be removable without impairment of the unprotected application level functionality of a radio.	53

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
245	B.4.1.1	Linking protection application levels. The application levels of LP are defined herein. The classified application level (AL-4), which offers the highest degree of protection, and the unclassified-but-sensitive application level (AL-3) use National Security Agency (NSA)-controlled algorithms described in classified documents. This standard can only make reference to these documents with very little other descriptive material. All protected radios shall be capable of operation at the unclassified application level (AL-1). A means shall be provided to disable automatic linking at linking protection application levels less secure than the application level in use by the station being called. For example, a station which is operating at unclassified enhanced application level (AL-2) shall be able to disable the receiver from listening for linking attempts at unprotected application level (AL-0) and AL-1. (Design objective (DO): Alert the operator but do not link automatically when a valid call is received from a transmitter with a lower linking protection application level.) This mechanism shall not preclude the operator from manually initiating ALE using a disabled application level. This manual override is required for interoperability.	53
246	B.4.1.1.1	AL-0. Assignment of the AL-0 indicates that no linking protection is being employed. No protection is provided against interfering, unintentional, or malicious linking attempts. All protected HF radios shall be capable of operation in the AL-0 mode.	53
247	B.4.1.1.2	AL-1. The AL-1 unclassified application level is mandatory for all protected radio systems, and therefore, provides protected interoperability within the U.S. Government. All protected radios shall be capable of operation in the AL-1 mode even if they also provide application levels with greater protection. The AL-1 scrambler shall employ the lattice encryption algorithm as specified in B.5.6, and may be implemented in hardware or software with manufacturer-specified interfaces. This scrambler is for general U.S. Government and commercial use. The AL-1 protection interval (PI) is 60 seconds, which provides slightly lower protection than any of the other available protected modes but allows for relaxed synchronization requirements.	53
248	B.4.1.1.3	AL-2. The AL-2 scrambler shall employ the same algorithm as specified for the AL-1, and may be implemented in hardware or software, with manufacturer-specific interfaces. This scrambler is for general U.S. Government and commercial use. The AL-2 PI is 2 seconds.	53

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
249	B.4.1.1.4	AL-3. AL-3 shall use distinct hardware scramblers and shall employ an algorithm and the corresponding interface control document (ICD) developed by the NSA. Systems employing the AL-3 LP shall meet NSA security requirements. The AL-3 PI is a maximum of 2 seconds.	53
250	B.4.1.1.5	Classified application level AL-4. AL-4 shall use distinct hardware scramblers and shall employ an algorithm and the corresponding ICD developed by NSA. An AL-4 scrambler may be used to protect classified orderwire traffic. Systems employing classified application level LP shall meet NSA security requirements. The AL-4 PI is a maximum of 1 second.	53
251	B.5.2.2	TOD. The LPCM requires accurate time and date for use in the LP procedure. The local time base shall not drift more than ±1 second per day when the station is in operation.	53
252	B.5.2.2.1	TOD entry. A means shall be provided for entry of TOD (date and time) via either an operator interface or an electronic fill port or time receiving port (DO: provide both operator interface and electronic port). This interface should also provide for the entry of the uncertainty of the time entered. If time uncertainty is not provided, a default time uncertainty shall be used. Defaults for the various time fill ports may be separately programmable. Default time uncertainty shall be determined by the procuring agency or manufacturer. Default uncertainty of ± 15 seconds is suggested.	53
253	B.5.2.2.2	Time exchange protocols. After initialization of TOD, the LPCM shall execute the time protocols of B.5.5 as required, to maintain total time uncertainty less than the PI length of the most secure LP mode it is using. The LPCM shall respond to time requests in accordance with B.5.5.3 unless this function is disabled by the operator.	53

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
254	B.5.2.3	Seed format. The LPCM shall maintain randomization information for use by the scrambler(s), and shall provide this information, or "seed," to each scrambler in accordance with the applicable ICD. The 64-bit seed shall contain the frequency, the current PI number, the date, and a word number in the format shown on figure B-3, where the most significant bits of the seed and of each field are on the left. The TOD portion of the seed shall be monotonically non-decreasing. The remaining bits are not so constrained. The date field shall be formatted in accordance with figure B-3. The month field shall contain a 4-bit integer for the current month (1 for January through 12 for December). The day field shall contain a 5-bit integer for the current day of the month (1 through 31). A mechanism shall be provided to accommodate leap years. The PI field shall be formatted in accordance with figure B-3. The coarse time field shall contain an 11-bit integer which counts minutes since midnight (except that temporary discrepancies may occur as discussed in B.5.3). The 6-bit fine time field shall be set to all 1s when time is not known more accurately than within 1 minute (i.e., time quality of six or seven). When a time synchronization protocol (see B.5.5) is employed to obtain more accurate time, the fine time field shall be set to the time obtained using this protocol and incremented as described in B.5.3. The fine time field shall always be a multiple of the PI length, and shall be aligned to PI boundaries (e.g., with a 2-second PI, fine time shall always be even). The word field shall be used to count words within a PI, as specified in B.5.3. The frequency field shall be formatted in accordance with figure B-3. Each 4-bit field shall contain one binary-coded decimal digit of the frequency of the current protected transmission. Regardless of time quality, the fine time field shall be set all 1s for the unclassified application level of LP.	53

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
255	B.5.3	Procedure for 2G ALE. The procedure to be employed in protecting transmissions consisting entirely of 24-bit ALE words is presented in B.5.3.1 and B.5.3.2. When a radio is neither transmitting nor receiving, the PI number shall be incremented as follows. When using linking protection level AL-2 and local time quality (see appendix A, A.5.6.4.6) is "5" or better, the fine time field shall be incremented at the end of each PI by the length of the PI, modulo 60. When the fine time field rolls over to "0," the coarse time field shall be incremented, modulo 1440. At midnight, the coarse and fine time fields shall be set to "0," and the date and month fields updated. When using linking protection level AL-1, or when the local time quality (see appendix A, A.5.6.4.6) is "6" or "7," the fine time field shall contain all "1s," and the coarse time field shall be incremented once per minute, modulo 1440. At midnight, the coarse time field shall be set to "0", and the date and month fields updated. Whenever the local time uncertainty is greater than the PI, the system shall: a. Present an alarm to the operator. b. Optionally, also attempt resynchronization (if enabled). The first attempt at resynchronization shall use the current fine seed. If this fails, the system shall use a coarse seed for subsequent attempts.	53

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
256	B.5.3.1	Transmitting station. Each word to be transmitted shall be encrypted by the scrambler using the current seed information. In the course of a transmission, the protocol described below may cause a discrepancy between the TOD fields in the seed and the real time. Such discrepancy shall be allowed to persist until the conclusion of each transmission, whereupon the TOD fields of the seed shall be corrected. The word number field “w” shall be as follows: a. During the scanning call phase (T_{sc}) of a call, or throughout a sound, the calling stations shall alternate transmission of words encrypted using w = 0 and w = 1. The first word of T_{sc} shall begin with w = 0 or w = 1, as required, such that the last word of T_{sc} is encrypted using w = 1. The TOD used during T_{sc} shall change as required to keep pace with real time, except that TOD shall only change when w = 0. Words encrypted with w = 1 shall use the same TOD as the preceding word. b. At the beginning of the leading call phase (T_{lc}) of a call (which is the beginning of a single-channel), the first word shall be encrypted using w = 0 and the correct TOD for the time of transmission of that word. c. All succeeding words of the call shall use succeeding word numbers up to and including w = w_{max}. For the word following a word encrypted with w = w_{max}, the TOD shall be incremented and w shall be reset to 0. (1) W_{max} = 2 for a 1-second PI. (2) W_{max} = 5 for a 2-second PI. (3) W_{max} = 153 for a 60-second PI. d. Responses and all succeeding transmissions shall start with w = 0 and the current (corrected) TOD, with these fields incremented as described in paragraph c above for each succeeding word. Figure B-4 illustrates the permissible TOD with combinations for a transmitting station using a 60-second (w_{max}=153) and a 2-second PI (w_{max} = 5), and the permissible sequences of these combinations. Sounds are protected in the same fashion with T_{rs} in place of T_{lc}.	53

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
257	B.5.3.2	Receiving station. Because of the possibility of acceptable decodes under multiple TOD/word number combinations, receivers shall attempt to decode received words under all allowed combinations (the current and adjacent PIs (future and past), and both w = 0 and w = 1) when attempting to achieve word synchronization with a calling station (six combinations). Stations prepared to accept time requests (see B.5.5.2.2) shall also attempt to decode received words using coarse TOD (fine time = all 1s, correct coarse time only) with both w = 0 and w = 1 (eight combinations total). All valid combinations shall be checked while seeking word sync. After achieving word sync, the number of valid combinations is greatly reduced by the link protection protocol. Figure B-4 illustrates the permissible TOD/w sequences for a receiving station using a 60-second PI and a 2-second PI respectively, after word sync is achieved. Note that unlike the transmitter, the receiving station state machine may be non-deterministic. For example, when in T_{sc} and in state N/1, a received word may yield valid preambles and ASCII when decrypted using all of the valid combinations: N/0, (N + 1)/0, and N/2 (the latter implying that T_{lc} started two words previously), and will therefore, be in three states at once until the ambiguity is resolved by evaluating the decrypted words for compliance with the LP and ALE protocols under the valid successor states to these three states. Stations using a PI of 2 seconds or less shall not accept more than one transmission encrypted using a given TOD, and need not check combinations using that TOD. For example, if a call is decrypted using TOD = N, no TOD before N+1 is valid for the acknowledgment.	53

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
258	B.5.3.4	Data block message (DBM) mode. a. A DBM data block contains an integral number of 12-bit words, the last of which comprises the least significant 12 bits of a cyclic redundancy check (CRC). These 12-bit words shall be encrypted in pairs, with the first 12-bit word presented to the LPCM by the ALE protocol module as the more significant of the two. When a data block contains an odd number of 12-bit words (i.e., basic DBM data block and extended DBM data blocks with odd N), the final 12-bit word shall not be encrypted, but shall be passed directly to the FEC sublayer. b. The word number field "w" of the seed shall be incremented only after three pairs of 12-bit words have been encrypted (rather than after every 24-bit word as in normal operation), except that the word number "w" shall be incremented exactly once after the last pair of 12-bit words in a DBM data block is encrypted, whether or not it was the third pair to use that word number. As usual, TOD shall be incremented whenever "w" rolls over to 0.	53

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
260	B.5.5.2.1	Time Request call (protected). A station requiring fine time shall request the current value of the network time by transmitting a Time Request call, formatted as follows. (In principle, any station may be asked for the time, but some stations may not be programmed to respond, and others may have poor time quality. Thus, multiple servers may need to be tried before sufficient time quality is achieved.) TO <time server> CMD Time Is <time> DATA <coarse time> REP <authenticator> TIS <requester>. The Time Is command shall be immediately followed by a coarse time word and an authentication word. The authenticator shall be generated by the exclusive-or of the command word and the coarse time word, as specified in appendix A, A.5.6.4.4. The Time Request call transmission shall be protected using the procedure specified in B.5.3.1 and B.5.3.2. When acquiring time synchronization, the coarse seed (fine time field in the seed set to all 1s) current at the requesting station shall be used. When used to reduce the time uncertainty of a station already in time sync, the current fine seed shall be used.	53

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
261	B.5.5.2.2	Time Service response (protected). A station which receives and accepts a Time Request call shall respond with a Time Service response formatted as follows: TO <requester> CMD Time Is <time> DATA <coarse time> REP <authenticator> TWAS <time server>. The Time Is command shall be immediately followed by a coarse time word and an authentication word. The authenticator shall be generated by the three-way exclusive-or of the command word and the coarse time word from this transmission and the authentication word (including the REP preamble) from the requester, as specified in appendix A, A.5.6.4.5. The entire Time Service response shall be protected as specified in B.5.3.1 and B.5.3.2 using the time server's current coarse seed if the request used a coarse seed, or the current fine seed otherwise. The seed used in protecting a Time Service response may differ from that used in the request that caused the response. A time server shall respond only to the first Time Request call using each fine or coarse seed; i.e., one coarse request per minute and one fine request per fine PI. Acceptance of time request may be disabled by the operator. Stations prepared to accept coarse Time Request commands shall decrypt the initial words of incoming calls under eight (vs. six) possible seeds: w = 0 and w = 1 with the current coarse TOD, and with the current fine TOD ±1 PI. (Note that only one coarse TOD is checked vs. three fine TODs.)	53
262	B.5.5.2.3	Time Server request (protected). A time server may request authenticated time from the original requestor by returning a Time Server request, which is identical to the Time Service response as given above except that the TWAS termination is replaced by TIS. The original requester shall then respond with a Time Service response, as above, with an authenticator generated by the three-way exclusive-or of the command word and the coarse time word from its Time Service response and the authentication word (including the REP preamble) from the Time Server request, as specified in appendix A, A.5.6.4.5.	53

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
263	B.5.5.2.4	Authentication and adjustment (protected). A station awaiting a Time Service response shall attempt to decrypt received words under the appropriate seeds. If the request used a coarse seed, the waiting station shall try the coarse seeds used to encrypt its request, with w = 0 and w = 1, and those corresponding to 1 minute later. If the request used a fine seed, the waiting station shall try the usual six seeds: w = 0 and w = 1, and those corresponding to 1 minute later. If the request used a fine seed, the waiting station shall try the usual six seeds: w = 0 and w = 1 with the current fine TOD ±1 PI. Upon successful decryption of a Time Service response, the requesting station shall exclusive-or the received command and coarse time words with the authentication word it sent in its request. If the 21 least significant bits of the result match the corresponding 21 bits of the received authentication word, the internal time shall be adjusted using the time received in the Time Is command and coarse time word, and the time uncertainty shall be set in accordance with appendix A, A.5.6.4.6.	53
264	B.5.5.3.1	Time Request call (non-protected). A station requiring time shall request the current value of the network time by transmitting a non-protected Time Request call, formatted as follows: TO <time server> CMD Time Request DATA <coarse time> REP <random #> TIS <requestor>. The Time Request command shall be immediately followed by a coarse time word, followed by an authentication word containing a 21-bit number, generated by the requesting station in such a fashion that future numbers are not predictable from recently used numbers from any net member. Encrypting a function of a radio-unique quantity and a sequence number that is incremented with each use (and is retained while the radio is powered off) may meet this requirement.	53

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
265	B.5.5.3.2	Time Service response (non-protected). A station that receives and accepts a non-protected Time Request call shall respond with a non-protected Time Service response formatted as follows: TO <requester> CMD Time Is <time> DATA <coarse time> REP <authenticator> TWAS <time server>. The Time Is command shall be immediately followed by a coarse time word and an authentication word. The 21-bit authenticator shall be generated by encrypting the 24-bit result of the three-way exclusive-or of the command word and the coarse time word from this transmission and the entire random number word (including the REP preamble) from the requester, as specified in appendix A, A.5.6.4.5. The encryption shall employ the AL-1 and AL-2 algorithm and a seed containing the time sent and w = all 1s. The least-significant 21 bits of this encryption shall be used as the authenticator. A time server shall respond only to the first error-free non-protected Time Request call received each minute (according to its internal time). Acceptance of non-protected time requests may be disabled by the operator.	53
266	B.5.5.3.3	Authentication and adjustment (non-protected mode). Upon receipt of a non-protected Time Service response, the requesting station shall exclusive-or the received coarse time word with the received Time Is command word. Then exclusive-or the result with the entire random number word it sent in its Time Request call, and encrypt this result using w = all 1s and the coarse time contained in the Time Service response. If the 21 least significant bits of the result match the corresponding 21 bits of the received authentication word, the internal time shall be adjusted using the received coarse and fine time, and the time uncertainty shall be set in accordance with appendix A, A.5.6.4.6.	53

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
267	B.5.5.4	Passive time acquisition (optional). As an alternative to the active time acquisition protocols specified above, stations may attempt to determine the correct network time passively by monitoring protected transmissions. Regardless of the technique used to otherwise accept or reject time so acquired, passive time acquisition shall include the following constraints: a. Local time may only be adjusted to times within the local window of uncertainty. Received transmissions using times outside of the local uncertainty window shall be ignored. b. Local time quality shall be adjusted only after receipt of transmissions from at least two stations, both of which include time quality values, and whose times are consistent with each other within the windows implied by those time qualities. A passive time acquisition mechanism may also be used to maintain network synchronization once achieved. Passive time acquisition is optional, and if provided, the operator shall be able to disable it.	53
268	B.5.5.5	Time broadcast. To maintain network synchronization, stations shall be capable of broadcasting unsolicited Time Is commands to the network, periodically or upon request by the operator: TO <net> CMD Time Is <time> DATA <coarse time> REP <authenticator> TWAS <time server>. The Time Is command shall be immediately followed by a coarse time word and an authentication word. The authenticator shall be generated by the exclusive-or of the command word and the coarse time word from this transmission as specified in appendix A, A.5.6.4.4. If the broadcast is made without LP (i.e., in the clear), the authenticator must be encrypted as described in appendix A, A.5.6.4.5 to provide any authentication. The use of an authenticator that does not depend on a challenge from a requesting station provides no protection against playback of such broadcasts. A station receiving such broadcasts must verify that the time and the time uncertainty that the broadcasts contain are consistent with the local time and uncertainty before such received time is at all useful.	53

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Reference Number	Military Standard Paragraph	Requirements	Subtest Number
269	B.5.6.1	Encryption using the Lattice Algorithm. A schematic representation of the algorithm is shown in figure B-5. The algorithm operates on each of the 3 bytes of the 24-bit word individually. At each step, here termed one "round" of processing, each byte is exclusive-ored with one or both of the other data bytes, a byte of key, and a byte of seed, and the result is then translated using the 256x8 bit substitution table ("S-box") listed in table B-I. Eight rounds shall be performed. Mathematically, the encryption algorithm works as follows: 1. Let f(•) be an invertible function mapping {0..255} -> {0..255}. 2. Let V be a vector of key variable bytes and S be a vector of TOD/frequency "seed" bytes. Starting with the first byte in each of V and S, perform eight "rounds" of the sequence in 4 below, using the next byte from V and S (modulo their lengths) each time a reference to V[ ] and S[ ] is made. 3. Let A be the most significant of the three-byte input to each round of encryption, B be the middle byte, and C be the least significant byte, and A', B', and C' be the corresponding output bytes of each round. 4. Then for each round, A' = f(A + B + V[ ] + S[ ]) C' = f(C + B + V[ ] + S[ ]) B' = f(A' + B + C' + V[ ] + S[ ]) The 24-bit output of the encryption algorithm consists of, in order of decreasing significance, the bytes A', B', and C' resulting from the eighth round of encryption.	53

Table B-1. MIL-STD-188-141B Requirements Matrix (continued)

Legend: ABCA — American, British, Canadian, Australian; ACK — Acknowledge; AJ — Anti-jam; AL — Application Level; ALC — Automatic Level Control; ALE — Automatic Link Establishment; AMD — Automatic Message Display; AQC — Alternative Quick Call; ARQ — Automatic Repeat-Request; ASCII —American Standard Code for Information Interchange; AWGN — Additive White Gaussian Noise; BCD — Binary Coded Decimal; Bd — Baud; BER — Bit Error Rate; b/s — bits per second; CCIR — International Radio Consultative Committee; CMD — Command; CRC — Cyclic Redundancy Check; dBc — decibels referenced to full peak envelope power; dBm — decibels referenced to one milliwatt; DCE — Data Circuit-Terminating Equipment; DO — Design Objective; DODISS —Department of Defense Index of Specifications and Standards; DTE — Data Terminal Equipment; DTM — Data Text Message; EMC — Electromagnetic Compatibility; FEC — Forward Error Correction; FCS — Frame Check Sequence; FDM — Frequency Division Multiplex; FSK — Frequency Shift Keying; HF — High Frequency; HFNC —High Frequency Network Controller; Hz — Hertz; ICD — Interface Control Document; ICW —Interrupted Continuous Wave; IF — Intermediate Frequency; IMD — Intermodulation Distortion; ISB — Independent Sideband; ISDN — Integrated Services Digital Network; ITU — International Telecommunications Union; kHz — kilohertz; LP — Linking Protection; LPCM — Linking Protection Control Mechanism; LQA — Link Quality Analysis; LSB — Lower Sideband; MF — Medium Frequency; MHz — Megahertz; MIL-STD — Military Standard; MP — multipath; msec — millisecond; MSB — Most Significant Bit; NAK — Non-Acknowledgement; NATO — North Atlantic Treaty Organization; NBFM — Narrowband Frequency Modulation; NSA — National Security Agency; NT — No Test; NTIA — National Telecommunications Information Agency; PEP — Peak Envelope Power; PI — Protection Interval; PQM — Path Quality Matrix; PSK — Pulse Shift Keying; PTT — Push to Talk; QSTAG — Quadripartite Standardization Agreement; REP — Repeat; RF — Radio Frequency; SINAD — Signal plus noise plus distortion to noise plus distortion; RT — Routing Table; SN — Slot Number; SNR — Signal to Noise Ratio; SSB — Single Sideband; T — time; TDMA — Time Division Multiple Access; TIS — This is; TOD — Time of Day; TWAS — This Was; UI — Unique Index; USB — Upper Sideband; UUF — Unique User Function; UUT — Unit Under Test; VSWR – Voltage Standing Wave Ratio; WRTT — wait-for-response-and-tune timeout

APPENDIX C

TEST PROCEDURES

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C-1 SUBTEST 1, BASELINE MODES

C-1.1 Objective. To determine the extent of compliance to the requirements of Military Standard (MIL-STD)-188-141B, reference numbers 1, 2, 3, and 4.

C-1.2 Criteria

a. Frequency control of all new High Frequency (HF) equipment, except manpack, shall be capable of being stabilized by an external standard, MIL-STD-188-141B, paragraph 4.2.1.

b. All new single channel HF equipment shall provide, as a minimum, the capability for the following one-at-a-time selectable operational modes:

(1) One nominal 3 kilohertz (kHz) channel Upper Sideband (USB) or Lower Sideband (LSB) (selectable).

(2) One (rate-dependent bandwidth) Interrupted Continuous Wave (ICW) channel.*

(3) A Narrowband Frequency Modulation (NBFM) channel capability should be included as a Design Objective (DO), MIL-STD-188-141B, paragraph 4.2.1.1.

*Not mandatory for radios designed for Automatic Link Establishment.

c. All new multichannel HF equipment shall provide a single channel capability as set forth in MIL-STD-188-141B, paragraph 4.2.1.1, as a minimum, and one or more of the following modes, selectable one at a time:

(1) Two nominal 3-kHz channels in the USB and LSB (two independent channels in the same sideband - sideband selectable).

(2) One nominal 6-kHz channel in the USB or LSB (selectable).

(3) Two nominal 3-kHz channels in the USB and two in the LSB (four independent 3-kHz channels - two in each sideband).

(4) One nominal 6-kHz channel in the USB and one in the LSB (two independent 6-kHz channels - one in each sideband).

(5) One nominal 3-kHz channel in the USB and one in the LSB (two independent 3-kHz channels - one in each sideband), MIL-STD-188-141B, paragraph 4.2.1.2.

d. Push to talk (PTT) operation. PTT operation is the most common form of interaction with Medium Frequency (MF)/HF Single Sideband (SSB) radios, especially for tactical use by minimally trained “noncommunicator” operators. Manual control with PTT shall be conventional; that is, the operator pushes the PTT button to talk and releases it to listen, MIL-STD-188-141B, paragraph 4.2.2.

C-1.3 Test Procedures

a. Test Equipment Required

(1) Attenuator

(2) Audio Generator

(3) Watt Meter

(4) External Frequency Standard (Accuracy: 1E-10)

(5) Frequency Counter

(6) Spectrum Analyzer

(7) Signal Generator

(8) Power Splitter

(9) Unit Under Test (UUT)

b. Test Configuration. Configure the equipment as shown in figures C-1.1 and C-1.2.

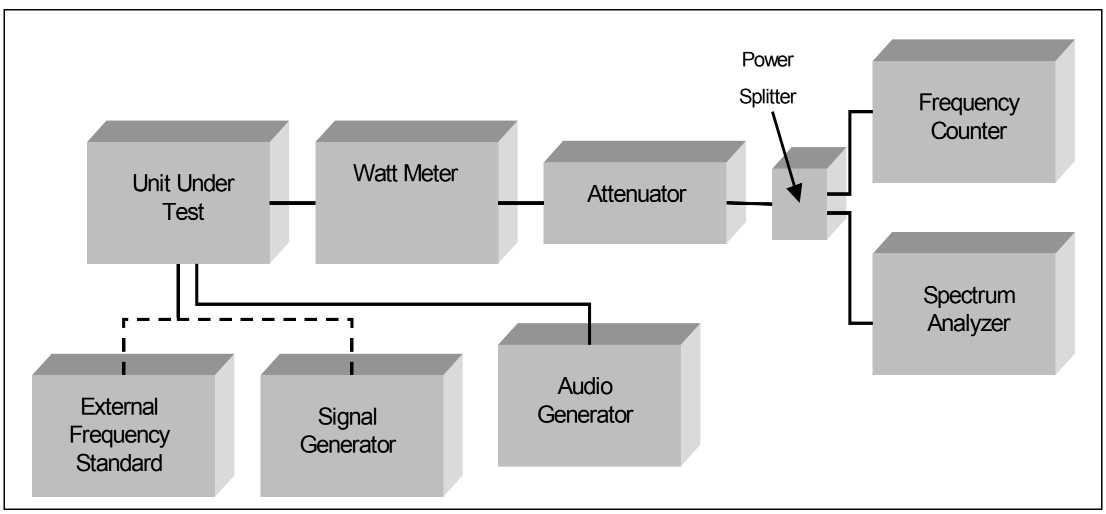


Figure C-1.1. Baseline Mode Test Equipment Configuration

c. Test Conduct. The procedures for this subtest are listed in table C-1.1.

Table C-1.1. Baseline Mode Procedures

Step	Action	Settings/Action	Result
The following procedure is for reference number 1.			
1	Set up equipment.	See figure C-1.1.	
2	Tune the UUT.	10.000 MHz; USB	
3	Input audio tone into UUT to drive transmitter.	1004 Hz from audio generator.	
4	Connect signal generator to the frequency reference port of the UUT.	Set frequency of signal generator to the manufacturers specified reference frequency. Program signal generator to output a square wave. Set level to 0 dBm.	
5	Measure RF output frequency of the UUT.	Using frequency counter.	
6	Change the frequency of the signal generator to introduce a 3 Hz error at the frequency standard input.	The resulting UUT output frequency change should be 3 Hz. Record the frequency change.	
7	Disconnect the signal generator from the frequency reference port of the UUT.		
The following procedure is for reference numbers 2 and 3.			
8	Program UUT (for single channel radios). Store these channel settings in the radio.	**Channel** **Frequency (MHz)** **Mode** 1 2.0000 USB (3 kHz) 2 3.0000 LSB (3 kHz) 3 4.0000 USB (3 kHz) 4 5.0000 LSB (3 kHz) 5 6.0000 USB (3 kHz) 6 7.0000 LSB (3 kHz) 7 8.000 NBFM* 8 9.000 ICW**	
9	Program UUT (for multichannel radios only). Store these channel settings in the radio.	**Channel** **Frequency (MHz)** **Mode** 1 2.0000 USB (3 kHz) 2 3.0000 LSB (3 kHz) 3 5.0000 USB/UUSB 4 6.0000 LSB/LLSB 5 7.0000 USB (6 kHz) 6 8.0000 LSB (6 kHz)	

Table C-1.1. Baseline Mode Procedures (continued)

Step	Action	Settings/Action	Result
10	Recall each mode and check with the spectrum analyzer.	Does each channel recall properly?	
		Channel 1	
		Channel 2	
		Channel 3	
		Channel 4	
		Channel 5	
		Channel 6	
		Channel 7	
		Channel 8	
11	Set up spectrum analyzer: Center frequency: 2 MHz Span: 12 kHz RBW = VBW = 1 kHz	Using an audio input of 1004 Hz, transmit on each of the programmed channels. Record the spectrum of the RF output for each channel, as displayed on the spectrum analyzer.	
The following procedure is for reference number 4.			
12	Verify that manual control with the PTT is conventional; that is, the operator pushes the PTT button to talk and releases it to listen.	Verify that the operator is not required to push the PTT to listen, and release to talk.	

* This is not a mandatory requirement, but a design objective.
** Not mandatory for radios designed with ALE.
Legend: dBm – decibels reference to one milliwatt; Hz – hertz; ICW – Interrupted Continuous Wave; kHz – kilohertz; LLSB – Lower Lower Sideband; LSB – Lower Sideband; MHz – megahertz; NBFM – Narrowband Frequency Modulation; PPM – Parts per Million; PTT – Push to talk; RBW – Resolution Bandwidth; RF – Radio Frequency; USB – Upper Sideband; UUSB – Upper Upper Sideband; UUT – Unit Under Test; VBW – Video Bandwidth

C-1.4 Presentation of Results. The results will be shown in tabular format (table C-1.2) indicating the requirement and measured value or indications of capability.

Table C-1.2. Baseline Mode Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
1	4.2.1	Frequency control of all new HF equipment, except manpack, shall be capable of being stabilized by an external standard.	1 PPM offset			
2	4.2.1.1	All new single channel HF equipment shall provide, as a minimum, the capability for the following one-at-a-time selectable operational modes: a. One nominal 3-kilohertz (kHz) channel upper sideband (USB) or lower sideband (LSB) (selectable).	3-kHz USB or LSB			
2	4.2.1.1	b. One (rate-dependent bandwidth) interrupted continuous wave (ICW) channel.* A Narrowband Frequency Modulation (NBFM) channel capability should be included as a Design Objective (DO). *Not mandatory for radios designed for ALE.	ICW channel NBFM is DO			
3	4.2.1.2	All new multichannel HF equipment shall provide a single channel capability as set forth in paragraph 4.2.1.1, as a minimum, and one or more of the following modes, selectable one at a time: a. Two nominal 3-kHz channels in the USB and LSB (two independent channels in the same sideband-sideband selectable).	Two 3-kHz channels			
3	4.2.1.2	b. One nominal 6-kHz channel in the USB or LSB (selectable).	One 6-kHz channel			
3	4.2.1.2	c. Two nominal 3-kHz channels in the USB and two in the LSB (four independent 3-kHz channels–two in each sideband).	Four 3-kHz channels			

Table C-1.2. Baseline Mode Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
3	4.2.1.2	d. One nominal 6-kHz channel in the USB and one in the LSB (two independent 6-kHz channels-one in each sideband).	Two 6-kHz channels.			
3	4.2.1.2	e. One nominal 3-kHz channel in the USB and one in the LSB (two independent 3-kHz channels–one in each sideband).	Two 3-kHz channels.			
4	4.2.2	<u>Push to talk (PTT) operation</u>. PTT operation is the most common form of interaction with MF/HF single sideband (SSB) radios, especially for tactical use by minimally trained, “noncommunicator” operators. Manual control with PTT shall be conventional; that is, the operator pushes the PTT button to talk and releases it to listen.	UUT uses convent-ional PTT control.			

Legend: ⇒ – yields; ALE – Automatic Link Establishment; freq – frequency; HF – High Frequency; ICW – Interrupted Continuous Wave; kHz – kilohertz; LSB – Lower Sideband; MF– Medium Frequency; MIL-STD – Military Standard; NBFM – Narrowband Frequency Modulation; PPM – parts per million; PTT – Push to talk; SSB – Single Sideband; USB – Upper Sideband; UUT – Unit Under Test

C-2 SUBTEST 2, ELECTRICAL CHARACTERISTICS OF DIGITAL INTERFACES

C-2.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 5.

C-2.2 Criteria. As a minimum, any incorporated interfaces for serial binary data shall be in accordance with the provisions of MIL-STD-188-114 and any other interfaces specified by the contracting agencies. Such interfaces shall include provisions for request-to-send and clear-to-send signaling. The capability to accept additional standard interfaces is not precluded, MIL-STD-188-141B, paragraph 4.3.1.

NOTE: MIL-STD-188-114, Electrical Characteristics of Digital Interface Circuits, paragraphs 5.1 through 5.3, specifies the electrical characteristics of digital interface circuits in terms of direct electrical measurements of the interface circuits unbalanced or balanced generator component. Therefore, the following criteria have been developed in terms of an unbalanced or balanced generator.

a. Unbalanced Generator Criteria for an Unbalanced Voltage Digital Interface Circuit:

(1) Open Circuit. The magnitude of the voltage (V_o) measured between the output terminal and ground shall not be less than 4 Volts (V) nor more than 6 V for any interface circuit in either binary state ($4V \leq |V_o| \leq 6V$). See figure C-2.1.

(2) Test Termination. The magnitude of the voltage (V_t), measured between the output terminal and ground, shall not be less than 90 percent of the magnitude of V_o with a test load (R_t) of 450 ohm ±1 percent connected between the generator output terminal and generator circuit ground, or ($|V_t| \geq 0.9|V_o|$, when R_t = 450 ohm, ±1 percent). See figure C-2.1.

(3) Short Circuit. The magnitude of the current (I_s) flowing through the generator output terminal shall not exceed 150 milliamperes (mA) when the generator output terminal is short circuited to generator circuit ground, ($|I_s| \leq 150$ mA). See figure C-2.1.

(4) Power Off. The magnitude of the generator output leakage current (I_x) shall not exceed 100 microamps (μA) under power-off conditions, with a voltage V_x ranging between +6 V and –6 V applied between the generator output terminal and generator circuit ground, or ($|I_x| \leq 100$ μA, when $-6 V \leq V_x \leq +6 V$). See figure C-2.1.

b. Balanced Generator Criteria for a Balanced Voltage Digital Interface Circuit:

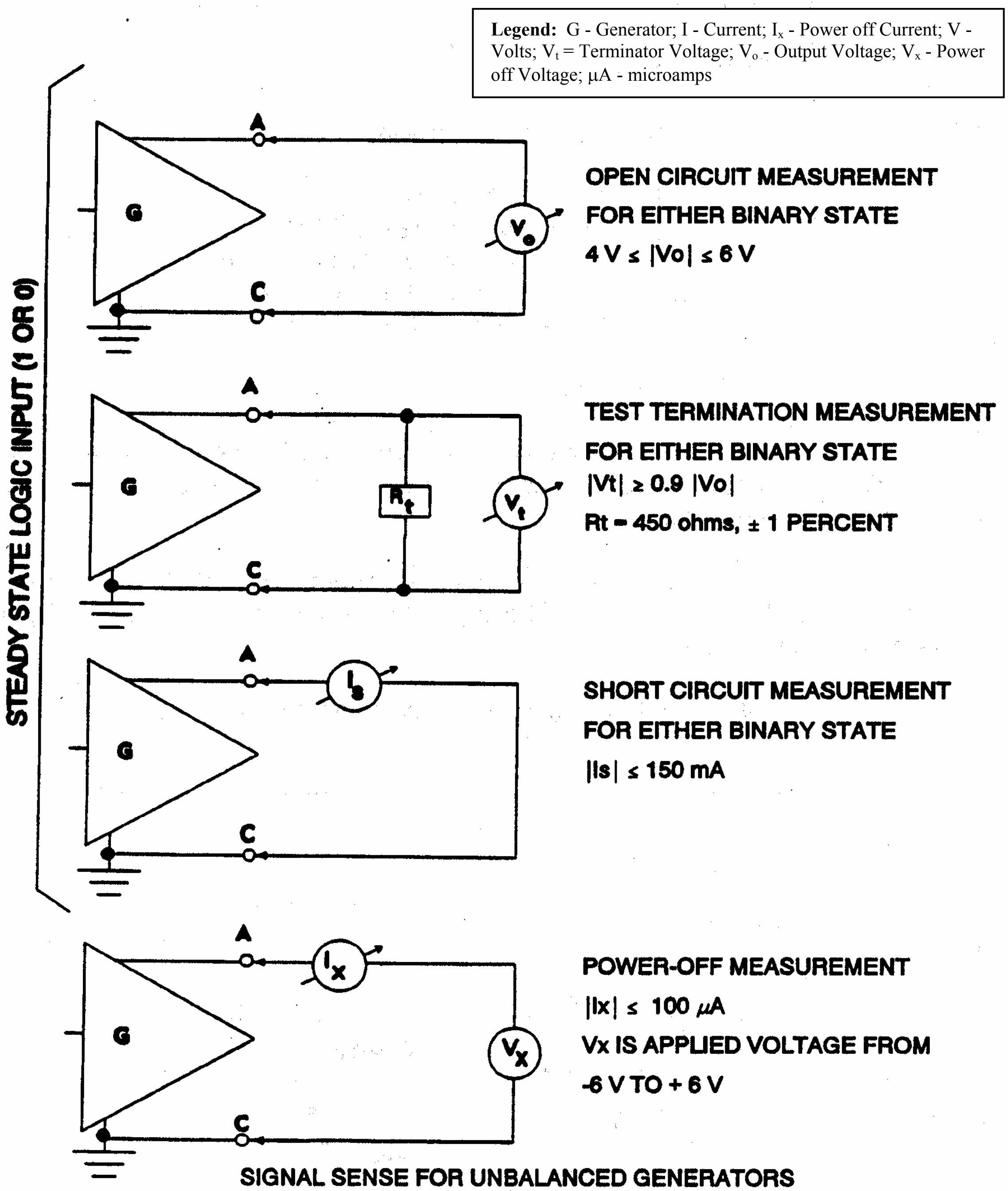
NOTE: MIL-STD-188-114, Electrical Characteristics of Digital Interface Circuits, paragraph 4.4.1, describes the three types of balanced generators. The type I balanced generator is best suited to meet the requirements of the data modem. The following criteria have been developed in terms of a balanced generator.

(1) Open Circuit. The magnitude of the differential voltage (V_o) between two generator output terminals shall not be less than 4 V nor more than 6 V ($4V \leq |V_o| \leq 6V$). The magnitude of the open circuit voltage V_{oa} and V_{ob} between the generator output terminals and the generator circuit ground shall not be less than 2 V nor more than 3 V, or ($2V \leq |V_{oa}| \leq 3V$ and $2V \leq |V_{ob}| \leq 3V$). See figure C-2.2.

(2) Test Termination. With a test load (R_t) of two resistors, 50 ohm (Ω) $\pm$1% each, connected in series between the generator output terminals, the magnitude of the differential voltage V_t, between the generator output terminals, shall not be less than one-half of the absolute value of V_o, or ($|V_t| \geq 0.5|V_o|$). For the opposite binary state, the polarity of V_t shall be reversed($_t$). The magnitude of the difference of the absolute values of V_t and $\mathbf{V_t}$ shall not be more than 0.4 V, or $|V_t| - |\mathbf{V_t}| \leq 0.4$ V. The magnitude of the difference of V_{os} and $\mathbf{V_{os}}$ for the opposite binary state shall not be more than 0.4 V, or $|V_{os} - \mathbf{V_{os}}| \leq 0.4$ V. The magnitude of the generator offset voltage V_{os} between the center point of the test load and generator circuit ground shall not be more than 0.4 V for either binary state, or $|V_{os}| \leq 0.4$ V. See figure C-2.2.

(3) Short Circuit. With the generator output terminals short circuited to generator circuit ground, the magnitudes of the currents (I_{sa} and I_{sb}) flowing through each generator output terminal shall not exceed 150 mA for either binary state, or ($|I_{sa}| \leq 150$ mA and $|I_{sb}| \leq 150$ mA). See figure C-2.2.

(4) Power off. Under power-off conditions, the magnitude of the generator output leakage current I_{xa} and I_{xb} shall not exceed 100 μA with voltage V_x ranging between +6 V and –6 V applied between each generator output terminal and generator circuit ground, or ($|I_{xa}| \leq 100$ μA and $|I_{xb}| \leq 100$ μA, when $-6V \leq V_x \leq +6V$). See figure C-2.2.

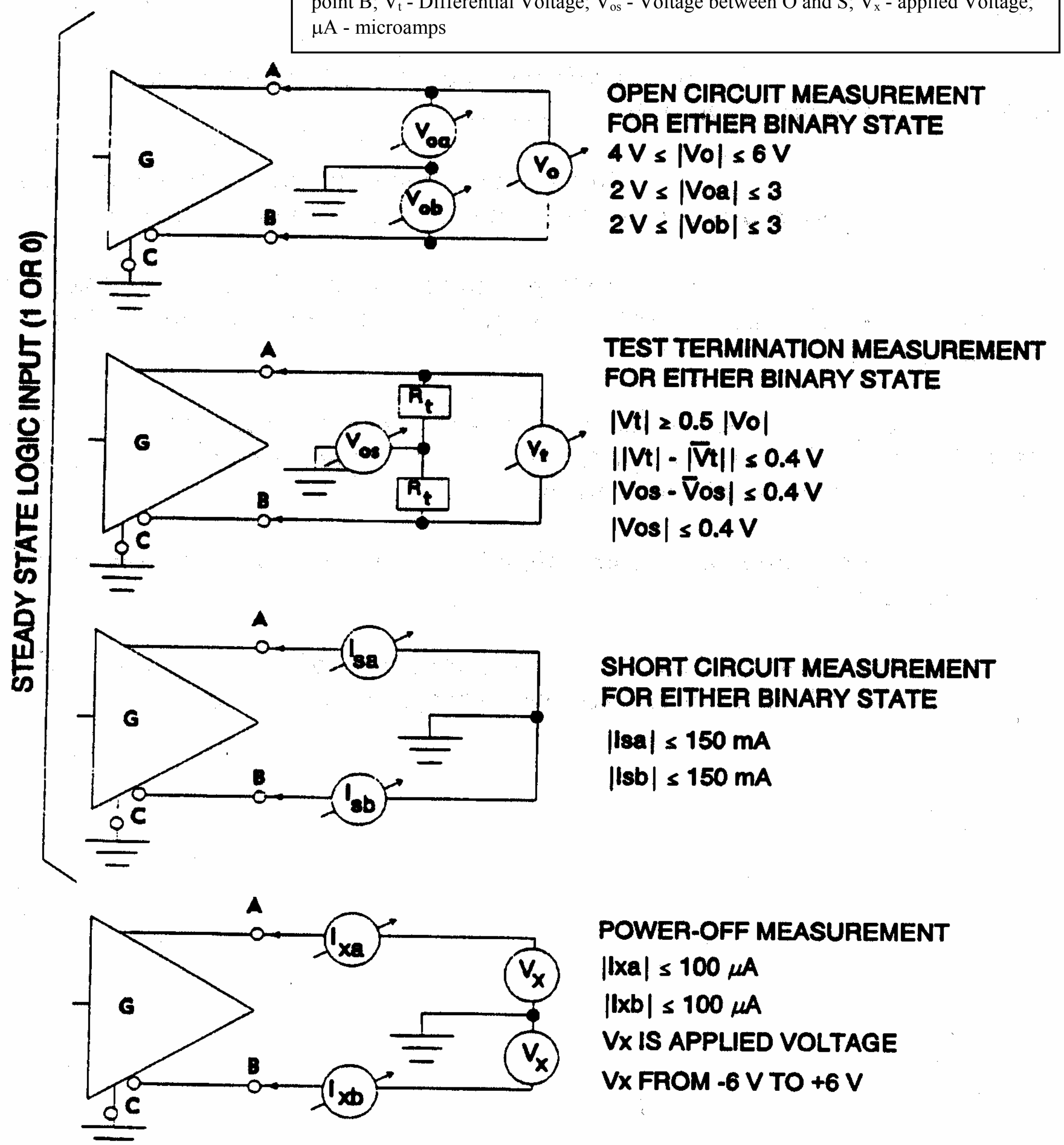


SIGNAL SENSE FOR UNBALANCED GENERATORS

VOLTAGE POLARITY	DATA	TIMING	CONTROL and ALARM
Point A negative with respect to Point C	1 or MARK	OFF (QUIESCENT)	OFF
Point A negative with respect to Point C	0 or SPACE	ON (ACTIVE)	ON

Figure C-2.1. Measurement Diagram for Unbalanced Circuit

Legend: G - Generator; I_{xa} - Current through node A; I_{xb} - Current through node B; I_{sa} - Current through node A; I_{sb} - Current through node B; V – Volts; V_o - Output Voltage; V_{oa} - Voltage between point A and the output; V_{ob} - Voltage between the output and point B; V_t - Differential Voltage; V_{os} - Voltage between O and S; V_x - applied Voltage; μA - microamps



SIGNAL SENSE FOR BALANCED GENERATORS

VOLTAGE POLARITY	DATA	TIMING	CONTROL and ALARM
Point A negative with respect to Point B	1 or MARK	OFF (QUIESCENT)	OFF
Point A negative with respect to Point B	0 or SPACE	ON (ACTIVE)	ON

Figure C-2.2. Measurement Diagram for Balanced Circuit

C-2.3 Test Procedures

a. Test Equipment Required

(1) Digital Volt Meter

(2) Oscilloscope

(3) Power Supply

(4) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figure C-2.3.

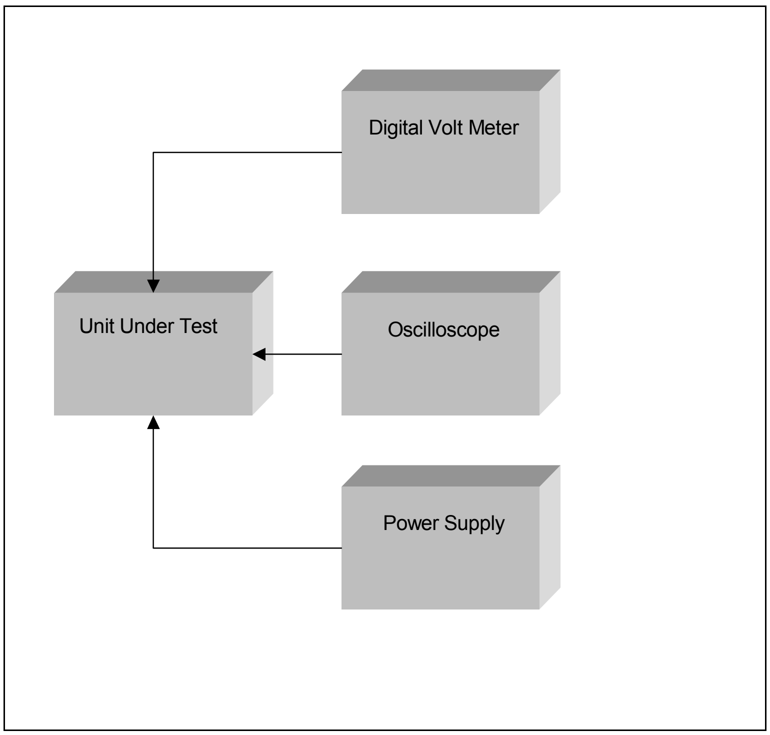


Figure C-2.3. Electrical Characteristics of Digital Interfaces Test Equipment Configuration

c. Test Conduct. The procedures for this subtest are listed in table C-2.1.

Table C-2.1. Electrical Characteristics of Digital Interfaces Procedures

Step	Action	Settings/Action	Result
The following procedure is for reference number 5.			
1	Set up equipment.	See figure C-2.3.	
2	Determine the type of interface that has been implemented (balanced or unbalanced).		
3	Conduct open circuit, test termination, and short circuit measurements for each digital state.	See figure C-2.1 for unbalanced interface, or figure C-2.2 for balanced interface.	
4	Power down system, apply external voltage from power supply to appropriate test points, and measure leakage current.		
5	Voltage and current readings will be taken from the respective measuring points as shown in figure C-2.1 or C-2.2, depending on which interface is implemented.		Record results on data collection form, page D-13.
6	Verify that these interfaces include provisions for request-to-send and clear-to-send signaling.		

C-2.4 Presentation of Results. The results will be shown in tabular format (table C-2.2) indicating the requirement and measured value or indications of capability.

Table C-2.2. Electrical Characteristics of Digital Interfaces Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
5	4.3.1	As a minimum, any incorporated interfaces for serial binary data shall be in accordance with the provisions of MIL-STD-188-114, and any other interfaces specified by the contracting agencies.				
5	4.3.1	Such interfaces shall include provisions for request-to-send (RTS) and clear-to-send (CTS) signaling. The capability to accept additional standard interfaces is not precluded.	RTS and CTS			
Legend: CTS – clear to send; MIL-STD – Military Standard; RTS – request to send						

C-3 SUBTEST 3, MODULATION AND SIGNALING RATES

C-3.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 6.

C-3.2 Criteria. The modulation rate (expressed in baud [Bd]) or the data signaling rate (expressed in bits per second [bps]) at interface points A and A' in figure C-3.1 shall include those contained in MIL-STD-188-110, MIL-STD-188-141B, paragraph 4.3.3.

The following criteria were extracted from MIL-STD-188-110:

a. The MF/HF radio system modem shall accept and deliver serial binary bit streams at data signaling rates of 75, 150, 300, 600, 1200, and 2400 bps ±0.01% with a bit error rate (BER) not to exceed 1×10^{-5} when using a standard (2047) BER test pattern.

b. The MF/HF radio system modem shall operate at modulation rates of 75, 150, 300, 600, 1200, and 2400 bd ±0.01% with a BER not to exceed 1×10^{-5} when using a standard (2047) BER test pattern.

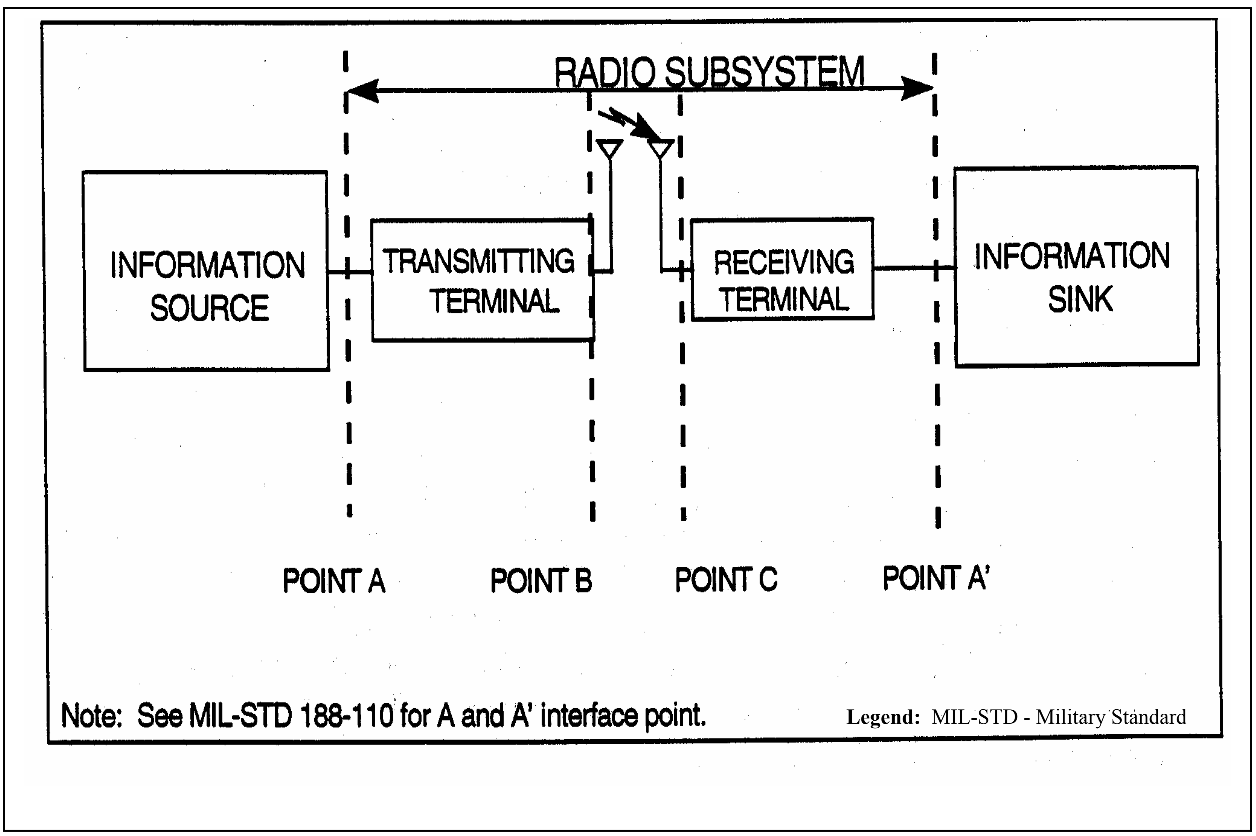


Figure C-3.1. Radio Subsystems Interface Points

C-3.3 Test Procedures

a. Test Equipment Required

(1) Bit Error Rate Tester (2)

(2) Attenuator

(3) Modem (2)

(4) Unit Under Test (2)

b. Test Configuration. Configure the equipment as shown in figures C-3.2 and C-3.3.

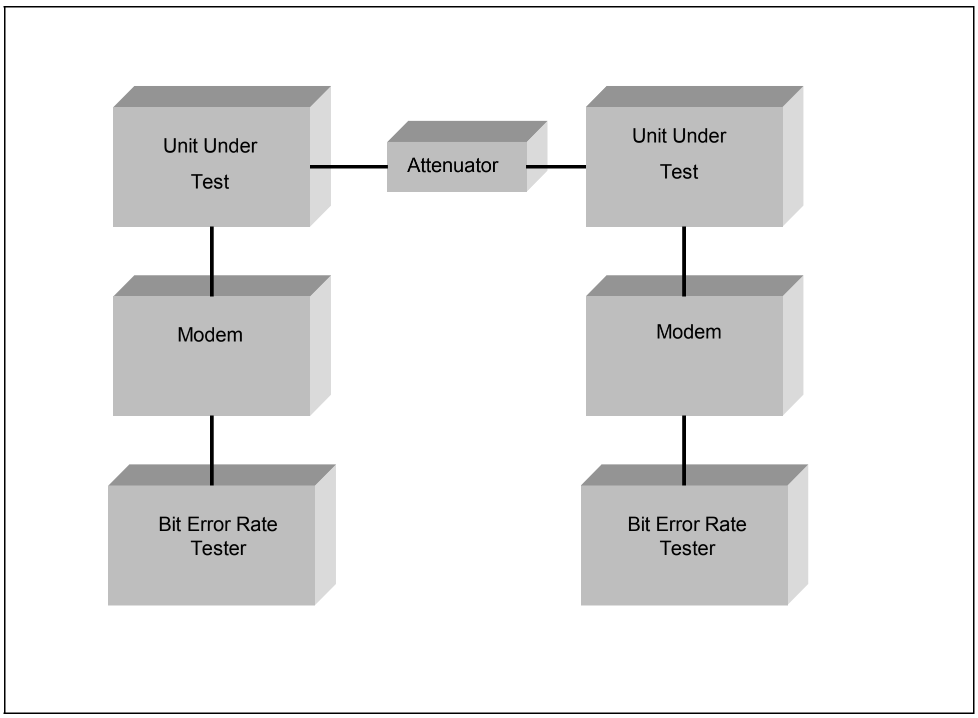


Figure C-3.2. Modulation and Signaling Rates Test Equipment Configuration (Using External Modem)

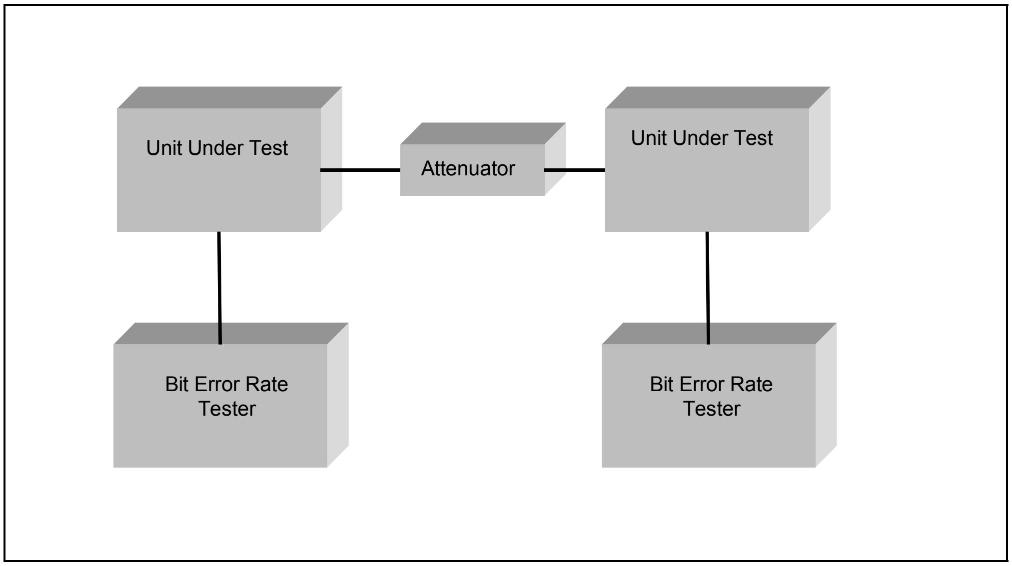


Figure C-3.3. Modulation and Signaling Rates Test Equipment Configuration (Using Internal Modem)

c. Test Conduct. The procedures for this subtest are listed in table C-3.1.

Table C-3.1. Modulation and Signaling Rates Procedures

Step	Action	Settings/Action	Result
The following procedure is for reference number 6.			
1	If the UUT does not contain an internal modem, set up equipment as shown in figure C-3.2, referencing figure C-3.1. If the UUT contains an internal modem, set up equipment as shown in figure C-3.3, referencing figure C-3.1.	A BER test will be used to test the various modulation and data signaling rates contained in MIL-STD-188-110. Normally the BER test is used to measure the transmission quality of digital information over a data link; however, if the correct BER test set digital interface system is connected to the transmitter's digital baseband input interface, and the same type of interface from the receiver baseband output interface to the BER test set is used, a complete test of the modulation and data signaling rates can be accomplished.	
2	Set up BERT.	Refer to BERT operator's manual for specific programming instructions.	
3	Power up all equipment.	Set transmit and receive frequency on radios to 8.000 MHz.	
4	Program BERT for 75 bps operation with a length of 1 x 10^5, using a 2047 test pattern.	Key modem to begin data transmission.	
5	Record BER results from receiving BERT.		
6	Repeat steps 4 and 5 for 150 bps operation.	Record BER results.	

Table C-3.1. Modulation and Signaling Rates Procedures (continued)

Step	Action	Settings/Action	Result
7	Repeat steps 4 and 5 for 300 bps operation.	Record BER results.	
8	Repeat steps 4 and 5 for 600 bps operation.	Record BER results.	
9	Repeat steps 4 and 5 for 1200 bps operation.	Record BER results.	
10	Repeat steps 4 and 5 for 2400 bps operation.	Record BER results.	
11	Repeat steps 4 and 5 for 75 bd operation.	Record BER results.	
12	Repeat steps 4 and 5 for 150 bd operation.	Record BER results.	
13	Repeat steps 4 and 5 for 300 bd operation.	Record BER results.	
14	Repeat steps 4 and 5 for 600 bd operation.	Record BER results.	
15	Repeat steps 4 and 5 for 1200 bd operation.	Record BER results.	
16	Repeat steps 4 and 5 for 2400 bd operation.	Record BER results.	
Legend: bd – baud; BER – Bit Error Rate; BERT – Bit Error Rate Tester; bps – bits per second; MHz – megahertz; MIL-STD – Military Standard			

C-3.4 Presentation of Results. The results will be shown in tabular format (table C-3.2) indicating the requirement and measured value or indications of capability.

Table C-3.2. Modulation and Signaling Rates Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
6	4.3.3	The modulation rate (expressed in baud (Bd)) or the data signaling rate (expressed in bits per second (bps)) at interface points A and A' in figure C-3.1 shall include those contained in MIL-STD-188-110.	Data and modulation rates of 75, 150, 300, 600, 1200, and 2400 bps result in low BER.			
Legend: Bd – baud; BER – Bit Error Rate; bps – bits per second; HF – High Frequency; MF – Medium Frequency; MIL-STD – Military Standard						

C-4 SUBTEST 4, FREQUENCY DISPLAY, COVERAGE, AND ACCURACY

C-4.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 7, 8, and 9.

C-4.2 Criteria

a. The displayed frequency shall be that of the carrier, whether suppressed or not, MIL-STD-188-141B, paragraph 5.2.1.

b. The radio equipment shall be capable of operating over the frequency range of 2.0 MHz to 29.9999 MHz in a maximum of 100-hertz (Hz) frequency increments (DO: 10 Hz) for single channel equipment and 10-Hz frequency increments (DO: 1 Hz) for multichannel equipment, MIL-STD-188-141B, paragraph 5.2.2.

c. The accuracy of the radio carrier frequency (fc), including tolerance and long-term stability but not any variation due to doppler shift, shall be within ±30 Hz for tactical application and within ±10 Hz for all others, during a period of not less than 30 days. If the tactical system includes long haul interoperability mission, tactical equipment must meet ±10 Hz radio carrier frequency specification, MIL-STD-188-141B, paragraph 5.2.3.

C-4.3 Test Procedures

a. Test Equipment Required

(1) Audio Generator

(2) Signal Generator

(3) Attenuators (2)

(4) Frequency Counters (2)

(5) Directional Coupler

(6) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figures C-4.1 and C-4.2.

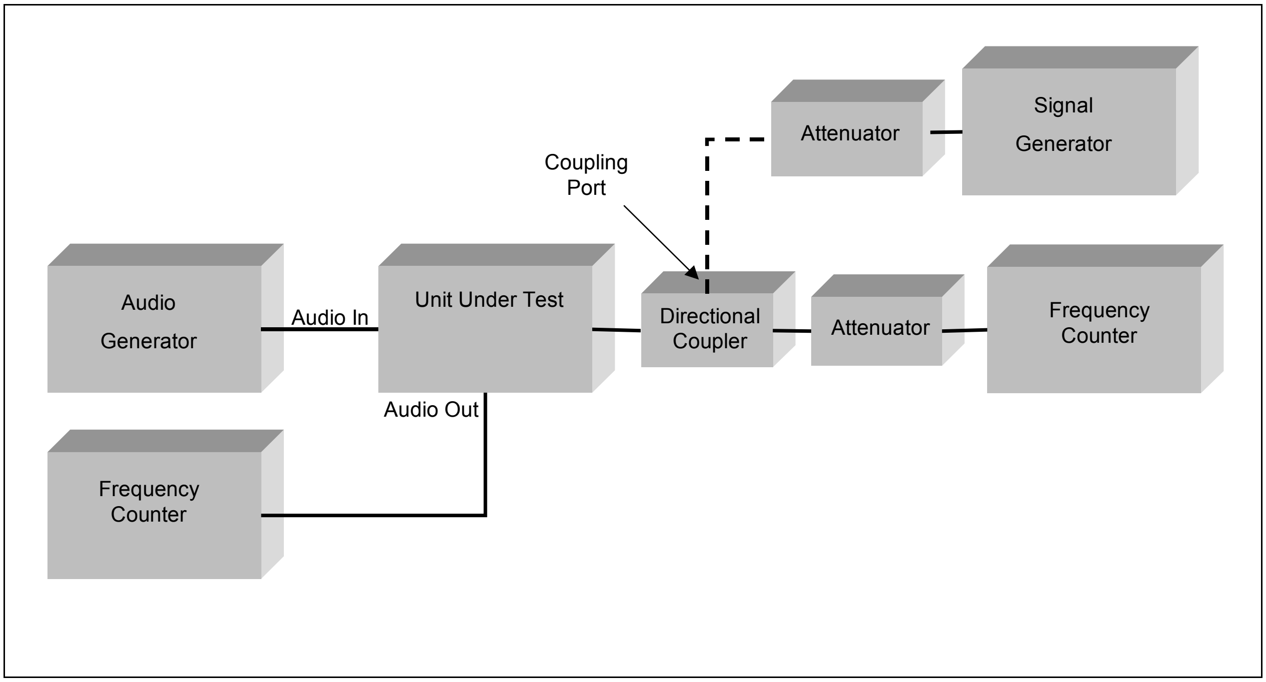


Figure C-4.1. Transmitter and Receiver Frequency Display and Frequency Coverage

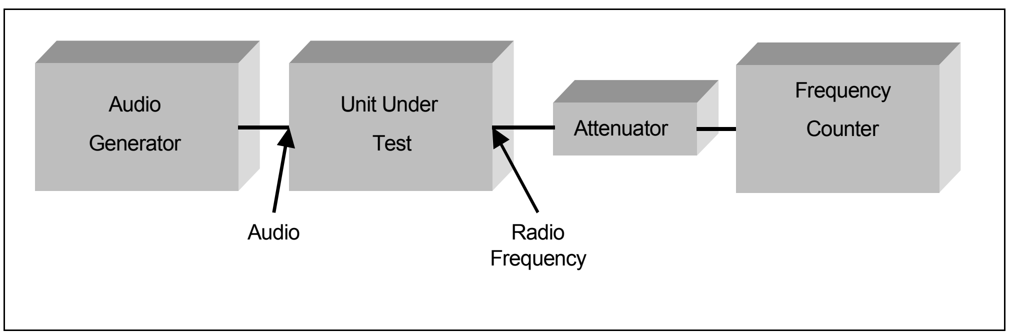


Figure C-4.2. Transmitter Frequency Accuracy

c. Test Conduct. The test procedures for this subtest are given in tables C-4.1 and C-4.2.

Table C-4.1. Procedures for Transmitter and Receiver Frequency Display and Frequency Coverage

Step	Action	Settings/Action	Result
The following procedure is for reference numbers 7 and 8.			
1	Set up equipment.	See figure C-4.1.	
2	Allow UUT to warm up by leaving it powered on in receive mode for 30 minutes.		
3	Set up audio generator.	Frequency: 1000 Hz Level: Set to a minimum audio input level into UUT to drive transmitter so that the RF output can be measured with the frequency counter. Impedance: 600 ohm	
4	Set up signal generator.	Frequency: Test frequency + 1000 Hz (given in steps 7 through 75). Level: Set to a minimum RF input level into UUT to drive receiver so that the audio output can be measured with the frequency counter.	
5	Tune UUT.	Frequency: Test frequency given in steps 7 through 75. Mode: USB	
6	In steps 7 through 75, transmit with UUT and record the RF frequency minus the audio tone (measure with the frequency counter). Then, place UUT in receive mode and set the frequency of the signal generator to test frequency + 1000 Hz. Record the frequency of the audio tone measured with the frequency counter.	The frequencies given in steps 7 through 75 should be the frequency displayed by the UUT.	

Table C-4.1. Procedures for Transmitter and Receiver Frequency Display and Frequency Coverage (continued)

Step	Action	Settings/Action	Result
7	Record RF and audio frequencies.	2.0000 MHz	TX:
			RX:
8	Record RF and audio frequencies.	2.00001 MHz (It is not required that single channel equipment tune to this frequency.)	TX:
			RX:
9	Record RF and audio frequencies.	2.00002 MHz (It is not required that single channel equipment tune to this frequency.)	TX:
			RX:
10	Record RF and audio frequencies.	2.00003 MHz (It is not required that single channel equipment tune to this frequency.)	TX:
			RX:
11	Record RF and audio frequencies.	2.00004 MHz (It is not required that single channel equipment tune to this frequency.)	TX:
			RX:
12	Record RF and audio frequencies.	2.00005 MHz (It is not required that single channel equipment tune to this frequency.)	TX:
			RX:
13	Record RF and audio frequencies.	2.0001 MHz	TX:
			RX:
14	Record RF and audio frequencies.	2.0002 MHz	TX:
			RX:
15	Record RF and audio frequencies.	2.0003 MHz	TX:
			RX:
16	Record RF and audio frequencies.	2.0004 MHz	TX:
			RX:
17	Record RF and audio frequencies.	2.0005 MHz	TX:
			RX:
18	Record RF and audio frequencies.	2.0006 MHz	TX:
			RX:
19	Record RF and audio frequencies.	2.0007 MHz	TX:
			RX:
20	Record RF and audio frequencies.	2.0008 MHz	TX:
			RX:
21	Record RF and audio frequencies.	2.0009 MHz	TX:
			RX:
22	Record RF and audio frequencies.	2.0019 MHz	TX:
			RX:

Table C-4.1. Procedures for Transmitter and Receiver Frequency Display and Frequency Coverage (continued)

Step	Action	Settings/Action	Result
23	Record RF and audio frequencies.	2.0029 MHz	TX: RX:
24	Record RF and audio frequencies.	2.0039 MHz	TX: RX:
25	Record RF and audio frequencies.	2.0049 MHz	TX: RX:
26	Record RF and audio frequencies.	2.0059 MHz	TX: RX:
27	Record RF and audio frequencies.	2.0069 MHz	TX: RX:
28	Record RF and audio frequencies.	2.0079 MHz	TX: RX:
29	Record RF and audio frequencies.	2.0089 MHz	TX: RX:
30	Record RF and audio frequencies.	2.0099 MHz	TX: RX:
31	Record RF and audio frequencies.	2.0199 MHz	TX: RX:
32	Record RF and audio frequencies.	2.0299 MHz	TX: RX:
33	Record RF and audio frequencies.	2.0399 MHz	TX: RX:
34	Record RF and audio frequencies.	2.0499 MHz	TX: RX:
35	Record RF and audio frequencies.	2.0599 MHz	TX: RX:
36	Record RF and audio frequencies.	2.0699 MHz	TX: RX:
37	Record RF and audio frequencies.	2.0799 MHz	TX: RX:
38	Record RF and audio frequencies.	2.0899 MHz	TX: RX:
39	Record RF and audio frequencies.	2.0999 MHz	TX: RX:
40	Record RF and audio frequencies.	2.1999 MHz	TX: RX:
41	Record RF and audio frequencies.	2.2999 MHz	TX: RX:
42	Record RF and audio frequencies.	2.3999 MHz	TX: RX:
43	Record RF and audio frequencies.	2.4999 MHz	TX: RX:
44	Record RF and audio frequencies.	2.5999 MHz	TX: RX:
45	Record RF and audio frequencies.	2.6999 MHz	TX: RX:
46	Record RF and audio frequencies.	2.7999 MHz	TX: RX:

Table C-4.1. Procedures for Transmitter and Receiver Frequency Display and Frequency Coverage (continued)

Step	Action	Settings/Action	Result
47	Record RF and audio frequencies.	2.8999 MHz	TX: RX:
48	Record RF and audio frequencies.	2.9999 MHz	TX: RX:
49	Record RF and audio frequencies.	3.9999 MHz	TX: RX:
50	Record RF and audio frequencies.	4.9999 MHz	TX: RX:
51	Record RF and audio frequencies.	5.9999 MHz	TX: RX:
52	Record RF and audio frequencies.	6.9999 MHz	TX: RX:
53	Record RF and audio frequencies.	7.9999 MHz	TX: RX:
54	Record RF and audio frequencies.	8.9999 MHz	TX: RX:
55	Record RF and audio frequencies.	9.9999 MHz	TX: RX:
56	Record RF and audio frequencies.	10.9999 MHz	TX: RX:
57	Record RF and audio frequencies.	11.9999 MHz	TX: RX:
58	Record RF and audio frequencies.	12.9999 MHz	TX: RX:
59	Record RF and audio frequencies.	13.9999 MHz	TX: RX:
60	Record RF and audio frequencies.	14.9999 MHz	TX: RX:
61	Record RF and audio frequencies.	15.9999 MHz	TX: RX:
62	Record RF and audio frequencies.	16.9999 MHz	TX: RX:
63	Record RF and audio frequencies.	17.9999 MHz	TX: RX:
64	Record RF and audio frequencies.	18.9999 MHz	TX: RX:
65	Record RF and audio frequencies.	19.9999 MHz	TX: RX:
66	Record RF and audio frequencies.	20.9999 MHz	TX: RX:
67	Record RF and audio frequencies.	21.9999 MHz	TX: RX:
68	Record RF and audio frequencies.	22.9999 MHz	TX: RX:
69	Record RF and audio frequencies.	23.9999 MHz	TX: RX:
70	Record RF and audio frequencies.	24.9999 MHz	TX: RX:

Table C-4.1. Procedures for Transmitter and Receiver Frequency Display and Frequency Coverage (continued)

Step	Action	Settings/Action	Result
71	Record RF and audio frequencies.	25.9999 MHz	TX:
			RX:
72	Record RF and audio frequencies.	26.9999 MHz	TX:
			RX:
73	Record RF and audio frequencies.	27.9999 MHz	TX:
			RX:
74	Record RF and audio frequencies.	28.9999 MHz	TX:
			RX:
75	Record RF and audio frequencies.	29.9999 MHz	TX:
			RX:
Legend: Hz – hertz; MHz – megahertz; RF – Radio Frequency; RX – Receiver; TX – Transmitter; USB – Upper Sideband; UUT – Unit Under Test			

Table C-4.2. Procedures for Frequency Accuracy/Stability of Transmitter

Step	Action	Settings/Action	Result
The following procedure is for reference number 9.			
1	Set up equipment.	See figure C-4.2.	
2	Set up audio generator.	Frequency: 1000 Hz Level: Set to a minimum audio input level into UUT to drive transmitter so that the RF output can be measured with the frequency counter. Impedance: 600 ohm	
3	Measure the RF output of the transmitter at 4.000 MHz, 8.000 MHz, and 16.000 MHz (USB mode) once a day for 30 days. Leave the UUT powered on for the duration of this 30-day test. The UUT should be in left in receive mode when frequency measurements are not being taken.	In steps 4 through 33, record the RF frequency minus the audio tone to the tenth of a hertz.	
4	Day 1	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
5	Day 2	4.000 MHz	
		16.000 MHz	

Table C-4.2. Procedures for Frequency Accuracy/Stability of Transmitter (continued)

Step	Action	Settings/Action	Result
		29.9999 MHz	
		Record date of measurement.	
6	Day 3	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
7	Day 4	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
8	Day 5	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
9	Day 6	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
10	Day 7	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
11	Day 8	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
12	Day 9	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
13	Day 10	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
14	Day 11	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
15	Day 12	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
16	Day 13	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	

Table C-4.2. Procedures for Frequency Accuracy/Stability of Transmitter (continued)

Step	Action	Settings/Action	Result
17	Day 14	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
18	Day 15	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
19	Day 16	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
20	Day 17	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
21	Day 18	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
22	Day 19	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
23	Day 20	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
24	Day 21	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
25	Day 22	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
26	Day 23	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
27	Day 24	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
28	Day 25	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	

Table C-4.2. Procedures for Frequency Accuracy/Stability of Transmitter (continued)

Step	Action	Settings/Action	Result
29	Day 26	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
30	Day 27	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
31	Day 28	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
32	Day 29	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
33	Day 30	4.000 MHz	
		16.000 MHz	
		29.9999 MHz	
		Record date of measurement.	
34	Review results of steps 4 through 33 and verify that the frequency accuracy of the transmitter carrier frequency is within ±30 Hz for tactical applications and within ±10 Hz for all others over the 30-day period.		
Legend: Hz – hertz; MHz – megahertz; RF – Radio Frequency; USB – Upper Sideband; UUT – Unit Under Test			

C-4.4 Presentation of Results. The results will be shown in tabular format (table C-4.3) indicating the requirement and measured value or indications of capability.

Table C-4.3. Frequency Display, Coverage, and Accuracy Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
7	5.2.1	The displayed frequency shall be that of the carrier, whether suppressed or not				
8	5.2.2	The radio equipment shall be capable of operating over the frequency range of 2.0 MHz to 29.9999 MHz in a maximum of 100-Hz frequency increments (DO: 10-Hz) for single channel equipment, and 10-Hz frequency increments (DO: 1-Hz) for multichannel equipment	2.0 MHz to 29.9999 MHz in 100-Hz increments			
9	5.2.3	The accuracy of the radio carrier frequency, including tolerance and long-term stability, but not any variation due to doppler shift, shall be within +30 Hz for tactical application and within +10 Hz for all others, during a period of not less than 30-days. If tactical system include long haul interoperability mission, tactical equipment must meet +10° Hz radio carrier frequency specification.	+30 Hz for tactical application and within +10 Hz for all others			
Legend: DO – Design Objective; Hz – hertz; MHz – megahertz; MIL-STD – Military Standard						

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C-5 SUBTEST 5, PHASE STABILITY

C-5.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 10.

C-5.2 Criteria. The phase stability shall be such that the probability that the phase difference will exceed 5 degrees over any two successive 10 millisecond (msec) periods (13.33 msec periods may also be used) shall be less than 1 percent. Measurements shall be performed over a sufficient number of adjacent periods to establish the specified probability with a confidence of at least 95 percent, MIL-STD-188-141B, paragraph 5.2.4.

C-5.3 Test Procedures

a. Test Equipment Required

(1) Oscilloscope

(2) Signal Generator

(3) Phase Detector

(4) Attenuator

(5) Low Pass Filter

(6) Audio Generator

(7) Frequency Counter

(8) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figure C-5.1.

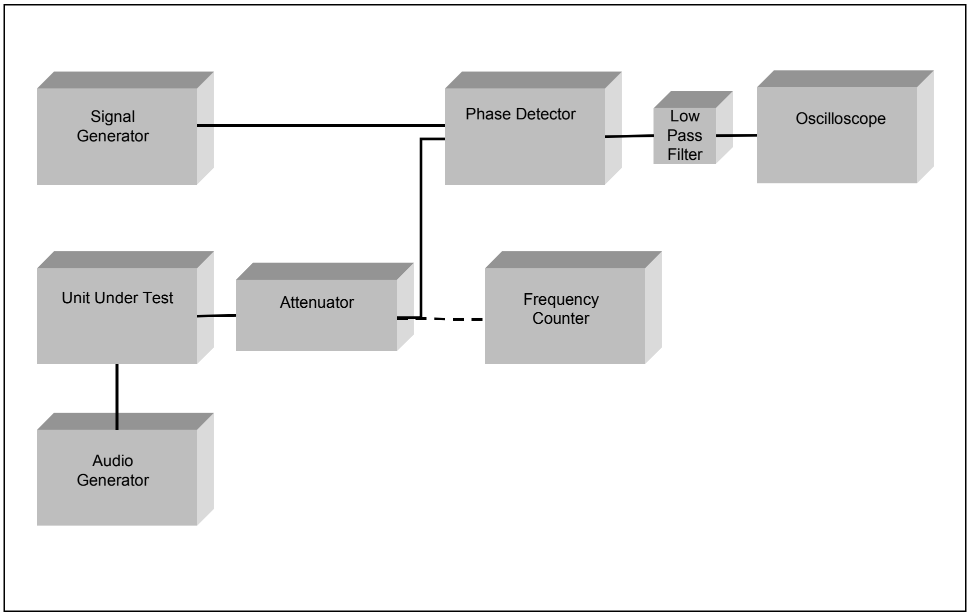


Figure C-5.1. Phase Stability Configuration

c. Test Conduct. The procedures for this subtest are listed in table C-5.1.

Table C-5.1. Procedures for Phase Stability

Step	Action	Settings/Action	Result
The following procedure is for reference number 10.			
1	Set up equipment.	See figure C-5.1.	
2	Set up UUT.	Mode: CW Frequency: UUT should transmit CW on 5.000 MHz.	
3	Measure and record the frequency of the UUT.	Use the frequency counter.	
4	Adjust and record the frequency of the signal generator to match the frequency of the UUT. The signal generator must be stable to within 1 part in 10^9.	Use the frequency measured in step 3.	
5	Measure and record the frequency of the reference source (signal generator).	Use the frequency counter.	
6	Adjust the output level of both the UUT and the signal generator. The UUT is to be connected to the RF port of the mixer while the signal generator will be connected to the local oscillator port.	Set to 7 dBm and mix them together using the MiniCircuits ZRPC-1 Mixer.	
7	Connect the output of the mixer to channel 1 of the oscilloscope.		

Table C-5.1. Procedures for Phase Stability (continued)

Step	Action	Settings/Action	Result
8	Set horizontal scale on the oscilloscope to 20 msec/div. Adjust the vertical scale so that the amplitude of the waveform fits within the oscilloscope display.	Toggle the RUN/STOP button on the oscilloscope to capture the waveform.	
9	Position the waveform on the display so that the maximum amplitude level (0 degree reference point for cosine waveform) crosses the center division grid on the oscilloscope.	Measure and record the maximum amplitude (voltage) level of the waveform.	
10	Multiply the voltage level recorded in step 9 by 0.035454 (see note 1).	Record result.	
11	Subtract the value found in step 10 from the value found in step 9.	Record result.	
12	Position horizontal reference cursor #1 to the maximum amplitude level of the waveform (this is the level recorded in step 9). Ensure that this maximum amplitude level still crosses the center division grid on the oscilloscope.	Position horizontal reference cursor #2 so that it is below cursor #1. Adjust cursor #2 until the Δ between cursors 1 and 2 equals the value recorded in step 11.	
13	Verify that the phase difference between two successive 10-msec periods does not exceed 5 degrees by observing the captured waveform on the oscilloscope display.	To meet this specification, the captured waveform, from the maximum amplitude level (crossing the center division grid) to the next grid to the right (20 msec after the waveform reaches its maximum) must stay between the two horizontal cursors.	Record results on data collection form, pages D-15 through D-23.
14	Capture new waveforms, repeating step 13 until the necessary number of measurements have been accomplished (see table C-5.2).		

Note 1. At 5 MHz, the difference between 5.000000 MHz and 5.00000139 MHz corresponds to a 5.0^0 phase difference over a 10-msec period. So, if the phase is changing more rapidly than 1.39 Hz in a 10-msec timeframe, the value of $|f_2 - f_1|$ will be greater than 1.39. Knowing that $|A\text{-}B| = A[\cos(2\pi f_1 T) - \cos(2\pi f_1(T+0.01))]$, and $|B\text{-}C| = A[\cos(2\pi f_2(T+0.01)) - \cos(2\pi f_2(T+0.02))]$, these equations can be combined and solved (using $|f_2 - f_1| = 1.39$) to give the maximum allowable value of $|A\text{-}C| = 0.035454(A)$.
Note 2. To meet the criteria of a 99-percent probability of not exceeding a phase change of 5° during any two successive 10-msec periods with a confidence of 95 percent, the following numbers of measurements with associated failures (that correspond to a phase measurement greater than 5 degrees) are listed in table C-5.2.
Legend: CW – Continuous Wave; JITC – Joint Interoperability Test Command; MHz – megahertz; msec – millisecond; mV – millivolt; RF – Radio Frequency; UUT – Unit Under Test

Table C-5.2. Numbers of Measurements with Associated Failures

Number of Measurements Required	Number of Failures
299	0
473	1
628	2

C-5.4 Presentation of Results. The results will be shown in tabular format (table C-5.3) indicating the requirement and measured value or indications of capability.

Table C-5.3. Phase Stability Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
10	5.2.4	The phase stability shall be such that the probability that the phase difference will exceed 5 degrees over any two successive 10 msec periods (13.33 msec periods may also be used) shall be less than 1 percent.	< 5 degrees			
10	5.2.4	Measurements shall be performed over a sufficient number of adjacent periods to establish the specified probability with a confidence of at least 95 percent.	See table C-5.2.			
Legend: MIL-STD – Military Standard; msec – millisecond						

C-6 SUBTEST 6, PHASE NOISE

C-6.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 11.

C-6.2 Criteria. The synthesizer and mixer phase noise spectrum at the transmitter output shall not exceed those limits as depicted in figures C-6.1 and C-6.2 under continuous carrier single tone output conditions. Figure C-6.1 depicts the limits of phase noise for cosited and non-cosited, fixed-site, and transportable long haul radio transmitters. Figure C-6.2 depicts the limits for tactical radio transmitters, MIL-STD-188-141B, paragraph 5.2.5.

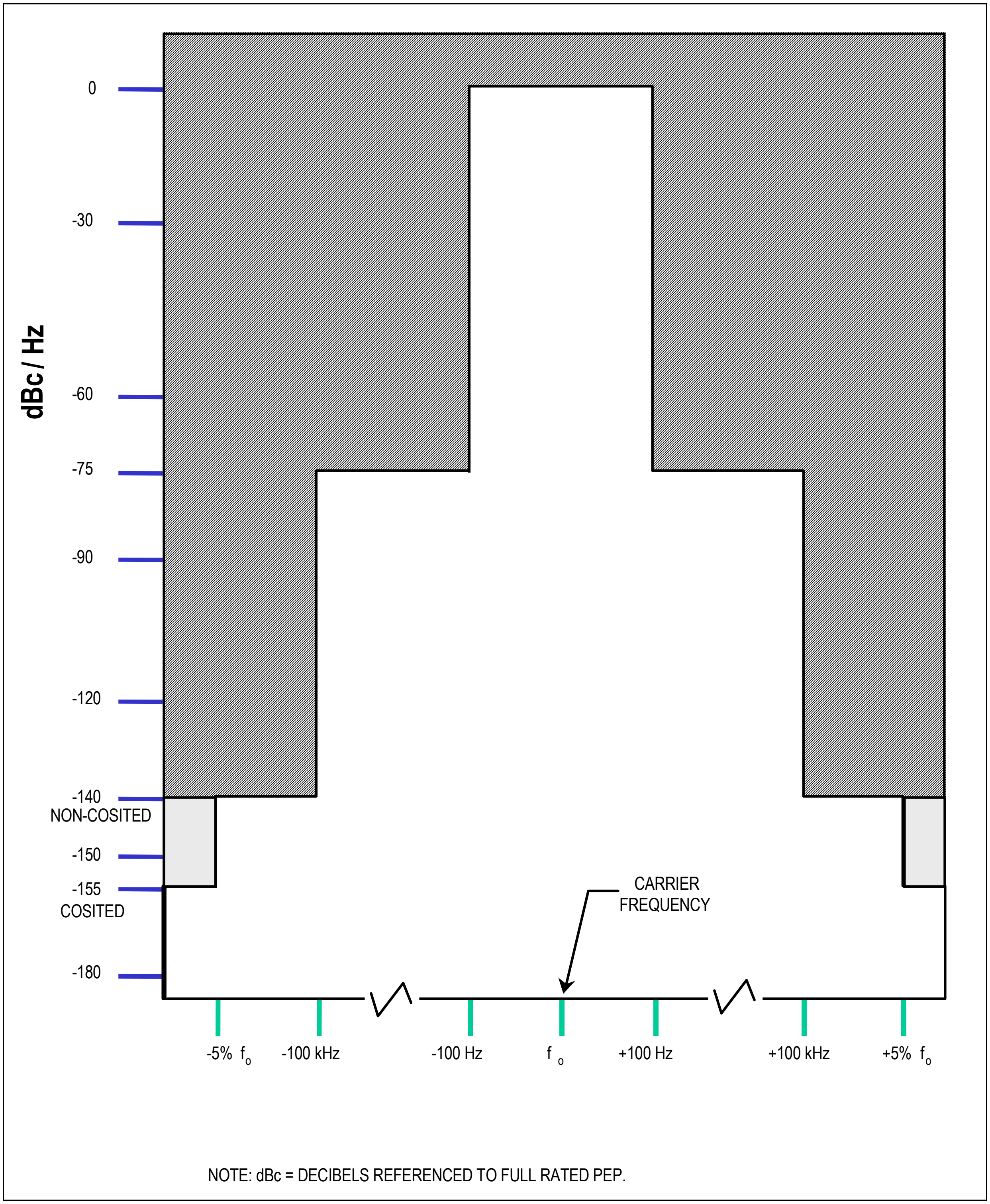


Figure C-6.1. Phase Noise Limit Mask for Fixed Site and Transportable Long Haul Radio Transmitters

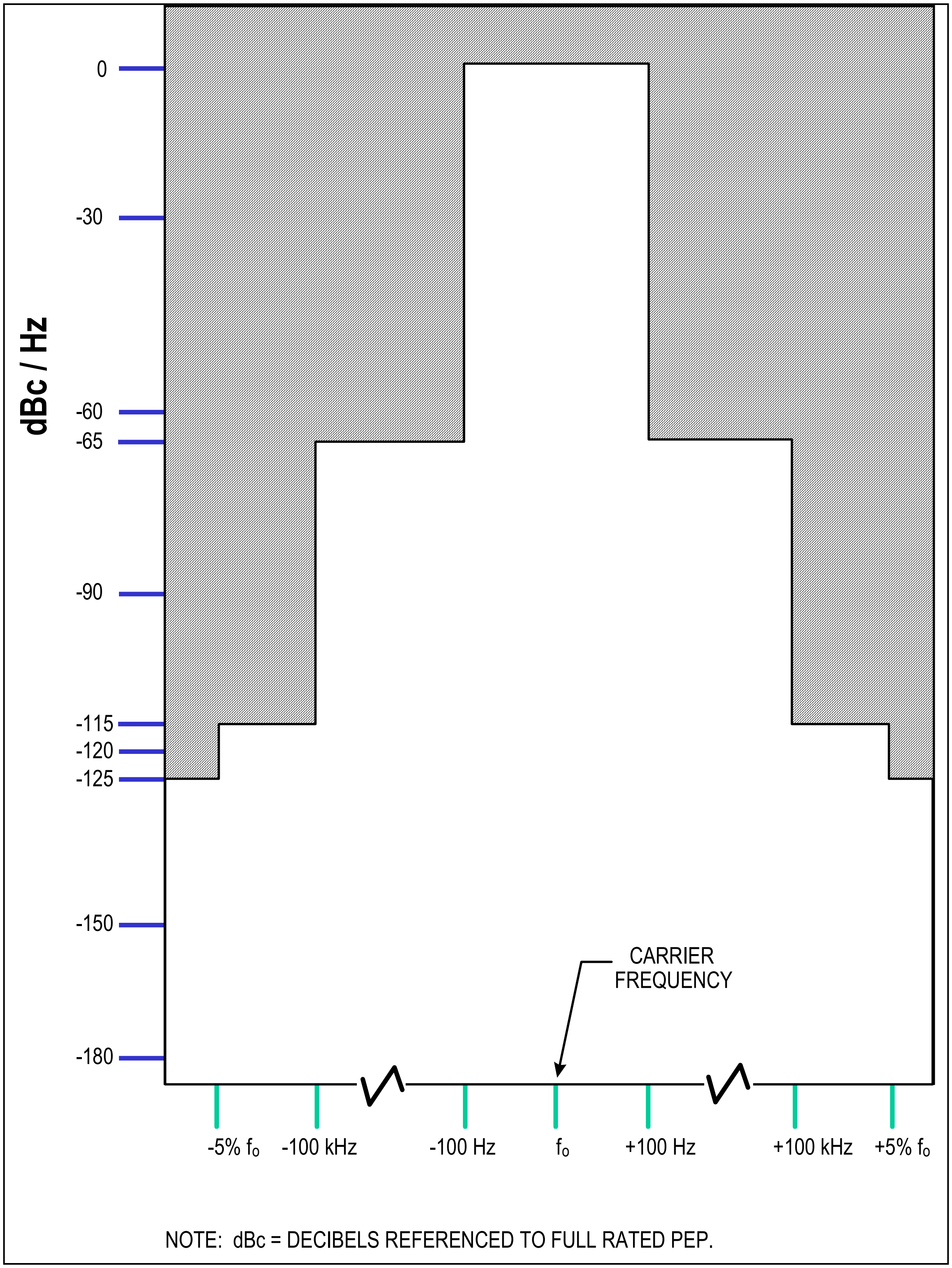


Figure C-6.2. Phase Noise Limit Mask for Tactical Radio Transmitters

C-6.3 Test Procedures

a. Test Equipment Required

(1) System PC Controller with E5500 Software

(2) Signal Generator (low phase noise)

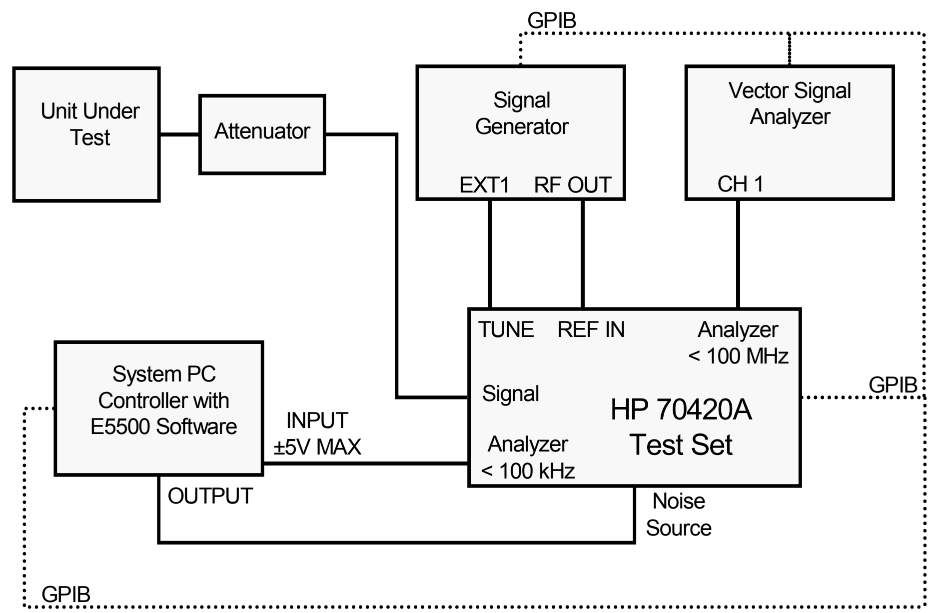
(3) Hewlett Packard (HP) 70420A Phase Noise Test Set

(4) Vector Signal Analyzer

(5) Attenuator

(6) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figure C-6.3.



Legend: CH – Channel; EXT – External; GPIB – General Purpose Interface Bus; HP – Hewlett Packard; kHz – kilohertz; MHz – megahertz; PC – Personal Computer; REF – Reference; RF – Radio Frequency; V – Volt

Figure C-6.3. Phase Noise Test Equipment Configuration

c. Test Conduct. The procedures for this subtest are listed in table C-6.1.

Table C-6.1. Procedures for Phase Noise

Step	Action	Settings/Action	Result
The following procedure is for reference number 11.			
1	Set up equipment as shown in figure C-6.3.		
2	Program UUT.	Frequency: 4 MHz; Mode: CW Adjust attenuation to provide a +10 dBm signal into the 70420A test set.	
3	Load the E5500 User Interface software.		
4	Click on Server Hardware Connections under the System menu.	General Assets Tab: Test Set: Agilent/HP 70420A. FFT Analyzer: Select analyzer. Sources Tab: Reference Source: Select signal generator used in test setup.	
5	Click on Measurements under the Define menu.	Enter the following settings: Measurement type: Absolute phase noise (using a phase locked loop). Start offset frequency: 1 Hz Stop offset frequency: 1 MHz Minimum number of FFT averages: 10 Carrier Source Frequency: 4.001 MHz Detector: Automatic detector selection Nominal VCO tune constant: 0.2 Hz/Volt Detector constant cal method: Use current. VCO tune constant cal method: Calculate the tune constant from nominal value. PLL Integrator Attenuation: 0 dB Carrier Source: manual VCO tuned using: Select EFC or DC FM. LNA LPF: 2 MHz Time Base: none Downconverter: none	
6	Place UUT in transmit mode.		
7	Click on New Measurement under the Measure menu.	Measure phase noise. Note: The minimum measurement level of phase noise is dependent upon the phase noise of the signal generator. Therefore, the lowest phase noise signal generator available should be used for this test.	
8	When the measurement is complete, un-key the UUT.		
9	Print results.		
Legend: CW – Continuous Wave; dB – decibels; dBm – decibels referenced to one milliwatt; DC – Direct Current; FFT – Fast Fourier Transform; FM – Frequency Modulation; HP – Hewlett Packard; Hz – hertz; LNA – Low Noise Amplifier; LPF – Low Pass Filter; MHz – megahertz; PLL – Phase Locked Loop; UUT – Unit Under Test; VCO – Voltage Controlled Oscillator			

C-6.4 Presentation of Results. The results will be shown in tabular format (table C-6.2) indicating the requirement and measured value or indications of capability.

Table C-6.2. Phase Noise Results

Reference Number	MIL-STD 188-141B	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
11	5.2.5	The synthesizer and mixer phase noise spectrum at the transmitter output shall not exceed those limits as depicted in figures C-6.1 and/or C-6.2 under continuous carrier single-tone output conditions.	See figures C-6.1 and C-6.2.			
Legend: MIL-STD – Military Standard						

C-7 SUBTEST 7, BANDWIDTH, OVERALL CHANNEL RESPONSE, AND ABSOLUTE DELAY

C-7.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 12, 13, 14, and 15.

C-7.2 Criteria

a. The bandwidths for HF band emissions shall be as shown in table C-7.1. Use of other HF band emissions is optional; however, if selected, they shall be as shown in table C-7.1. Other HF band emissions, which may be required to satisfy specific user requirements, can be found in the National Telecommunications Information Agency (NTIA) Manual of Regulations and Procedures for Federal Radio Frequency Management, MIL-STD-188-141B, paragraph 5.2.6.

b. The amplitude versus frequency response between (f_0 + 300 Hz) and (f_0 + 3050 Hz) shall be within 3 decibels (dB) (total) where f_0 is the carrier frequency. The attenuation shall be at least 20 dB from f_0 to (f_0 - 415 Hz), at least 40 dB from (f_0 - 415 Hz) to (f_0 - 1000 Hz), and at least 60 dB below (f_0 - 1000 Hz). Attenuation shall be at least 30 dB from (f_0 + 4000 Hz) to (f_0 + 5000 Hz) and at least 60 dB above (f_0 + 5000 Hz). See figure C-7.1. Group delay time shall not vary by more than 1.0 msec over 80 percent of the passband of 300 Hz to 3050 Hz (575-2775 Hz). Measurements shall be performed end-to-end (transmitter audio input to receiver audio output) with the radio equipment configured in a back-to-back test setup.

NOTE: The response values given are for single channel USB operation; an identical shape, but inverted channel response, is required for LSB or the inverted channel of a dual channel independent sideband operation, MIL-STD-188-141B, paragraph 5.2.7.1.

c. When four channel independent sideband operation is employed, the four individual 3-kHz channels shall be configured as shown in figure C-7.2, which also shows the amplitude response for these four channels. Channels A2 and B2 shall be inverted and displaced with respect to channels A1 and B1 as shown in figure C-7.2. This can be accomplished by using subcarrier frequencies of 6290 Hz above and below the center carrier frequency or by other suitable techniques that produce the required channel displacements and inversions. The suppression of any subcarriers used shall be at least 40 dB (DO: 50 dB) below the level of a single tone in the A2 or B2 channel modulating the transmitter to 25 percent of Peak Envelope Power (PEP). See figure C-7.2. The RF amplitude versus frequency response for each Independent Sideband (ISB) channel shall be within 2 dB (DO: 1 dB) between 250 Hz and 3100 Hz, referenced to each channel's carrier (either actual or virtual). Referenced from each channel's carrier, the channel attenuation shall be at least 40 dB at 50 Hz and 3250 Hz and at least 60 dB at -250 Hz and 3550 Hz. Group delay distortion shall not exceed 1500 microseconds over the ranges of 370 Hz to 750 Hz and 3000 Hz to 3100 Hz. The distortion shall not exceed 1000 microseconds over the range of 750 Hz to 3000 Hz. Group delay distortion shall not exceed 150 microseconds for any 100-Hz frequency increment between 570 Hz and 3000 Hz. Measurements shall be performed end-to-end (transmitter audio input to receiver audio output) with the radio equipment configured in a back-to-back test setup, MIL-STD-188-141B, paragraph 5.2.7.2.

d. The absolute delay shall not exceed 10 msec (DO: 5 msec) over the frequency range of 300 Hz to 3050 Hz. Measurements shall be performed back-to-back as in paragraph C-7.2b, MIL-STD-188-141B, paragraph 5.2.8.

Legend: dB - decibels; fo - center frequency; Hz - hertz; ISB - Independent Sideband; khz - kilohertz

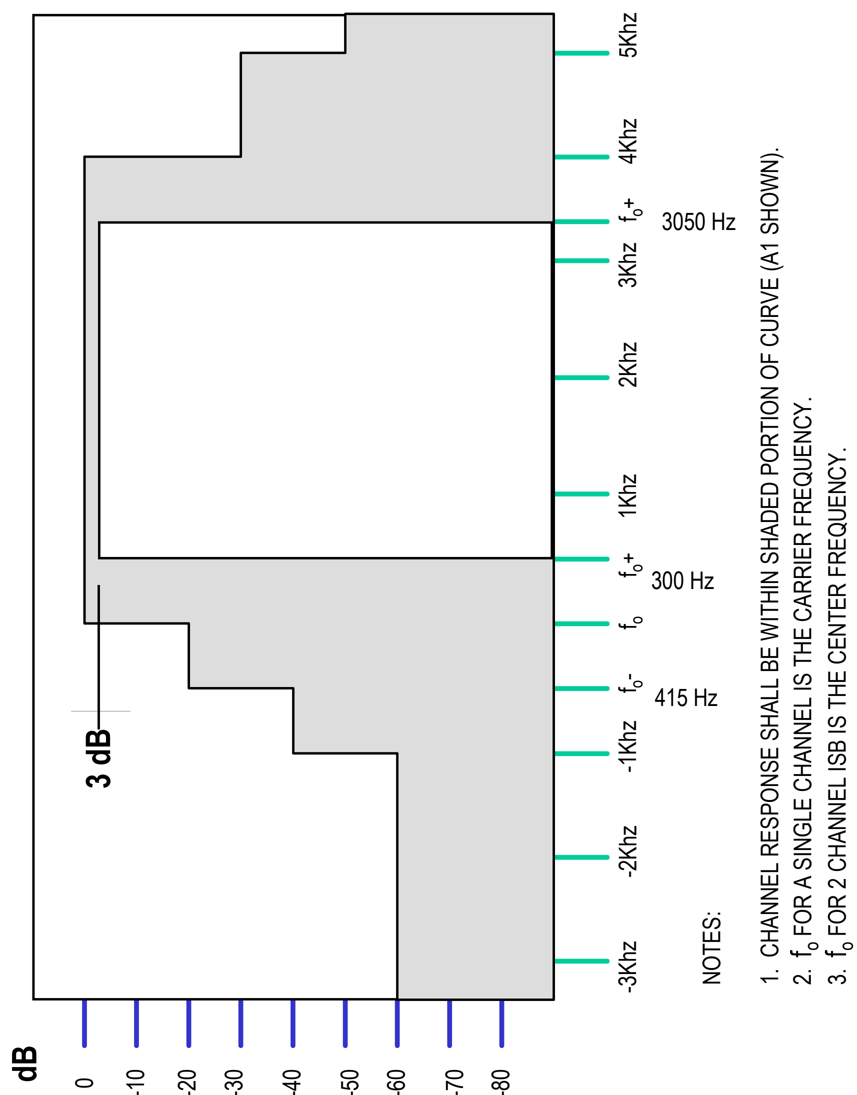


Figure C-7.1. Overall Channel Response for Single Channel or Dual Channel Equipment

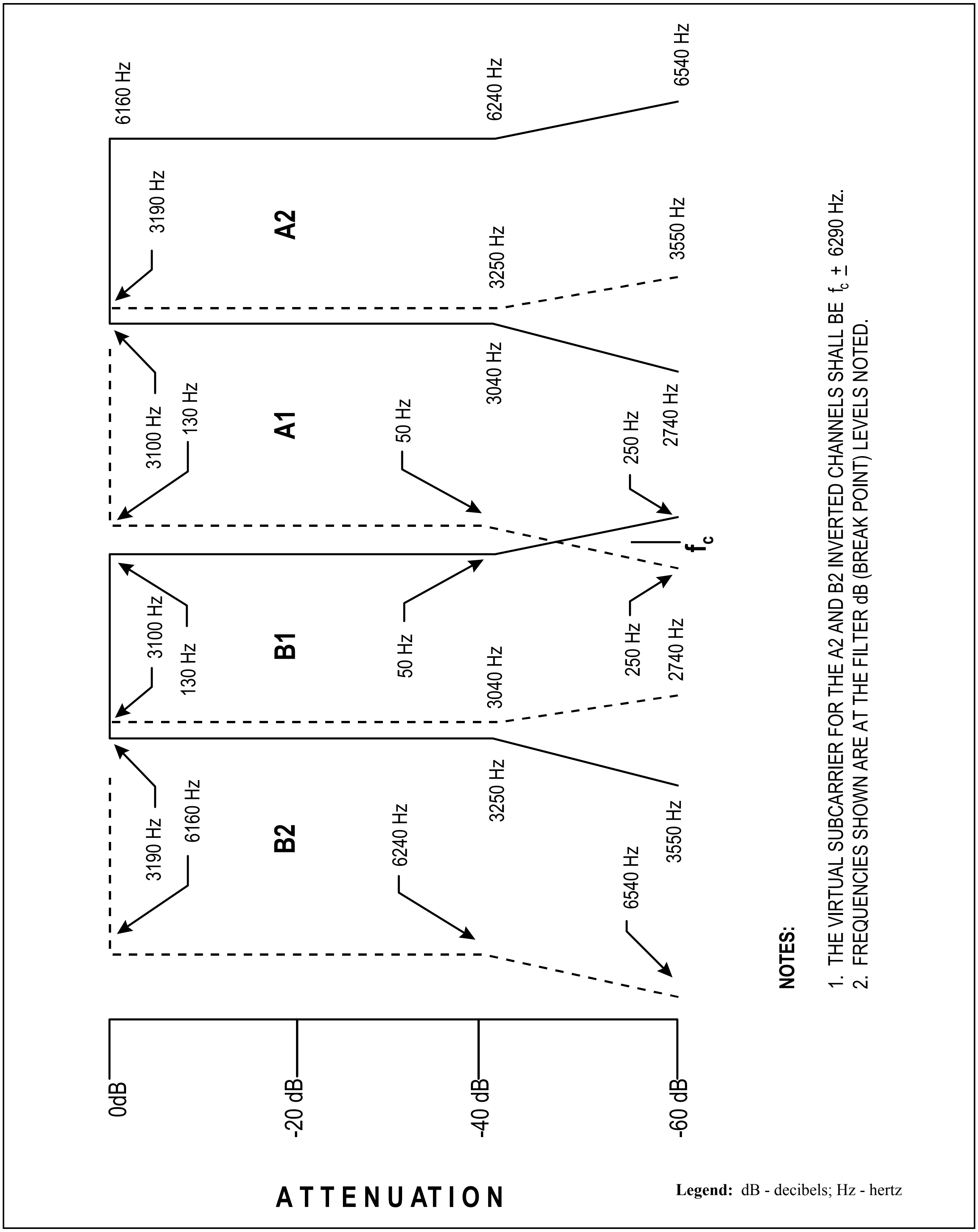


Figure C-7.2. Overall Channel Characteristics (Four Channel Equipment)

Table C-7.1. Bandwidths

Emission Type	Maximum Allowable 3 dB Bandwidth (kHz)	Mandatory Requirements
ICW	0.5	Yes*
FSK (85-Hz shift)	0.3	No
FSK (850-Hz shift)	1.1	No
SSB modulation single channel	See paragraph 5.2.7.1**	Yes
ISB modulation		
Two channels	See paragraph 5.2.7.1**	No
Four channels	See paragraph 5.2.7.2**	No

* Not mandatory for radios designed for ALE.
** MIL-STD-188-141B Requirement Paragraph
Legend: ALE – Automatic Link Establishment; dB – decibels; FSK – Frequency Shift Keying; Hz – hertz; ICW – Interrupted Continuous Wave; ISB – Independent Sideband Modulation; kHz – kilohertz; SSB – Single Sideband

C-7.3 Test Procedures

a. Test Equipment Required

(1) Spectrum Analyzer

(2) Audio Generator

(3) Watt Meter

(4) Attenuator

(5) Super Transmission Impairment Measurement Sets (2)

(6) Unit Under Test (2)

b. Test Configuration. Configure the equipment as shown in figures C-7.3 and C-7.4.

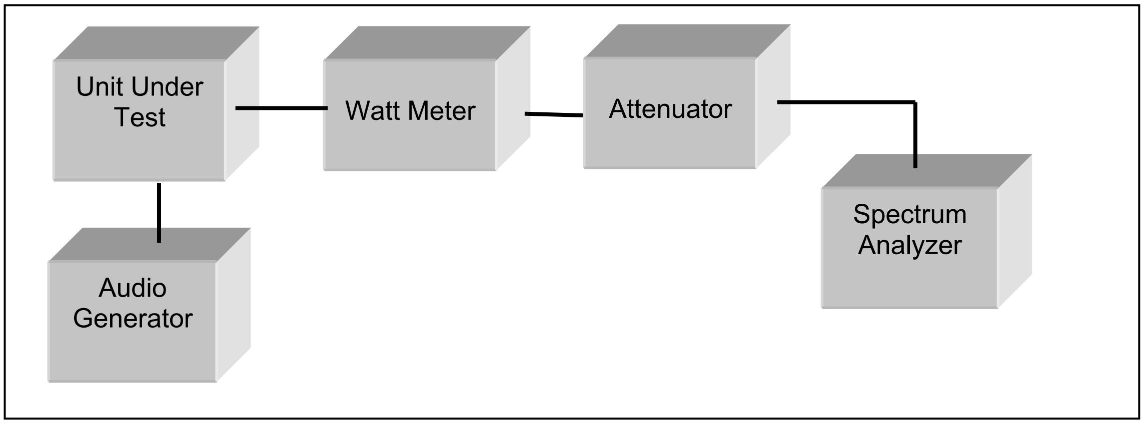


Figure C-7.3. Bandwidth and Overall Response Configuration

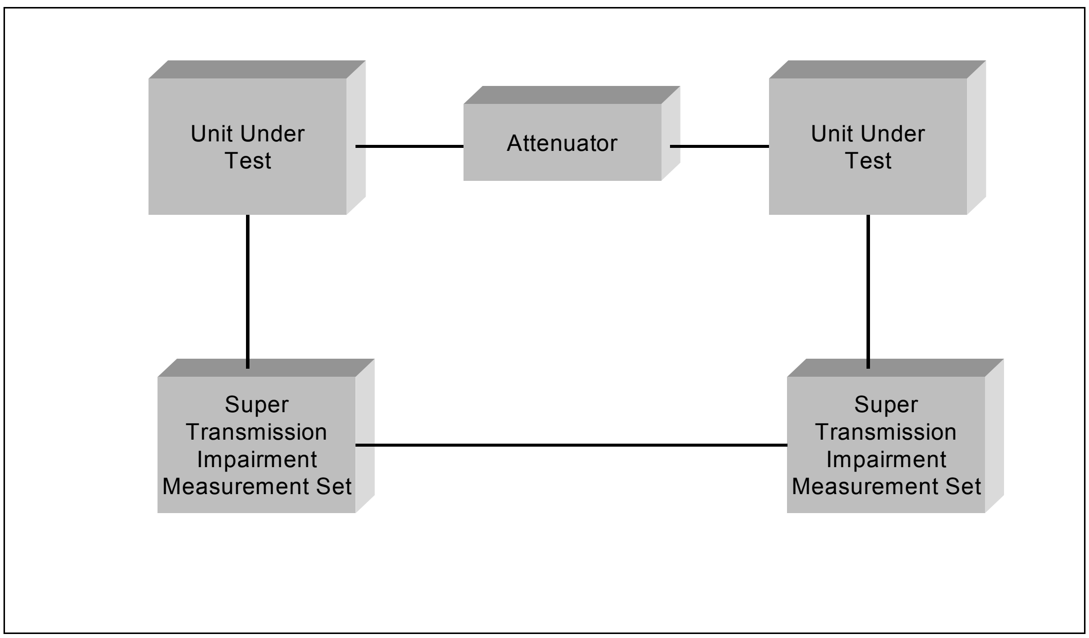


Figure C-7.4. Absolute Delay Equipment Configuration

c. Test Conduct. The procedures for this subtest are listed in tables C-7.2 and C-7.3.

Table C-7.2. Procedures for Bandwidth and Overall Channel Response

Step	Action	Settings/Action	Result
The following procedure is for reference number 12, 13 and 14.			
1	Set up equipment.	See figure C-7.3.	
2	Tune the UUT.	8.0000 MHz	
3	Modulate transmitter to full PEP using audio generator at 1000 Hz.	Determine with measurement from watt meter or radio manufacturer's specifications. Record audio generator level.	
4	Set up spectrum analyzer.	Set reference level on spectrum analyzer to 0 and turn Max Hold on. Center Frequency: 8.0000 MHz Span: 12 kHz (15 kHz for four-channel radio) RBW: 30 Hz VBW: 100 Hz	
5	When required, apply appropriate audio tone(s) to modulate transmitter.	2750 Hz for SSB/USB or SSB/LSB and equal strength audio signals for ISB two and four channel modes.	
6	Change frequency of audio generator to 50 Hz, and set to level recorded in step 3.		
7	Sweep the spectrum analyzer.	Max Hold on.	
8	Increase frequency in 100-Hz steps up to 5050 Hz.	Continue spectrum analyzer sweep with Max Hold on. Save and/or print screen after incrementing audio to 5050 Hz.	
9	Check frequency response from 300 Hz to 3050 Hz.	From f_0 + 300 Hz to f_0 + 3050 Hz, is the frequency response within 3 dB?	
10	Check frequency response from 250 Hz to 3100 Hz.	Is the amplitude verses frequency response for each ISB channel within 2 dB between 250 and 3100 Hz, referenced to each channel's carrier?	
11	Check frequency response from -410 Hz to carrier.	From f_0 to f_0 -415 Hz, is the attenuation at least 20 dB?	
12	Check frequency response from -410 Hz to -1000 Hz.	From f_0 -415 Hz to f_0 -1000 Hz, is the attenuation at least 40 dB?	
13	Check frequency response from -1000 Hz and below.	From f_0 -1000 Hz and below, is the attenuation at least 60 dB?	
14	Check frequency response from 4000 Hz to 5000 Hz.	From f_0 + 4000 Hz to f_0 + 5000 Hz, is the attenuation at least 30 dB?	
15	Check frequency response from 5000 Hz and above.	From f_0 + 5000 Hz and above, is the attenuation at least 60 dB?	
16	If UUT is a four-channel radio, repeat steps 6 through 8 for each channel. Use the audio generator to modulate the transmitter to 25 percent of full PEP.	Verify that the frequency response of each channel conforms to specifications in figure C-7.2.	
17	Program UUT. (Only if UUT has FSK option)	Select FSK 85 Hz.	
18	Set up spectrum analyzer.	Center Frequency: Center of FSK tones. Bandwidth: 1000 Hz	
19	Key UUT and sweep spectrum analyzer.		
20	Measure FSK 85-Hz waveform.	Is the waveform contained in a 300-Hz bandwidth?	

Table C-7.2. Procedures for Bandwidth and Overall Channel Response (continued)

Step	Action	Settings/Action	Result
21	Program UUT. (Only if UUT has FSK option)	Select FSK 850 Hz.	
22	Set up spectrum analyzer.	Center Frequency: Center of FSK tones. Bandwidth: 1500 Hz	
23	Key UUT and sweep spectrum analyzer.		
24	Measure FSK 850-Hz waveform.	Is the waveform contained in a 1100 Hz bandwidth?	
Legend: ALC – Automatic Level Control; CW – Continuous Wave; dB – decibels; dBm – decibels referenced to one milliwatt; FSK – Frequency Shift Key; Hz – hertz; ISB – Independent Sideband; kHz – kilohertz; LSB – Lower Sideband; MHz – megahertz; MIL-STD – Military Standard; PEP – Peak Envelope Power; RBW – Resolution Bandwidth; SSB – Single Sideband; USB – Upper Sideband; UUT – Unit Under Test; VBW – Video Bandwidth			

Table C-7.3. Procedures for Absolute Delay

Step	Action	Settings/Action	Results
The following procedure is for reference numbers 13, 14, and 15.			
1	Set up equipment.	See figure C-7.4.	
2	Tune the UUT.	8.0000 MHz; USB	
3	Set up Super TIMS.	Connect the control path between the two Super TIMS as shown in figure C-7.4. Level: 0 dBm Setup: MASTER SLAVE ON Test: ENVELOPE DELAY Program Sweep: 300 Hz to 3100 Hz in 100-Hz steps.	
4	Measure total time delay at 300 Hz.	Record result.	
5	Measure total time delay at 400 Hz.	Record result.	
6	Measure total time delay at 500 Hz.	Record result.	
7	Measure total time delay at 600 Hz.	Record result.	
8	Measure total time delay at 700 Hz.	Record result.	
9	Measure total time delay at 800 Hz.	Record result.	
10	Measure total time delay at 900 Hz.	Record result.	
11	Measure total time delay at 1000 Hz.	Record result.	
12	Measure total time delay at 1100 Hz.	Record result.	
13	Measure total time delay at 1200 Hz.	Record result.	
14	Measure total time delay at 1300 Hz.	Record result.	
15	Measure total time delay at 1400 Hz.	Record result.	

Table C-7.3. Procedures for Absolute Delay (continued)

Step	Action	Settings/Action	Results
16	Measure total time delay at 1500 Hz.	Record result.	
17	Measure total time delay at 1600 Hz.	Record result.	
18	Measure total time delay at 1700 Hz.	Record result.	
19	Measure total time delay at 1800 Hz.	Record result.	
20	Measure total time delay at 1900 Hz.	Record result.	
21	Measure total time delay at 2000 Hz.	Record result.	
22	Measure total time delay at 2100 Hz.	Record result.	
23	Measure total time delay at 2200 Hz.	Record result.	
24	Measure total time delay at 2300 Hz.	Record result.	
25	Measure total time delay at 2400 Hz.	Record result.	
26	Measure total time delay at 2500 Hz.	Record result.	
27	Measure total time delay at 2600 Hz.	Record result.	
28	Measure total time delay at 2700 Hz.	Record result.	
29	Measure total time delay at 2800 Hz.	Record result.	
30	Measure total time delay at 2900 Hz.	Record result.	
31	Measure total time delay at 3000 Hz.	Record result.	
32	Measure total time delay at 3050 Hz.	Record result.	
33	Analyze data from steps 4 through 32.	Verify that group delay distortion does not exceed 1500 microseconds over the ranges 370 Hz to 750 Hz and 3000 Hz to 3050 Hz.	
34	Analyze data from steps 4 through 32.	Verify that the group delay distortion does not exceed 1000 microseconds over the range 750 Hz to 3000 Hz.	
35	Analyze data from steps 4 through 32.	Verify that group delay distortion does not exceed 150 microseconds for any 100-Hz frequency increment between 570 Hz and 3000 Hz.	
36	Analyze data from steps 4 through 32.	Verify that the absolute delay does not exceed 10 msec from 300 Hz to 3050 Hz.	
Legend: dBm – decibels referenced to 1 milliwatt; Hz – hertz; MHz - megahertz; msec – millisecond; TIMS – Transmission Impairment Measurement Set; USB – Upper Sideband; UUT – Unit Under Test			

C-7.4 Presentation of Results. The results will be shown in tabular format (table C-7.4) indicating the requirement and measured value or indications of capability.

Table C-7.4. Bandwidth, Overall Response, and Absolute Delay Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
12	5.2.6	The bandwidths for high frequency band emissions shall be as shown in table C-7.1.	See table C-7.1.			
12	5.2.6	Use of other HF band emissions is optional; however, if selected, shall be as shown in table C-7.1.	See table C-7.1.			
13	5.2.7.1	The amplitude vs. frequency response between (f_0 + 300 Hz) and (f_0 + 3050 Hz) shall be within 3 dB (total) where f_0 is the carrier frequency.	Within 3 dB (total).			
13	5.2.7.1	The attenuation shall be at least 20 dB from f_0 to (f_0 - 415 Hz), at least 40 dB from (f_0 - 415 Hz) to (f_0 - 1000 Hz), and at least 60 dB below (f_0 - 1000 Hz).	At least 20 dB.			
13	5.2.7.1	Attenuation shall be at least 30 dB from (f_0 + 4000 Hz) to (f_0 + 5000 Hz) and at least 60 dB above (f_0 + 5000 Hz).	See figure C-7.1.			
13	5.2.7.1	Group delay time shall not vary by more than 1.0 msec over 80 percent of the passband of 300 Hz to 3050 Hz (575-2775 Hz).	1.0 msec over 80 percent of the passband.			
14	5.2.7.2	When four-channel independent sideband operation is employed, the four individual 3-kHz channels shall be configured as shown in figure C-7.2, which also shows the amplitude response for these four channels.	See figure C-7.2.			
14	5.2.7.2	Channels A2 and B2 shall be inverted and displaced with respect to channels A1 and B1 as shown on the figure. This can be accomplished by using subcarrier frequencies of 6290 Hz above and below the center carrier frequency or by other suitable techniques that produce the required channel displacements and inversions.	Channels A2 and B2 inverted and displaced with respect to channels A1 and B1.			
14	5.2.7.2	The suppression of any subcarriers used shall be at least 40 dB (DO: 50 dB) below the level of a single tone in the A2 or B2 channel modulating the transmitter to 25 percent of PEP.	See figure C-7.2.			
14	5.2.7.2	The RF amplitude versus frequency response for each ISB channel shall be within 2 dB (DO: 1 dB) between 250 Hz and 3100 Hz, referenced to each channel's carrier (either actual or virtual).	Within 2 dB (DO: 1 dB) between 250 Hz and 3100 Hz.			
14	5.2.7.2	Referenced from each channel's carrier, the channel attenuation shall be at least 40 dB at 50 Hz and 3250 Hz.	At least 40 dB.			

Table C-7.4. Bandwidth, Overall Response and Absolute Delay Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
14	5.2.7.2	And at least 60 dB at -250 Hz and 3550 Hz	At least 60 dB.			
14	5.2.7.2	Group delay distortion shall not exceed 1500 µs over the ranges 370 Hz to 750 Hz and 3000 Hz to 3100 Hz.	Not exceed 1500 µs.			
14	5.2.7.2	The distortion shall not exceed 1000 µs over the range 750 Hz to 3000 Hz.	Not exceed 1000 µs.			
14	5.2.7.2	Group delay distortion shall not exceed 150 µs for any 100-Hz frequency increment between 570 Hz and 3000 Hz.	Not exceed 150 µs.			
15	5.2.8	The absolute delay shall not exceed 10 msec (DO: 5 msec) over the frequency range of 300 Hz to 3050 Hz.	Not exceed 10 msec.			

Legend: µs – microseconds; dB – decibels; DO – Design Objective; HF – High Frequency; Hz – hertz; ISB – Independent Sideband; kHz – kilohertz; MIL-STD – Military Standard; msec – milliseconds; PEP – Peak Envelope Power; RF – Radio Frequency

C-8 SUBTEST 8, IN-BAND NOISE

C-8.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 16.

C-8.2 Criteria. Broadband noise in a 1-Hz bandwidth, within the selected sideband, shall be at least 75 decibels referenced to full-rated peak envelope power (PEP)(dBc) below the level of the rated PEP of the HF transmitter for fixed station application and 65 dBc below the level of the rated PEP of the HF transmitter for tactical application, MIL-STD-188-141B, paragraph 5.3.1.1.

C-8.3 Test Procedures

a. Test Equipment Required

(1) Spectrum Analyzer

(2) Audio Generator

(3) Watt Meter

(4) Attenuator

(5) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figure C-8.1.

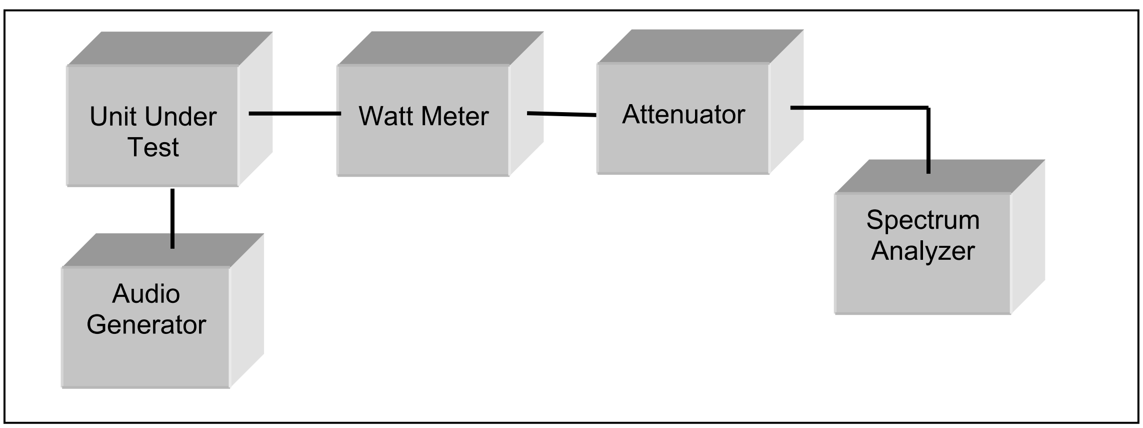


Figure C-8.1. In-Band Noise Configuration

c. Test Conduct. The procedures for this subtest are listed in table C-8.1.

Table C-8.1. Procedures for In-Band Noise

Step	Action	Settings/Action	Result
The following procedure is for reference number 16.			
1	Set up equipment.	See figure C-8.1.	
2	Tune the UUT.	8.0000 MHz; USB	
3	Insert audio into UUT.	Use 1004 Hz and drive transmitter to its rated PEP.	
4	Adjust attenuation level of transmitter output.	Present the spectrum analyzer with a 0-dBm RF signal.	
5	Set up spectrum analyzer.	Center Frequency: 8.0000 MHz Span: 10 kHz RBW: 1 Hz VBW: 1 Hz Noise Level: ON Set reference level of the modulated carrier to the top of the display.	
6	Take noise floor reading.	Record the level of noise floor for reference.	
7	Take reading at carrier frequency + 500 Hz.	Set marker at test frequency + 500 Hz and select single sweep. Record dBm reading and print the spectrum.	
8	Take reading at carrier frequency + 1500 Hz.	Set marker at test frequency + 1500 Hz and select single sweep. Record dBm reading and print the spectrum.	
9	Take reading at carrier frequency + 2250 Hz.	Set marker at test frequency + 2250 Hz and select single sweep. Record dBm reading and print the spectrum.	
10	Take reading at carrier frequency + 2750 Hz.	Set marker at test frequency + 2750 Hz and select single sweep. Record dBm reading and print the spectrum.	
11	Tune the UUT.	24.000 MHz; USB	
12	Insert audio into UUT.	Use 1004 Hz and drive transmitter to its rated PEP.	
13	Adjust attenuation level of transmitter output.	Present the spectrum analyzer with a 0 dBm RF signal.	
14	Set up spectrum analyzer.	Center Frequency: 24.0000 MHz Span: 10 kHz RBW: 1 Hz VBW: 1 Hz Noise Level: On Set reference level of the modulated carrier to the top of the display.	
15	Take noise floor reading.	Record the level of noise floor for reference.	
16	Take reading at carrier frequency + 500 Hz.	Set marker at test frequency + 500 Hz and select single sweep. Record dBm reading and print the spectrum.	
17	Take reading at carrier frequency + 1500 Hz.	Set marker at test frequency + 1500 Hz and select single sweep. Record dBm reading and print the spectrum.	
18	Take reading at carrier frequency + 2250 Hz.	Set marker at test frequency + 2250 Hz and select single sweep. Record dBm reading and print the spectrum.	
19	Take reading at carrier frequency + 2750 Hz.	Set marker at test frequency + 2750 Hz and select single sweep. Record dBm reading and print the spectrum.	
Legend: dBm – decibels referenced to one milliwatt; Hz – hertz; kHz – kilohertz; MHz – megahertz; PEP – Peak Envelope Power; RBW – Resolution Bandwidth; RF – Radio Frequency; USB – Upper Sideband; UUT – Unit Under Test; VBW – Video Bandwidth			

C-8.4 Presentation of Results. The results will be shown in tabular format (table C-8.2) indicating the requirement and measured value or indications of capability.

Table C-8.2. In-Band Noise Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
16	5.3.1.1	Broadband noise in a 1-Hz bandwidth within the selected sideband shall be at least 75 dBc below the level of the rated PEP of the HF transmitter for fixed station application.	At least 75 dB below PEP.			
16	5.3.1.1	And 65 dBc below the level of the rated PEP of the HF transmitter for tactical application.	At least 65 dB below PEP.			
Legend: dB – decibels; dBc – decibels referenced to full rated peak envelope power; HF – High Frequency; Hz – hertz; MIL-STD – Military Standard; PEP – Peak Envelope Power						

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C-9 SUBTEST 9, INTERMODULATION DISTORTION (IMD)

C-9.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 17.

C-9.2 Criteria. The IMD products of HF transmitters produced by any two equal-level signals within the 3-dB bandwidth (a single frequency audio output) shall be at least 30 dB below either tone for fixed station application and 24 dB below either tone for tactical application when the transmitter is operating at rated PEP. The frequencies of the two audio test signals shall not be harmonically or subharmonically related and shall have a minimum separation of 300 Hz, MIL-STD-188-141B, paragraph 5.3.1.2.

C-9.3 Test Procedures

a. Test Equipment Required

(1) Spectrum Analyzer

(2) Audio Generator

(3) Watt Meter

(4) Attenuator

(5) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figure C-9.1.

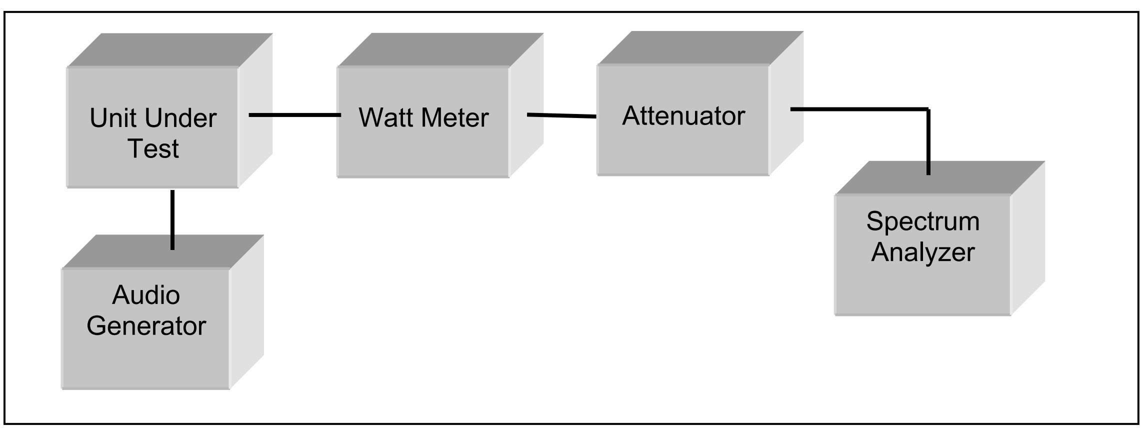


Figure C-9.1. Intermodulation Distortion Configuration

c. Test Conduct. The procedures for this subtest are listed in table C-9.1.

Table C-9.1. Procedures for Intermodulation Distortion

Step	Action	Settings/Action	Result
The following procedure is for reference number 17.			
1	Set up equipment.	See figure C-9.1.	
2	Tune the UUT.	8.0000 MHz; USB	
3	Set up audio generator.	Frequency A: Channel 1 800 Hz Frequency B: Channel 1 1125 Hz Raise level of audio to drive transmitter to rated PEP. Both frequencies must be the same level going into the UUT.	
4	Set up spectrum analyzer.	Center Frequency: 8.0000 MHz Frequency Span: 10 kHz RBW: 30 Hz VBW: 30 Hz Sweep: Single Noise Level: Off	
5	Key radio and capture the display of the spectrum analyzer.	Set reference level on spectrum analyzer so that the highest point is at 0 dB.	
6	Measure peaks on the spectrum analyzer.	Identify in-passband peaks other than frequencies A and B on the spectrum analyzer. Record the frequency and the difference (dB) between peak levels and two-tone levels for all peaks that are not at least 30 dB below the peak of either tone for fixed station application and 24 dB below peak of either tone for tactical applications.	
7	Analyze the IMD products.	Record the highest peak value (dB) found in the previous step.	
8	Print the display.		
9	Set up audio generator.	Frequency A: Channel 1 1400 Hz Frequency B: Channel 1 1775 Hz Raise level of audio to drive transmitter to rated PEP. Both frequencies must be the same level going into the UUT.	
10	Set up spectrum analyzer.	Center Frequency: 8.0000 MHz Frequency Span: 10 kHz RBW: 30 Hz VBW: 30 Hz Sweep: Single Noise Level: Off	
11	Key radio and capture the spectrum analyzer display.	Set reference level on spectrum analyzer so that the highest point is at 0 dB.	

Table C-9.1. Procedures for Intermodulation Distortion (continued)

Step	Action	Settings/Action	Result
12	Measure peaks on spectrum analyzer.	Identify in-passband peaks other than frequencies A and B on the spectrum analyzer. Record the frequency and the difference (dB) between peak levels and two-tone levels for all peaks that are not at least 30 dB below the peak of either tone for fixed station application and 24 dB below peak of either tone for tactical applications.	
13	Analyze the IMD products.	Record the highest peak value (dB) found in the previous step.	
14	Print the display.		
15	Set up audio generator.	Frequency A: Channel 1 2000 Hz Frequency B: Channel 1 2375 Hz Raise level of audio to drive transmitter to rated PEP. Both frequencies must be the same level going into the UUT.	
16	Set up spectrum analyzer.	Center Frequency: 8.0000 MHz Frequency Span: 10 kHz RBW: 30 Hz VBW: 30 Hz Sweep: Single Noise Level: Off	
17	Key radio and capture the spectrum analyzer display.	Set reference level on spectrum analyzer so that the highest point is at 0 dB.	
18	Measure peaks on the spectrum analyzer.	Identify in-passband peaks other than frequencies A and B on the spectrum analyzer. Record the frequency and the difference (dB) between peak levels and two-tone levels for all peaks that are not at least 30 dB below the peak of either tone for fixed station application and 24 dB below peak of either tone for tactical applications.	
19	Analyze the IMD products.	Record the highest peak value (dB) found in the previous step.	
20	Print the display.		
21	Set up audio generator.	Frequency A: Channel 1 2700 Hz Frequency B: Channel 1 3050 Hz Raise level of audio to drive transmitter to rated PEP. Both frequencies must be the same level going into the UUT.	

Table C-9.1. Procedures for Intermodulation Distortion (continued)

Step	Action	Settings/Action	Result
22	Set up spectrum analyzer.	Center Frequency: 8.0000 MHz Frequency Span: 10 kHz RBW: 30 Hz VBW: 30 Hz Sweep: Single Noise Level: Off	
23	Key radio and capture the spectrum analyzer display.	Set reference level on spectrum analyzer so that the highest point is at 0 dB.	
24	Measure peaks on spectrum analyzer display.	Identify in-passband peaks other than frequencies A and B on the spectrum analyzer. Record the frequency and the difference (dB) between peak levels and two-tone levels for all peaks that are not at least 30 dB below the peak of either tone for fixed station application and 24 dB below peak of either tone for tactical applications.	
25	Analyze the IMD products.	Record the highest peak value (dB) found in the previous step.	
26	Print the display.		
27	Repeat steps 1 through 26 using a test frequency of 2.0 MHz.		
28	Repeat steps 1 through 26 using a test frequency of 29.9999 MHz.		
Legend: dB – decibel; dBm – decibels referenced to one milliwatt; Hz – hertz; IMD – Intermodulation Distortion; kHz – kilohertz; MHz – megahertz; MIL-STD – Military Standard; PEP – Peak Envelope Power; RBW – Resolution Bandwidth; USB – Upper Sideband; UUT – Unit Under Test; VBW – Video Bandwidth			

C-9.4 Presentation of Results. The results will be shown in tabular format (table C-9.2) indicating the requirement and measured value or indications of capability.

Table C-9.2. Intermodulation Distortion Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
17	5.3.1.2	The IMD products of HF transmitters produced by any two equal-level signals within the 3-dB bandwidth (a single frequency audio output) shall be at least 30 dB below either tone for fixed station application and 24 dB below either tone for tactical application when the transmitter is operating at rated PEP.	Fixed station: IMD peaks < 30 dB Tactical radio: IMD peaks < 24 dB			
Legend: dB – decibels; HF – High Frequency; Hz – hertz; IMD – Intermodulation Distortion; MIL-STD – Military Standard; PEP – Peak Envelope Power						

C-10 SUBTEST 10, BROADBAND EMISSIONS AND DISCRETE FREQUENCY SPURIOUS EMISSIONS

C-10.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 18 and 19.

C-10.2 Criteria

a. When the transmitter is driven with a single tone to the rated PEP, the power spectral density of the transmitter broadband emission shall not exceed the level established in table C-10.1 and as shown in figure C-10.1. Discrete spurs shall be excluded from the measurement and the measurement bandwidth shall be 1 Hz, MIL-STD-188-141B, paragraph 5.3.2.1.

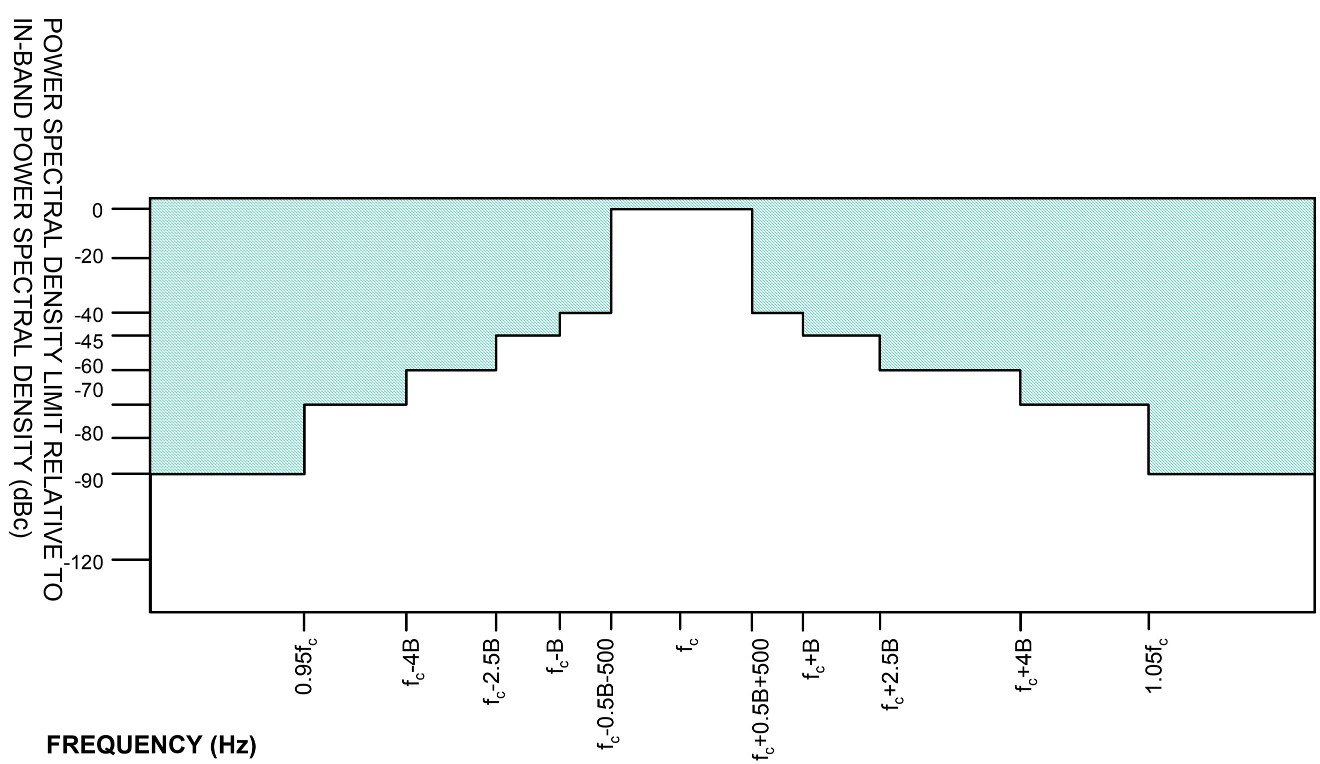
Table C-10.1. Out-of-Band Power Spectral Density Limits for Radio Transmitters

Frequency (Hz)	Attenuation Below In-Band Power Density (dBc)
$f_m = f_c \pm (0.5\ B + 500)$	40 (DO: 43)
$f_m = f_c \pm 1.0\ B$	45 (DO: 48)
$f_m = f_c \pm 2.5\ B$	60 (DO: 80)
$(f_c + 4.0\ B) \leq f_m \leq 1.05\ f_c$ $0.95\ f_c \leq f_m \leq (f_c - 4.0\ B)$	70 (DO: 80)
$f_m \leq 0.95\ f_c$ $f_m \geq 1.05\ f_c$	90 (DO: 120)
Legend: B – Bandwidth (Hz); dBc – decibels referenced to full peak envelope power; DO – Design Objective; f_c – center frequency of bandwidth (Hz); f_m – frequency of measurement (Hz); Hz – hertz	

b. For HF transmitters, when driven with a single tone to produce an RF output of 25-percent rated PEP, all discrete frequency spurious emissions shall be suppressed as follows:

(1) Fixed Application. Between the carrier frequency (fc) and fc ± 4B (where B = bandwidth), at least 40 dBc. Between fc ± 4B and ± 5 percent of fc removed from the carrier frequency, at least 60 dBc. Beyond ±5 percent removed from the carrier frequency, at least 80 dBc. Harmonic performance levels shall not exceed -63 dBc. See figure C-10.2.

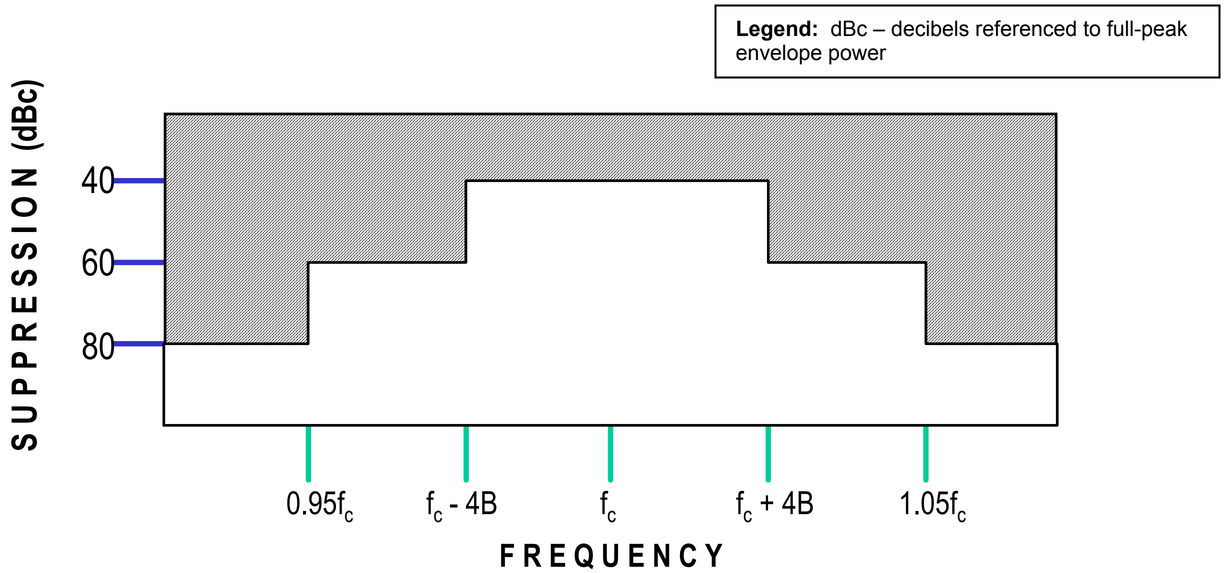
(2) Tactical Application. Between the carrier frequency f_c and $f_c \pm 4B$ (where B = bandwidth), at least 40 dBc. Beyond $f_c \pm 4B$, at least 50 dBc. Harmonic performance levels shall not exceed -40 dBc. See figure C-10.2, MIL-STD-188-141B, paragraph 5.3.2.2.



Legend: dBc – decibels referenced to full-peak envelope power; Hz – Hertz

NOTES:
1. B=Necessary bandwidth (Hz).
2. F_c=Center frequency of bandwidth (Hz).
3. Emissions shall fall within the unshaded portion of the curve.

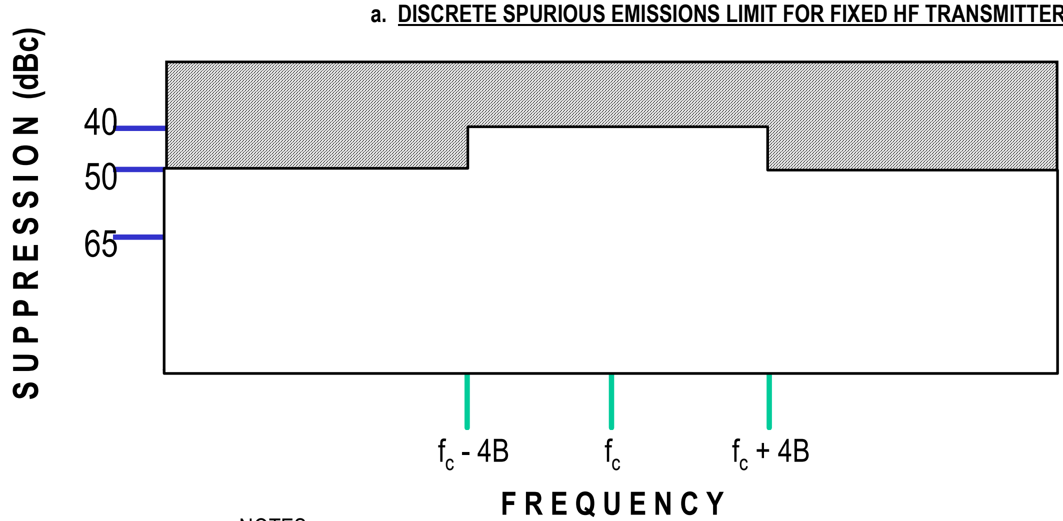
Figure C-10.1. Out-of-Band Power Spectral Density for High Frequency Transmitters



NOTES:

1. EMISSIONS SHALL FALL WITHIN THE UNSHADED PORTION OF THE CURVE.
2. HARMONIC PERFORMANCE LEVELS FOR FIXED TRANSMITTERS SHALL NOT EXCEED -63dBc.

a. <u>DISCRETE SPURIOUS EMISSIONS LIMIT FOR FIXED HF TRANSMITTERS.</u>



NOTES:

1. EMISSIONS SHALL FALL WITHIN THE UNSHADED PORTION OF THE CURVE.
2. HARMONIC PERFORMANCE LEVELS FOR TACTICAL TRANSMITTERS SHALL NOT EXCEED -40dBc.

b. <u>DISCRETE SPURIOUS EMISSIONS LIMIT FOR TACTICAL HF TRANSMITTERS.</u>

Figure C-10.2. Discrete Spurious Emissions Limit for High Frequency Transmitters

C-10.3 Test Procedures

a. Test Equipment Required

(1) Spectrum Analyzer

(2) Audio Generator

(3) Watt Meter

(4) Attenuator

(5) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figure C-10.3.

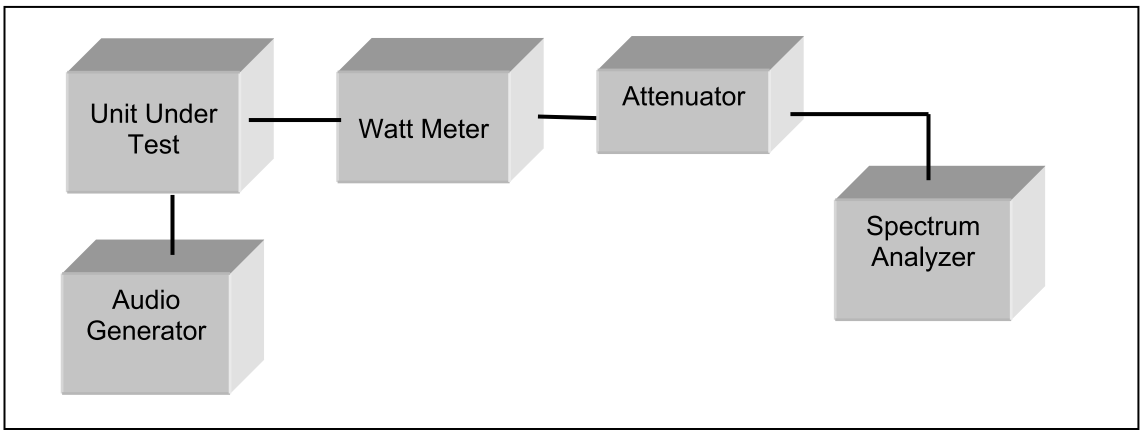


Figure C-10.3. Broadband Emissions and Discrete Frequency Spurious Emissions Configuration

c. Test Conduct. The procedures for this subtest are listed in table C-10.2. The center frequency used is 3.001675 MHz and the bandwidth is 2750 Hz.

Table C-10.2. Procedures for Broadband Emissions and Discrete Frequency Spurious Emissions

Step	Action	Settings/Action	Result
The following procedure is for reference numbers 18 and 19.			
1	Set up equipment.	See figure C-10.3.	
2	Tune the UUT.	3.0000 MHz; USB	

Table C-10.2. Procedures for Broadband Emissions and Discrete Frequency Spurious Emissions (continued)

Step	Action	Settings/Action	Result
3	Set up spectrum analyzer.	Center Frequency: 3.000 MHz Span: 10 kHz $R_{BW} = V_{BW}$ = 100 Hz Noise Level: On	
4	Set up audio generator.	Frequency: 1000Hz Level: To produce PEP at transmitter RF output.	
5	Key radio.		
6	Set up spectrum analyzer.	Place cursor on spectrum analyzer on 2.85 MHz (0.95 X center frequency).	
7	Sweep and record spectrum.	Record frequency and noise level from spectrum analyzer for 0.95 X center frequency.	
8	Set up spectrum analyzer.	Place cursor on spectrum analyzer on 2.988 MHz (center frequency – 4 X bandwidth).	
9	Sweep and record spectrum.	Record frequency and noise level from spectrum analyzer for center frequency – 4 X bandwidth.	
10	Set up spectrum analyzer.	Place cursor on spectrum analyzer on 2.9925 MHz (center frequency – 2.5 X bandwidth).	
11	Sweep and record spectrum.	Record frequency and noise level from spectrum analyzer for center frequency – 2.5 X bandwidth.	
12	Set up spectrum analyzer.	Place cursor on spectrum analyzer on 2.997 MHz (center frequency – bandwidth).	
13	Sweep and record spectrum.	Record frequency and noise level from spectrum analyzer for center frequency – bandwidth.	
14	Set up spectrum analyzer.	Place cursor on spectrum analyzer on 2.998 MHz (center frequency – (0.5 X bandwidth + 500)).	
15	Sweep and record spectrum.	Record frequency and noise level from spectrum analyzer for center frequency – (0.5 X bandwidth + 500).	
16	Set up spectrum analyzer.	Place cursor on spectrum analyzer on 3.002 MHz (center frequency + (0.5 X bandwidth + 500)).	
17	Sweep and record spectrum.	Record frequency and noise level from spectrum analyzer for center frequency + (0.5 X bandwidth + 500).	
18	Set up spectrum analyzer.	Place cursor on spectrum analyzer on 3.003 MHz (center frequency + bandwidth).	
19	Sweep and record spectrum.	Record frequency and noise level from spectrum analyzer for center frequency + bandwidth.	
20	Set up spectrum analyzer.	Place cursor on spectrum analyzer on 3.0075 MHz (center frequency + 2.5 X bandwidth).	
21	Sweep and record spectrum.	Record frequency and noise level from spectrum analyzer for center frequency + 2.5 X bandwidth.	
22	Set up spectrum analyzer.	Place cursor on spectrum analyzer on 3.012 MHz (center frequency + 4 X bandwidth).	
23	Sweep and record spectrum.	Record frequency and noise level from spectrum analyzer for center frequency + 4 X bandwidth.	
24	Set up spectrum analyzer.	Place cursor on spectrum analyzer on 3.15 MHz (center frequency X 1.05).	

Table C-10.2. Procedures for Broadband Emissions and Discrete Frequency Spurious Emissions (continued)

Step	Action	Settings/Action	Result
25	Sweep and record spectrum.	Record frequency and noise level from spectrum analyzer for center frequency X 1.05.	
26	Set up spectrum analyzer.	Center Frequency: 2.2 MHz Frequency Span: 400 kHz Noise Level: Off	
27	Insert audio into UUT.	Frequency: 1004 Hz Level: Reduce audio input level to produce an RF output of 25 percent rated PEP.	
28	Adjust the center frequency of the spectrum analyzer (in 400 kHz steps) to sweep the spectrum from 2.0 MHz to 2.8 MHz.	Record the level of any spurious emissions. Use the “Find Peak” and “Next Peak” functions.	
29	Set up spectrum analyzer.	Center Frequency: 3.3500 MHz Frequency Span: 400 kHz Noise Level: Off	
30	Adjust the center frequency of the spectrum analyzer (in 400 kHz steps) to sweep the spectrum from 3.15 MHz to 30 MHz.	Record the level of any spurious emissions. Use the “Find Peak” and “Next Peak” functions.	
31	Tune the UUT.	29.9999 MHz, USB.	
32	Set up spectrum analyzer.	Center Frequency: 10.2 MHz Frequency Span: 400 kHz Noise Level: Off	
33	Insert audio into UUT.	Frequency: 1004 Hz Level: Reduce audio input level to produce an RF output of 25 percent rated PEP.	
34	Adjust the center frequency of the spectrum analyzer (in 400 kHz steps) to sweep the spectrum from 10.0 MHz to 28.4999 MHz.	Record the level of any spurious emissions. Use the “Find Peak” and “Next Peak” functions.	
35	Set up spectrum analyzer.	Center Frequency: 31.6999 MHz Frequency Span: 400 kHz Noise Level: Off	
36	Adjust the center frequency of the spectrum analyzer (in 400 kHz steps) to sweep the spectrum from 31.4999 MHz to 50 MHz.	Record the level of any spurious emissions. Use the “Find Peak” and “Next Peak” functions.	

Legend: dBm – decibels referenced to one milliwatt; Hz – hertz; kHz – kilohertz; MHz – megahertz; PEP – Peak Envelope Power; RF – Radio Frequency; USB – Upper Sideband; UUT – Unit Under Test

C-10.4 Presentation of Results. The results will be shown in tabular format (table C-10.3) indicating the requirement and measured value or indications of capability.

Table C-10.3. Broadband Emissions and Discrete Frequency Spurious Emissions Results

<table>
<tr><th rowspan="2">Reference Number</th><th rowspan="2">MIL-STD-188-141B, paragraph</th><th rowspan="2">Requirement</th><th colspan="2">Result</th><th colspan="2">Finding</th></tr>
<tr><th>Required Value</th><th>Measured Value</th><th>Met</th><th>Not Met</th></tr>
<tr><td>18</td><td>5.3.2.1</td><td>When the transmitter is driven with a single tone to the rated PEP, the power spectral density of the transmitter broadband emission shall not exceed the level established in table C-10.1 and as shown in figure C-10.1.</td><td>See table C-10.1 and figure C-10.1.</td><td></td><td></td><td></td></tr>
<tr><td>18</td><td>5.3.2.1</td><td>Discrete spurs shall be excluded from the measurement, and the measurement bandwidth shall be 1 Hz.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>19</td><td>5.3.2.2</td><td>For HF transmitters, when driven with a single tone to produce an RF output of 25-percent rated PEP, all discrete frequency spurious emissions shall be suppressed as follows:
1. For fixed application:
Between the carrier frequency f_c and $f_c \pm$ 4B (where B = bandwidth), at least 40 dBc.
Between fc $\pm$ 4B and $\pm$ 5 percent of fc removed from the carrier frequency, at least 60 dBc.
Beyond $\pm$5 percent removed from the carrier frequency, at least 80 dBc. Harmonic performance levels shall not exceed -63 dBc.</td><td>See figure C-10.2.</td><td></td><td></td><td></td></tr>
<tr><td>19</td><td>5.3.2.2</td><td>2. For tactical application:
Between the carrier frequency f_c and $f_c \pm$ 4B (where B = bandwidth), at least 40 dBc.
Beyond $f_c \pm$ 4B at least 50 dBc. Harmonic performance levels shall not exceed -40 dBc.</td><td>See figure C-10.1.</td><td></td><td></td><td></td></tr>
<tr><td colspan="7">Legend: dB – decibels; dBc – decibels referenced to full-peak envelope power; f_c – carrier frequency; HF – High Frequency; Hz – hertz; MIL-STD – Military Standard; PEP – Peak Envelope Power</td></tr>
</table>

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C-11 SUBTEST 11, CARRIER SUPPRESSION

C-11.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 20.

C-11.2 Criteria. The suppressed carrier for tactical applications shall be at least 40 dBc (DO: 60 dBc) below the output level of a single tone modulating the transmitter to rated PEP. The suppressed carrier for fixed site applications shall be at least 50 dBc (DO: 60 dBc) below the output level of a single tone modulating the transmitter to rated PEP, MIL-STD-188-141B, paragraph 5.3.3.

C-11.3 Test Procedures

a. Test Equipment Required

(1) Spectrum Analyzer

(2) Audio Generator

(3) Watt Meter

(4) Attenuator

(5) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figure C-11.1.

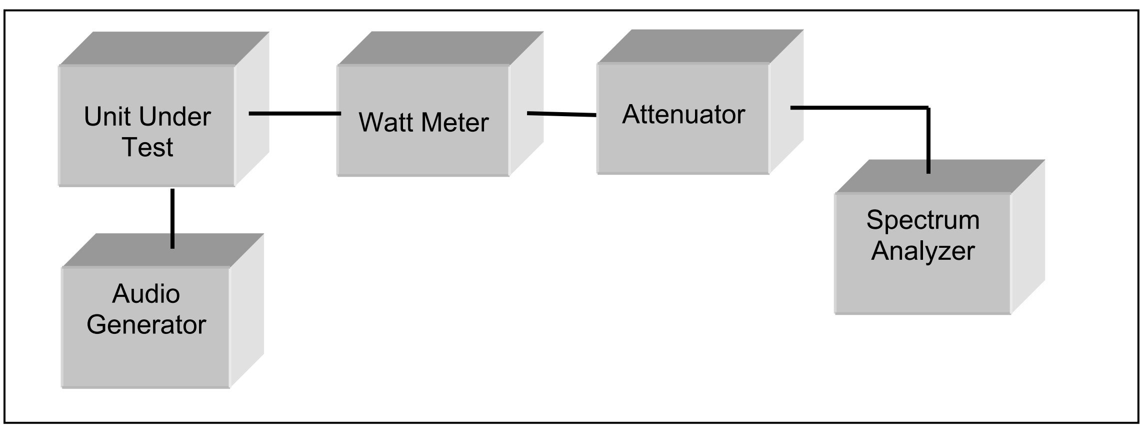

Figure C-11.1. Carrier Suppression Configuration

c. Test Conduct. The procedures for this subtest are listed in table C-11.1.

Table C-11.1. Procedures for Carrier Suppression

Step	Action	Settings/Action	Result
The following procedure is for reference number 20.			
1	Set up equipment.	See figure C-11.1.	
2	Tune the UUT.	8.0000 MHz; USB	
3	Set up spectrum analyzer.	Center Frequency: 3.0000 MHz Frequency Span: 6.0000 kHz RBW: 30 Hz VBW: 100 Hz Noise Level: Off Max Hold: On	
4	Set up audio generator.	Frequency: 1004 Hz Level: As required to modulate transmitter to rated PEP.	
5	Key radio and capture spectrum. Unkey radio when spectrum is swept.	Press sweep on the spectrum analyzer. Print the display.	
6	Measure the peak on the spectrum.	Place cursor at peak and record the frequency and level in dBm.	
7	Measure the carrier on the spectrum.	Place cursor at 3.0000 MHz and record the frequency and level in dBm.	
8	Verify that the carrier is at least 40 dBc below the tone for tactical applications, and 50 dBc below the tone for fixed site applications.		
Legend: dBc – decibels referenced to full-peak envelope power; dBm – decibels referenced to one milliwatt; Hz – hertz; kHz – kilohertz; MHz – megahertz; PEP – Peak Envelope Power; RBW – Resolution Bandwidth; RF – Radio Frequency; USB – Upper Sideband; UUT – Unit Under Test; VBW – Video Bandwidth			

C-11.4 Presentation of Results. The results will be shown in tabular format (table C-11.2) indicating the requirement and measured value or indications of capability.

Table C-11.2. Carrier Suppression Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
20	5.3.3	The suppressed carrier for tactical applications shall be at least 40 dBc (DO: 60 dBc) below the output level of a single tone modulating the transmitter to rated PEP.	40 dBc below transmitter PEP.			
20	5.3.3	The suppressed carrier for fixed site applications shall be at least 50 dBc (DO: 60 dBc) below the output level of a single tone modulating the transmitter to rated PEP.	50 dBc below transmitter PEP.			
Legend: dBc – decibels referenced to full-peak envelope power; DO – Design Objective; MIL-STD – Military Standard; PEP – Peak Envelope Power						

C-12 SUBTEST 12, AUTOMATIC LEVEL CONTROL (ALC)

C-12.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 21.

C-12.2 Criteria. Starting at ALC threshold, an increase of 20 dB in audio input shall result in less than a 1-dB increase in average RF power output, MIL-STD-188-141B, paragraph 5.3.4.

C-12.3 Test Procedures

a. Test Equipment Required

(1) Spectrum Analyzer

(2) Audio Generator

(3) Watt Meter

(4) Attenuator

(5) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figure C-12.1.

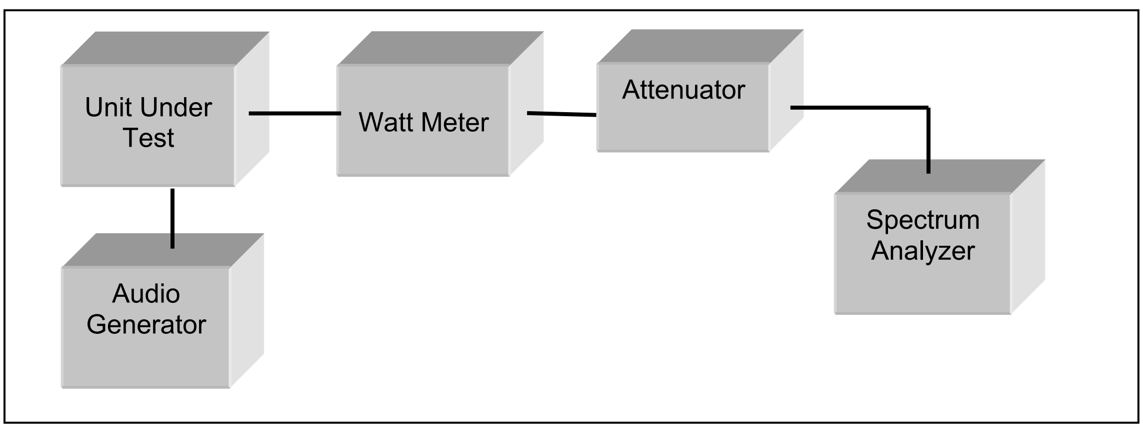

Figure C-12.1. Automatic Level Control Configuration

c. Test Conduct. The procedures for this subtest are listed in table C-12.1.

Table C-12.1. Procedures for Automatic Level Control

Step	Action	Settings/Action	Result
The following procedure is for reference number 21.			
1	Set up equipment.	See figure C-12.1.	
2	Tune the UUT.	8.0000 MHz; USB	
3	Set up audio generator and key UUT.	Frequency: 1004 Hz Level: Increase the level of audio until the transmitter's ALC reacts.	
4	Record the minimum audio input level (in dB) that causes the ALC of the transmitter to react. This is the ALC threshold.	The ALC threshold is found by increasing the level of the audio generator until the RF output level of the transmitter reaches steady state.	
5	In steps 6 through 25, increase the audio generator level in 1 dB increments to the ALC threshold level plus 20 dB.	Use the watt meter to measure the RF output level of the UUT at each test point.	
6	Set level of audio generator to ALC threshold + 1 dB.	Record the RF output level of the UUT.	
7	Set level of audio generator to ALC threshold + 2 dB.	Record the RF output level of the UUT.	
8	Set level of audio generator to ALC threshold + 3 dB.	Record the RF output level of the UUT.	
9	Set level of audio generator to ALC threshold + 4 dB.	Record the RF output level of the UUT.	
10	Set level of audio generator to ALC threshold + 5 dB.	Record the RF output level of the UUT.	
11	Set level of audio generator to ALC threshold + 6 dB.	Record the RF output level of the UUT.	
12	Set level of audio generator to ALC threshold + 7 dB.	Record the RF output level of the UUT.	
13	Set level of audio generator to ALC threshold + 8 dB.	Record the RF output level of the UUT.	
14	Set level of audio generator to ALC threshold + 9 dB.	Record the RF output level of the UUT.	
15	Set level of audio generator to ALC threshold + 10 dB.	Record the RF output level of the UUT.	
16	Set level of audio generator to ALC threshold + 11 dB.	Record the RF output level of the UUT.	
17	Set level of audio generator to ALC threshold + 12 dB.	Record the RF output level of the UUT.	
18	Set level of audio generator to ALC threshold + 13 dB.	Record the RF output level of the UUT.	
19	Set level of audio generator to ALC threshold + 14 dB.	Record the RF output level of the UUT.	
20	Set level of audio generator to ALC threshold + 15 dB.	Record the RF output level of the UUT.	
21	Set level of audio generator to ALC threshold + 16 dB.	Record the RF output level of the UUT.	
22	Set level of audio generator to ALC threshold + 17 dB.	Record the RF output level of the UUT.	
23	Set level of audio generator to ALC threshold + 18 dB.	Record the RF output level of the UUT.	

Table C-12.1. Procedures for Automatic Level Control (continued)

Step	Action	Settings/Action	Result
24	Set level of audio generator to ALC threshold + 19 dB.	Record the RF output level of the UUT.	
25	Set level of audio generator to ALC threshold + 20 dB.	Record the RF output level of the UUT.	
26	Analyze data from steps 6 through 25.	Starting at ALC threshold, verify that an increase of 20 dB in audio input level causes the RF output level of the UUT to increase less than 1 dB.	
Legend: ALC – Automatic Level Control; dB – decibels; Hz – hertz; MHz – megahertz; RF – Radio Frequency; USB – Upper Sideband; UUT – Unit Under Test			

C-12.4 Presentation of Results. The results will be shown in tabular format (table C-12.2) indicating the requirement and measured value or indications of capability.

Table C-12.2. Automatic Level Control Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
21	5.3.4	Starting at ALC threshold, an increase of 20 dB in audio input shall result in less than a 1-dB increase in average RF power output.	Not more than 1 dB.			
Legend: ALC – Automatic Level Control; dB – decibels; MIL-STD – Military Standard; RF – Radio Frequency						

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C-13 SUBTEST 13, ATTACK AND RELEASE TIME DELAYS

C-13.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 22 and 23.

C-13.2 Criteria

a. Attack Time Delay. The time interval from keying-on a transmitter until the transmitted RF signal amplitude has increased to 90 percent of its steady-state value shall not exceed 25 msec (DO: 10 msec). This delay excludes any necessary time for automatic antenna tuning, MIL-STD-188-141B, paragraph 5.3.5.1.

b. Release Time Delay. The time interval from keying-off a transmitter until the transmitted RF signal amplitude has decreased to 10 percent of its key-on steady-state value shall be 10 msec or less, MIL-STD-188-141B, paragraph 5.3.5.2.

C-13.3 Test Procedures

a. Test Equipment Required

(1) Oscilloscope

(2) Attenuator

(3) Audio Generator

(4) Break Out Box

(5) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figure C-13.1.

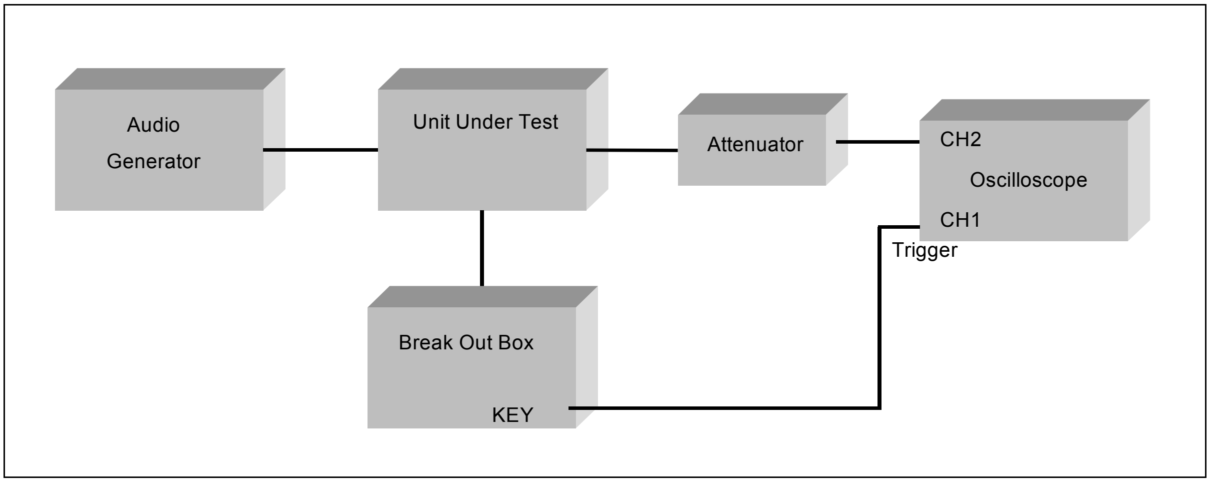

Figure C-13.1. Attack and Release Time Delay Equipment Configuration

c. Test Conduct. The procedures for this subtest are listed in tables C-13.1 and C-13.2.

Table C-13.1. Procedures for Attack Time Delay

Step	Action	Settings/Action	Result
The following procedure is for reference number 22.			
1	Set up equipment.	See figure C-13.1.	
2	Tune UUT.	8.0000 MHz; USB	
3	Set up oscilloscope.	Set horizontal scale to 5 msec/div. Set vertical scale to 0.5 V/div. Set trigger to single sweep. Trigger on channel 1, (+) slope.	
4	Set up audio generator.	Frequency: 1004 Hz Level: Drive transmitter to full rated PEP.	
5	Press RUN on oscilloscope and key UUT to capture the Attack Time Delay.		
6	Measure and record the Attack Time Delay.	The Attack Time Delay is measured by placing vertical marker #1 on the trigger position (from channel one), and vertical marker #2 at the point where the amplitude of the signal on channel two reaches 90% of its steady-state value. The time difference between the two vertical markers is the Attack Time Delay.	
Legend: Hz – hertz; MHz – megahertz; msec/div – milliseconds per division; PEP – Peak Envelope Power; USB – Upper Sideband; UUT – Unit Under Test; V/div – Volts per division; % – percent			

Table C-13.2. Procedures for Release Time Delay

Step	Action	Settings/Action	Result
The following procedure is for reference number 23.			
1	Set up equipment.	See figure C-13.1.	
2	Tune the UUT.	8.0000 MHz; USB	
3	Set up oscilloscope.	Set horizontal scale to 2 msec/div. Set vertical scale to 0.5 V/div. Set trigger to channel 1, single sweep.	
4	Set up audio generator.	Frequency: 1004 Hz Level: Drive transmitter to full rated PEP.	
5	Key UUT, press RUN on oscilloscope, then key-off UUT to capture the Release Time Delay.		
6	Measure and record the Release Time Delay.	The Release Time Delay is measured by placing vertical marker #1 on the point where the UUT is keyed-off (trigger position), and vertical marker #2 at the point where the amplitude of the RF signal decreases to 10% of its keyed-on steady-state value. The time difference between the two vertical markers is the Release Time Delay.	
Legend: Hz – hertz; MHz – megahertz; msec/div – milliseconds per division; PEP – Peak Envelope Power; USB – Upper Sideband; UUT – Unit Under Test; V/div – Volts per division; % – percent			

C-13.4 Presentation of Results. The results will be shown in tabular format (table C-13.3) indicating the requirement and measured value or indications of capability.

Table C-13.3. Results of Attack and Release Time Delay

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
22	5.3.5.1	Attack Time Delay. The time interval from keying-on a transmitter until the transmitted RF signal amplitude has increased to 90 percent of its steady-state value shall not exceed 25 msec (DO: 10 msec). This delay excludes any necessary time for automatic antenna tuning.	Shall not exceed 25 msec.			
23	5.3.5.2	Release Time Delay. The time interval from keying-off a transmitter until the transmitted RF signal amplitude has decreased to 10 percent of its key-on steady-state value shall be 10 msec or less.	Shall be 10 msec or less.			
Legend: DO – Design Objective; MIL-STD – Military Standard; msec – millisecond; RF – Radio Frequency						

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C-14 SUBTEST 14, SIGNAL INPUT INTERFACE CHARACTERISTICS

C-14.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 24, 25, and 26.

C-14.2 Criteria

a. Input signal power. Input signal power for microphone or handset input is not standardized. When a line-level input is provided (see paragraph 5.3.6.2), rated transmitter PEP shall be obtainable for single tone amplitudes from -17 dBm to +6 dBm (manual adjustment permitted), MIL-STD-188-141B, paragraph 5.3.6.1.

b. Unbalanced interface. When an unbalanced interface is provided, it shall have an audio input impedance of a nominal 150 ohm, unbalanced with respect to ground, with a minimum return loss of 20 dB against a 150-ohm resistance over the nominal 3-kHz passband, MIL-STD-188-141B, paragraph 5.3.6.2.1.

c. Balanced interface. When a balanced interface is provided, the audio input impedance shall be a nominal 600 ohm, balanced with respect to ground, with a minimum return loss of 26 dB against a 600-ohm resistance over the frequency range of 300 Hz to 3050 Hz. The electrical symmetry shall be sufficient to suppress longitudinal currents at least 40 dB below the reference signal level, MIL-STD-188-141B, paragraph 5.3.6.2.2.

C-14.3 Test Procedures

a. Test Equipment Required

(1) Audio Generator

(2) Spectrum Analyzer

(3) Watt Meter

(4) Attenuator

(5) Audio Voltmeter (2)

(6) Unit Under Test

(7) Transformer and Resistor

(8) Multimeter

b. Test Configuration. Configure the equipment as shown in figures C-14.1, C-14.2, and C-14.3.

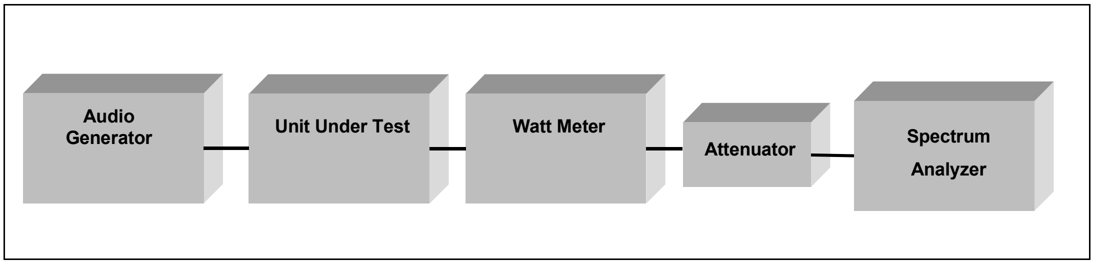

Figure C-14.1. Signal Input Interface Characteristics Equipment Configuration

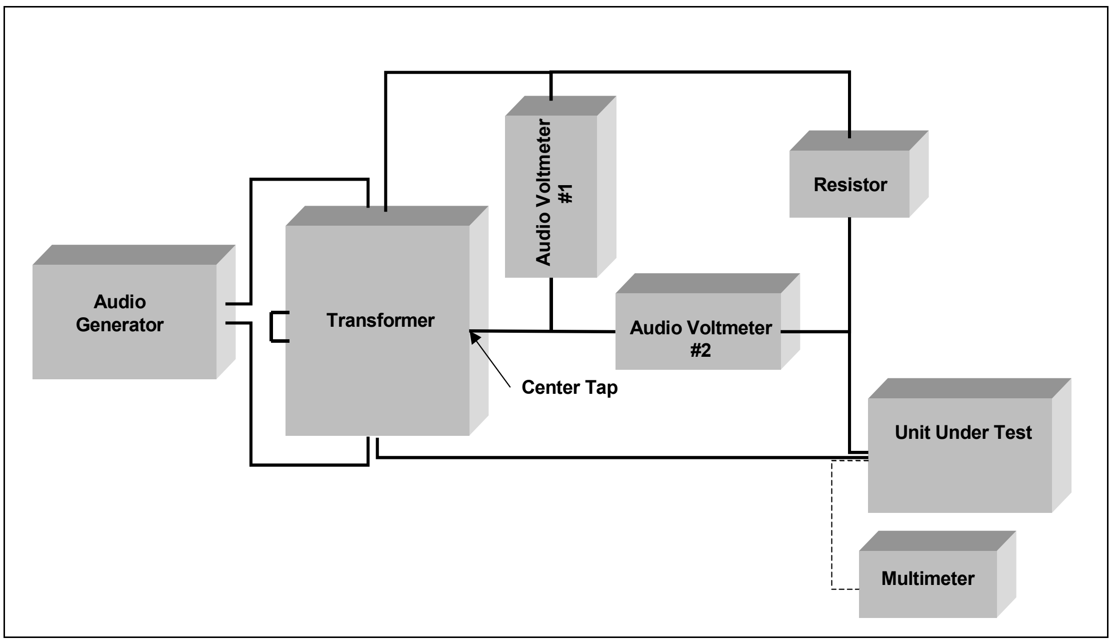

Figure C-14.2. Equipment Configuration for Measuring Audio Frequency Return Loss

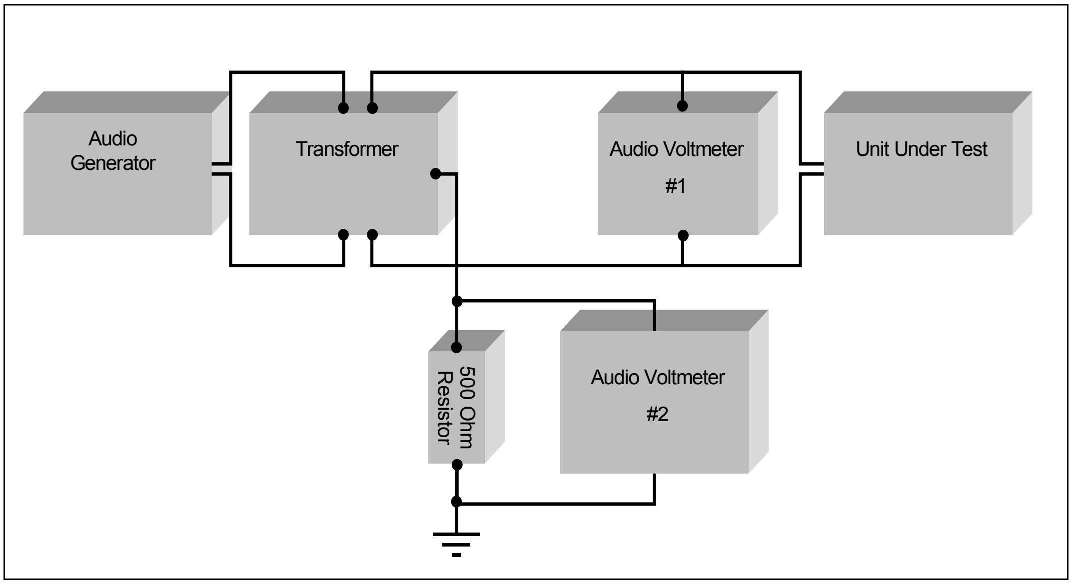

Figure C-14.3. Equipment Configuration for Longitudinal Current Suppression

c. Test Conduct. The procedures for this subtest are listed in tables C-14.1 and C-14.2.

Table C-14.1. Procedures for Signal Input Interface Characteristics

Step	Action	Settings/Action	Result
The following procedure is for reference number 24.			
1	Set up equipment.	See figure C-14.1. Test Frequency: 8.000 MHz	
2	Set up spectrum analyzer.	Center Frequency: Test Frequency Span: 6.000 kHz RBW: 30 Hz VBW: 100 Hz Sweep Time: Single/Manual Reference Level: As required to prevent input overload. Noise Level: Off	
3	Set up audio generator.	Frequency: 1275 Hz Level: As required.	
4	Set transmitter to 8.000 MHz. Select mode.		
5	Modulate transmitter with 1004-Hz tone to rated PEP.		
6	Apply single tone audio signal (1275 Hz) at -17 dBm.	Verify that rated transmitter PEP is obtainable with this input signal (manual radio adjustment is permitted).	
7	Apply single tone audio signal (1275 Hz) at -14 dBm.	Verify that rated transmitter PEP is obtainable with this input signal (manual radio adjustment is permitted).	
8	Apply single tone audio signal (1275 Hz) at -11 dBm.	Verify that rated transmitter PEP is obtainable with this input signal (manual radio adjustment is permitted).	

Table C-14.1. Procedures for Signal Input Interface Characteristics (continued)

Step	Action	Settings/Action	Result
9	Apply single tone audio signal (1275 Hz) at -8 dBm.	Verify that rated transmitter PEP is obtainable with this input signal (manual radio adjustment is permitted).	
10	Apply single tone audio signal (1275 Hz) at -5 dBm.	Verify that rated transmitter PEP is obtainable with this input signal (manual radio adjustment is permitted).	
11	Apply single tone audio signal (1275 Hz) at -2 dBm.	Verify that rated transmitter PEP is obtainable with this input signal (manual radio adjustment is permitted).	
12	Apply single tone audio signal (1275 Hz) at 0 dBm.	Verify that rated transmitter PEP is obtainable with this input signal (manual radio adjustment is permitted).	
13	Apply single tone audio signal (1275 Hz) at +3 dBm.	Verify that rated transmitter PEP is obtainable with this input signal (manual radio adjustment is permitted).	
14	Apply single tone audio signal (1275 Hz) at +6 dBm.	Verify that rated transmitter PEP is obtainable with this input signal (manual radio adjustment is permitted).	
The following procedure is for reference numbers 25 and 26.			
15	Set up test equipment as shown in figure C-14.2.	Use a 150-ohm resistor if an unbalanced interface is provided, or a 600-ohm resistor if a balanced interface is provided.	
16	Use multimeter to determine if the audio input interface is unbalanced or balanced with respect to ground.		
17	Set the audio generator to 300 Hz. Adjust audio level such that V_1 = 1 Volt.	Read V_2. Calculate return loss by: Return Loss = $20\log_{10}(V_1/V_2)$ dB	300 Hz:
18	Repeat step 17 at 1000 Hz, 2000 Hz, and 3000 Hz.		1000 Hz: 2000 Hz: 3000 Hz:
Legend: Ω – ohm; dBm – decibels referenced to one milliwatt; Hz – hertz; kHz – kilohertz; MHz – megahertz; PEP – Peak Envelope Power; RBW – Resolution Bandwidth; VBW – Video Bandwidth			

Table C-14.2. Procedures for Longitudinal Current Suppression

Step	Action	Settings/Action	Result
The following procedure is for reference number 26.			
1	Set up equipment.	See figure C-14.3.	
2	Set up audio generator.	Frequency: 300 Hz	
3	Turn receiver off. Disconnect power source.		
4	Adjust the audio generator to a -16-dBm signal at 300 Hz.		

Table C-14.2. Procedures for Longitudinal Current Suppression (continued)

Step	Action	Settings/Action	Result
5	The difference, in dB, between the voltage reading observed on audio voltmeter #1 and the reading on audio voltmeter #2 is taken as the longitudinal balance indication.	Record frequency and level of audio generator and audio voltmeter readings.	
6	Repeat steps 4 and 5 in 300-Hz steps across the audio range (i.e., 600, 900, 1200 Hz, etc.).		
Legend: dB – decibels; dBm – decibels referenced to one milliwatt; Hz – hertz; TIMS – Transmission Impairment Measurement Set			

C-14.4 Presentation of Results. The results will be shown in tabular format (table C-14.3) indicating the requirement and measured value or indications of capability.

Table C-14.3. Signal Input Interface Characteristics Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
24	5.3.6.1	Input Signal Power. Input signal power for microphone or handset input is not standardized. When a line-level input is provided (see paragraph 5.3.6.2), rated transmitter PEP shall be obtainable for single tone amplitudes from -17 dBm to +6 dBm (manual adjustment permitted).	Can single tone input amplitude vary from –17 dBm to +6 dBm?			
25	5.3.6.2.1	Unbalanced Interface. When an unbalanced interface is provided, it shall have an audio input impedance of a nominal 150 ohm, unbalanced with respect to ground	Nominal 150 ohms			
25	5.3.6.2.1	with a minimum return loss of 20 dB against a 150-ohm resistance over the nominal 3 kHz passband.	20 dB minimum			
26	5.3.6.2.2	Balanced Interface. When a balanced interface is provided, the audio input impedance shall be a nominal 600 ohm, balanced with respect to ground	Nominal 600 ohm			
26		with a minimum return loss of 26 dB against a 600-ohm resistance over the frequency range of 300 Hz to 3050 Hz.	26 dB minimum			
26		The electrical symmetry shall be sufficient to suppress longitudinal currents at least 40 dB below the reference signal level.	At least 40 dB below the reference signal level.			
Legend: dB – decibels; dBm – decibels referenced to one milliwatt; Hz – hertz; kHz – kilohertz; MIL-STD – Military Standard; PEP – Peak Envelope Power						

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C-15 SUBTEST 15, TRANSMITTER OUTPUT LOAD IMPEDANCE

C-15.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 27.

C-15.2 Criteria. The nominal RF output load impedance at interface point B in MIL-STD-188-141B figure 2 shall be 50 ohms, unbalanced with respect to ground. (Note: Nominal will be defined as whatever gives a VSWR of 2.0 for tactical radios and 1.5 for fixed station, if antennas are available). Transmitters shall survive any voltage standing wave ratio (VSWR) at point B, while derating the output power as a function of increasing VSWR. However, the transmitter shall deliver full rated forward power into a 1.3:1 VSWR load. MIL-STD-188-141B figure 11 is a Design Objective for the derating curve. The VSWR between an exciter and an amplifier shall be less than 1.5:1. The VSWR between an amplifier and an antenna coupler shall be less than 1.5:1 for fixed applications and less than 2.0:1 for tactical application, MIL-STD-188-141B, paragraph 5.3.7.

C-15.3 Test Procedures

a. Test Equipment Required

(1) Spectrum Analyzer

(2) Directional Coupler

(3) Dummy Load

(4) Attenuator

(5) Signal Generator

(6) PC (Optional)

(7) Oscilloscope

(8) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figures C-15.1 and C-15.2.

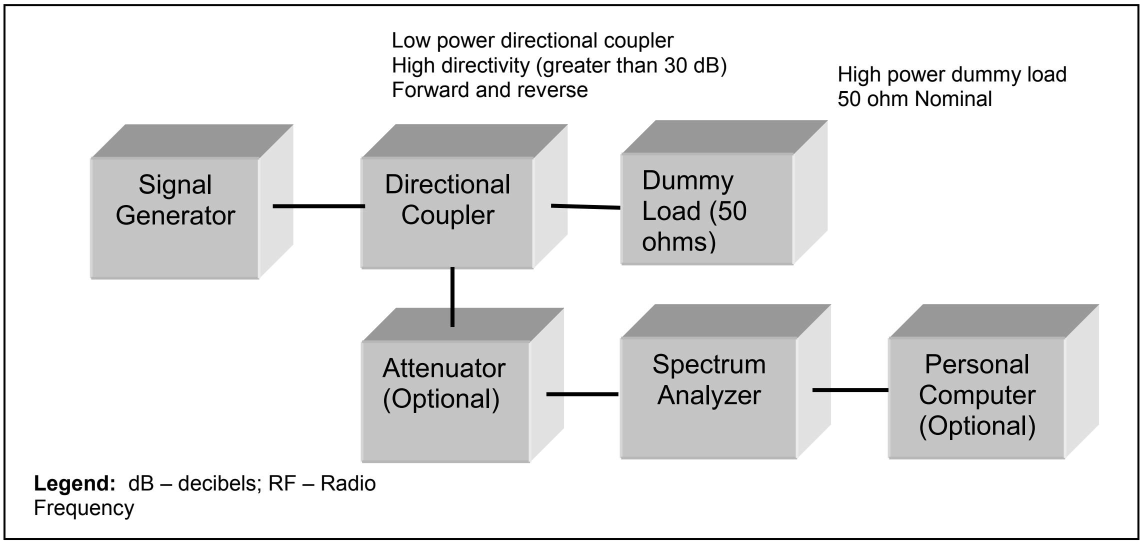

Figure C-15.1. Configuration to Determine Frequency of 1.3 VSWR Across Dummy Load Configuration

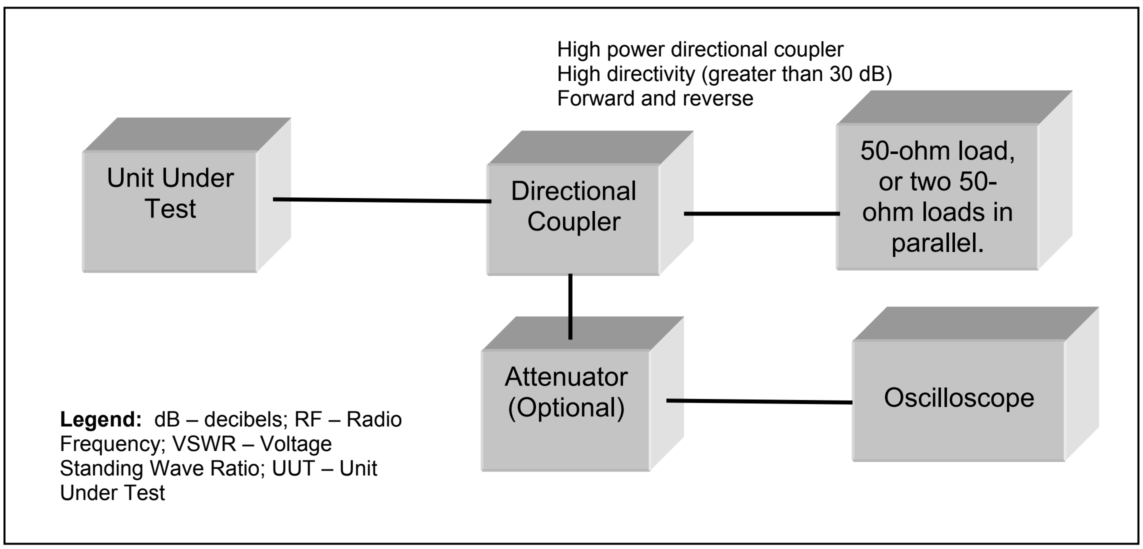

Figure C-15.2. Configuration to Determine Power Output Impedance Configuration

c. Test Conduct. The procedures for this subtest are listed in table C-15.1.

Table C-15.1. Procedures for Transmitter Output Load Impedance

Step	Action	Settings/Action	Result
The following procedure is for reference number 27.			
1	Set up equipment.	See figure C-15.1.	
2	Tune RF signal generator.	Frequency: 2.0000 MHz Level: 0 dBm	
3	Set up spectrum analyzer.	Frequency Span: 2.0000 MHz to 30.0000 MHz Max Hold: On	
4	Sweep the spectrum.		
5	Tune RF signal generator.	Increment the frequency by 500 kHz.	
6	Sweep the spectrum.		
7	Tune RF signal generator.	Repeat steps 5 and 6 until 30 MHz is swept.	
8	Plot the forward spectrum.		
9	Repeat steps 2 through 8 for the reflected power.	Position the directional coupler to record the reflected power.	
10	Calculate the VSWR from the forward and reflected data for each frequency measured.	Use the equation: $VSWR = (1 + \Gamma) / (1 - \Gamma)$ Where Γ is: $\Gamma = V_{reflected} / V_{forward}$	
11	Record frequency.	Record the frequency that has a VSWR that is the closest to 1.3:1 (from step 10). (Note: If necessary, the tester may add a capacitor external to the dummy load to achieve the required VSWR).	
12	Set up equipment (replace lower power directional coupler with high power directional coupler).	See figure C-15.2.	
13	Program the UUT.	Enter frequency from step 11.	
14	Transmit UUT at full power with 1004-Hz tone.		
15	Press sweep on spectrum analyzer.	Use spectrum analyzer to verify that the UUT is outputting full PEP.	
16	Tune the UUT to 8.000 MHz; USB.		
17	Transmit UUT.	Record measured forward power.	
18	Add 50-ohm loads in parallel to increase the VSWR.		
19	Transmit UUT. Record transmit power.	Record measured forward power.	
20	Put short circuit at end of cable and transmit for 1 to 3 seconds.		
21	Put open circuit at end of cable and transmit for 1 to 3 seconds.	Verify that the transmitter will survive any VSWR at the antenna coupler.	
Legend: Hz – hertz; kHz – kilohertz; MHz – megahertz; PEP – Peak Envelope Power; RF – Radio Frequency; USB – Upper Sideband; UUT – Unit Under Test; V – Volts; VSWR – Voltage Standing Wave Ratio			

C-15.4 Presentation of Results. The results will be shown in tabular format (table C-15.2) indicating the requirement and measured value or indications of capability.

Table C-15.2. Transmitter Output Load Impedance Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
27	5.3.7	Transmitters shall survive any VSWR at point B, while de-rating the output power as a function of increasing VSWR.	Any VSWR.			
27	5.3.7	However, the transmitter shall deliver full rated forward power into a 1.3:1 VSWR load.	Full rated power into 1.3:1.			
Legend: MIL-STD – Military Standard; VSWR – Voltage Standing Wave Ratio						

C-16 SUBTEST 16, RECEIVER RF CHARACTERISTICS

C-16.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 28, 29, 30, and 31.

C-16.2 Criteria

a. Receiver RF Characteristics. All receiver input amplitudes are in terms of available power in dBm from a 50-ohm source impedance signal generator, MIL-STD-188-141B, paragraph 5.4.1.

b. Image Rejection. The rejection of image signals shall be at least 70 dB for tactical HF receivers and 80 dB for all other HF receivers (DO: 100 dB), MIL-STD-188-141B, paragraph 5.4.1.1.

c. Intermediate Frequency (IF) Rejection. Spurious signals at the Intermediate Frequency (IF) (frequencies) shall be rejected by at least 70 dB for tactical HF receivers and 80 dB for all other HF receivers (DO: 100 dB), MIL-STD-188-141B, paragraph 5.4.1.2.

d. Adjacent Channel Rejection. The receiver shall reject any signal in the undesired sideband and adjacent channel in accordance with figure 6, MIL-STD-188-141B, paragraph 5.4.1.3.

e. Other Signal Frequency External Spurious Responses. Receiver rejection of spurious frequencies, other than IF and image, shall be at least 65 dB (55 dB for tactical application) for frequencies from +2.5 percent to +30 percent, and from -2.5 percent to -30 percent of the center frequency, and at least 80 dB (70 dB for tactical application) for frequencies beyond +30 percent of the center frequency, MIL-STD-188-141B, paragraph 5.4.1.4.

C-16.3 Test Procedures

a. Test Equipment Required

(1) Spectrum Analyzer

(2) Signal Generator

(3) Transmission Impairment Measurement Set

(4) Distortion Analyzer

(5) Power Combiner

(9) Band Pass Filter

(10) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figure C-16.1.

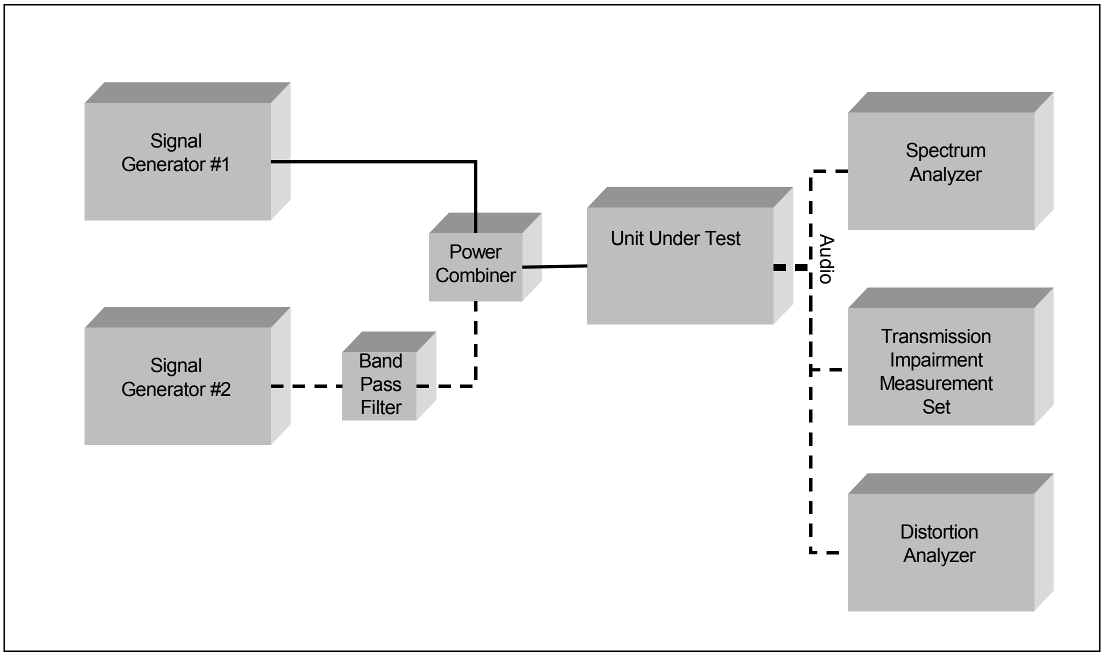

Figure C-16.1. Equipment Configuration Receiver RF Characteristics

c. Test Conduct. The procedures for this subtest are listed in tables C-16.1 through C-16.3.

Table C-16.1. Procedures for Image Rejection Test

Step	Action	Settings/Action	Result
The following procedure is for reference number 28.			
1	Set up equipment.	See figure C-16.1.	
2	Consult manufacturer's provided data, or contact manufacturer directly, to determine the internal IF frequency (or frequencies) used by the UUT.	Record frequency.	
3	Tune receiver to 14 MHz.	Select USB.	
4	Set RF signal generator #1 to the selected test frequency plus 1 kHz.	Adjust output level for a 10-dB signal-to-noise reading. Record RF signal generator #1 output level.	

Table C-16.1. Procedures for Image Rejection Test (continued)

Step	Action	Settings/Action	Result
5	Set RF signal generator #1 to the image frequency (see below) plus 1.000 kHz. Increase the output level of the signal generator by 80 dB. In single down conversion receivers, the image frequency is determined by subtracting twice the IF from the test frequency: (Image Frequency = Test Frequency – 2IF). In up conversion receivers the image frequency is determined by adding twice the IF to the test frequency if the IF is less than the local oscillator frequency: (Image Frequency = 2IF + Test Frequency). In up conversion receivers where the IF frequency is greater than the local oscillator frequency, the image frequency is determined by subtracting the test frequency from twice the IF: (Image = 2IF – Test Frequency). Dual conversion receivers (i.e., receivers with two local oscillators) follow the same rules as given above. Since these radios use two IF frequencies, there will be three possible image frequencies. Two of these image frequencies come from the individual IF stages, and the third image frequency is the result of the combination of the two IF stages.		
6	Measure the new SINAD.	The new SINAD must be less than 10 dB for the UUT to meet this criteria.	
Legend: dB – decibels; dBm – decibels referenced to one milliwatt; IF – Intermediate Frequency; kHz – kilohertz; RF – Radio Frequency; TIMS – Transmission Impairment Measurement Set; USB – Upper Sideband; UUT – Unit Under Test			

Table C-16.2. Procedures for IF Rejection Test

Step	Action	Settings/Action	Result
The following procedure is for reference number 29.			
1	Set up equipment.	See figure C-16.1.	
2	Tune receiver to 14 MHz.	Select USB.	
3	Set RF signal generator #1 to the selected test frequency plus 1 kHz.	Adjust output level for a 10-dB SINAD.	
4	Set RF signal generator #1 to the IF plus 1 kHz. The IF was found in step 2 of table C-16.2.	Increase the output level of the signal generator by 80 dB.	
5	Measure the new SINAD.	The new SINAD must be less than 10 dB for the UUT to meet this criteria.	
Legend: dB – decibels; dBm – decibels referenced to one milliwatt; IF – Intermediate Frequency; kHz – kilohertz; RF – Radio Frequency; SINAD – signal-plus-noise-plus-distortion to noise-plus-distortion ratio; TIMS – Transmission Impairment Measurement Set; USB – Upper Sideband			

Table C-16.3. Procedures for Adjacent Channel Rejection Test

Step	Action	Settings/Action	Result
The following procedure is for reference number 30.			
1	Set up equipment for adjacent channel rejection test.	See figure C-16.1.	
2	Tune receiver to 14 MHz.	Select USB.	
3	Set RF signal generator #1 to the selected frequency plus 1 kHz.	Adjust output for a 10-dB SINAD and record level.	
4	Reset RF signal generator #2 to each of the frequencies shown in the column to the right. Measure, record, and calculate rejection level for each frequency (see step 5 of table C-16.3). Observe noise floor for reciprocal mixing noise.	a) f_0 - 415 Hz b) f_0 - 1 kHz c) f_0 - 2 kHz d) f_0 - 3 kHz e) f_0 + 4 kHz f) f_0 + 5 kHz	Record on data collection form, pages D-25 and D-27.
Legend: dB – decibels; f_0 – Oscillator Frequency; Hz – hertz; kHz – kilohertz; RF – Radio Frequency; SINAD – signal-plus-noise-plus-distortion to noise-plus-distortion ratio; TIMS – Transmission Impairment Measurement Set; USB – Upper Sideband			

Table C-16.4. Procedures for Other Signal Frequency External Spurious Responses Test

Step	Action	Settings/Action	Result
The following procedure is for reference number 31.			
1	Set up equipment for adjacent channel rejection test.	See figure C-16.1.	
2	Tune receiver to 14 MHz.	Select USB.	
3	Set RF signal generator #1 to the selected frequency plus 1 kHz.	Adjust output for a 10-dB SINAD and record level. This will be the reference level for this test.	
4	Set RF signal generator #1 to 9.800 MHz.	Increase the output level of the signal generator 65 dB above reference level.	
5	Slowly sweep the RF signal generator from 9.800 MHz to 13.650 MHz.	Monitor the receiver output. If a tone is detected in the receiver's output, stop the sweep and check frequency to verify that the response is less than 10 dB SINAD.	
6	Slowly sweep the RF signal generator from 14.350 MHz to 18.200 MHz.	Monitor the receiver output. If a tone is detected in the receiver's output, stop the sweep and check frequency to verify that the response is less than 10 dB SINAD.	
7	Set RF signal generator #1 to 2.000 MHz.	Increase the output level of the signal generator 80 dB above reference level.	
8	Slowly sweep the RF signal generator from 2.000 MHz to 9.800 MHz.	Monitor the receiver output. If a tone is detected in the receiver's output, stop the sweep and check frequency to verify that the response is less than 10 dB SINAD.	
9	Slowly sweep the RF signal generator from 18.200 MHz to 30.000 MHz.	Monitor the receiver output. If a tone is detected in the receiver's output, stop the sweep and check frequency to verify that the response is less than 10 dB SINAD.	
10	If any failure points are found (i.e. response greater than 10 dB SINAD), connect signal generator output directly to spectrum analyzer input.	Tune the signal generator to the failure point frequency. Set the center frequency of the spectrum analyzer to 14.000 MHz. Set the span to 6 kHz.	
11	Record the frequency of all failure points (i.e. response greater than 10 dB SINAD).		
12	View the output of the spectrum analyzer. Measure the level of any spurious or harmonic emissions.	If any spurious or harmonic emissions are observed with a level greater than or equal to the reference level recorded in step 3, then this failure point should be considered invalid.	
Legend: dB – decibels; f_0 – Oscillator Frequency; Hz – hertz; kHz – kilohertz; RF – Radio Frequency; SINAD – signal-plus-noise-plus-distortion to noise-plus-distortion ratio; TIMS – Transmission Impairment Measurement Set; USB – Upper Sideband			

C-16.4 Presentation of Results. The results will be shown in tabular format (table C-16.5) indicating the requirement and measured value or indications of capability.

Table C-16.5. Receiver RF Characteristic Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
28	5.4.1.1	Image Rejection. The rejection of image signals shall be at least 70 dB for tactical HF receivers and 80 dB for all other HF receivers (DO: 100 dB).	Tactical: < 70 dB Other: < 80 dB			
29	5.4.1.2	Intermediate Frequency (IF) Rejection. Spurious signals at the IF (frequencies) shall be rejected by at least 70 dB for tactical HF receivers and 80 dB for all other HF receivers (DO: 100 dB).	Tactical: < 70 dB Other: < 80 dB			
30	5.4.1.3	Adjacent Channel Rejection. The receiver shall reject any signal in the undesired sideband and adjacent channel in accordance with figure C-7.1.	See figure C-7.1.			
31	5.4.1.4	Other Signal Frequency External Spurious Responses. Receiver rejection of spurious frequencies, other than IF and image, shall be at least 65 dB (55 dB for tactical application) for frequencies from +2.5 percent to +30 percent, and from -2.5 percent to -30 percent of the center frequency.	At least 65 dB (55 dB for tactical application).			
31	5.4.1.4	At least 80 dB (70 dB for tactical application) for frequencies beyond +30 percent of the center frequency.	At least 80 dB (70 dB for tactical application).			

Legend: dB – decibels; dBm – decibels referenced to one milliwatt; DO – Design Objective; HF – High Frequency; IF – Intermediate Frequency; MIL-STD – Military Standard; RF – Radio Frequency

C-17 SUBTEST 17, RECEIVER PROTECTION

C-17.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 32.

C-17.2 Criteria. The receiver, with primary power on or off, shall be capable of survival without damage with applied signals of up to +43 dBm (DO: +53 dBm) available power delivered from a 50-ohm source for a duration of 5 minutes for fixed site applications and 1 minute for tactical applications, MIL-STD-188-141B, paragraph 5.4.1.5.

C-17.3 Test Procedures

a. Test Equipment Required

(1) Signal Generator

(2) Power Amplifier

(3) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figure C-17.1

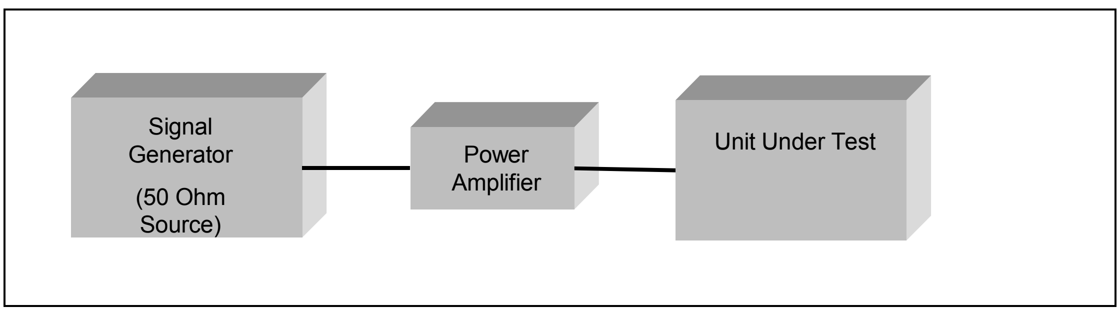

Figure C-17.1. Equipment Configuration for Receiver Protection

c. Test Conduct. This subtest should be the last test conducted. This subtest may damage the UUT if the UUT does not meet criteria given in MIL-STD-188-141B, paragraph 5.4.1.5. Confirm the limits of the UUT with the manufacturer before testing. The procedures for this subtest are listed in table C-17.1.

Table C-17.1. Procedure for Receiver Protection

Step	Action	Settings/Action	Result
The following procedure is for reference number 32.			
1	Analyze manufacturer's provided data and schematic drawings to ensure that the UUT is designed so that with primary power on or off, it will be capable of survival without damage with applied signals of up to +43 dBm available power delivered from a 50-ohm source for a duration of 5 minutes for fixed site applications and 1 minute for tactical applications.		
2	Set up equipment.	See figure C-17.1.	
3	Tune the UUT to 8.000 MHz; USB.		
4	Power off UUT.		
5	Set up signal generator.	Frequency: 8.000 MHz Level: Set so that the RF level into the receiver is +1 dBm.	
6	Inject the +1-dBm signal from the signal generator into the RF port of the UUT.		
7	Slowly increase the level of the input signal until it reaches +43 dBm into the UUT.		
8	Verify that the UUT can survive a +43 dBm input for a duration of 5 minutes for fixed site applications and 1 minute for tactical applications.	Repeat receiver sensitivity test (subtest 19) to verify that the UUT survived this test.	
9	Power on UUT and repeat steps 5 through 8.		
Legend: dBm – decibels referenced to one milliwatt; MHz – megahertz; RF – Radio Frequency; USB – Upper Sideband; UUT – Unit Under Test			

C-17.4 Presentation of Results. The results will be shown in tabular format (table C-17.2) indicating the requirement and measured value or indications of capability.

Table C-17.2. Receiver Protection Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
32	5.4.1.5	Receiver Protection. The receiver, with primary power on or off, shall be capable of survival without damage with applied signals of up to +43 dBm (DO: +53 dBm) available power delivered from a 50-ohm source for a duration of 5 minutes for fixed site applications and 1 minute for tactical applications.	Subtest 19 criteria met after +43-dBm signal is applied to UUT.			
Legend: dBm – decibels referenced to one milliwatt; DO – Design Objective; MIL-STD – Military Standard						

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C-18 SUBTEST 18, DESENSITIZATION DYNAMIC RANGE

C-18.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 33.

C-18.2 Criteria. The following requirement shall apply to the receiver in an SSB mode of operation with an IF passband setting providing at least 2750 Hz (nominal 3-kHz bandwidth) at the 2-dB points. With the receiver tuning centered on a sinusoidal input test signal and with the test signal level adjusted to produce an output (Signal-plus-noise-plus-distortion to noise-plus-distortion) SINAD of 10 dB, a single interfering sinusoidal signal, offset from the test signal by an amount equal to ±5 percent of the carrier frequency, is injected into the receiver input. The output SINAD shall not be degraded by more than 1 dB as follows:

a. For fixed site radios, the interfering signal is equal to or less than 100 dB above the test signal level.

b. For tactical radios, the interfering signal is equal to or less than 90 dB above the test signal level, MIL-STD-188-141B, paragraph 5.4.1.6.

C-18.3 Test Procedures

a. Test Equipment Required

(1) Audio Analyzer

(2) Low Phase Noise Signal Generators (2)

(3) Power Combiner

(4) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figure C-18.1.

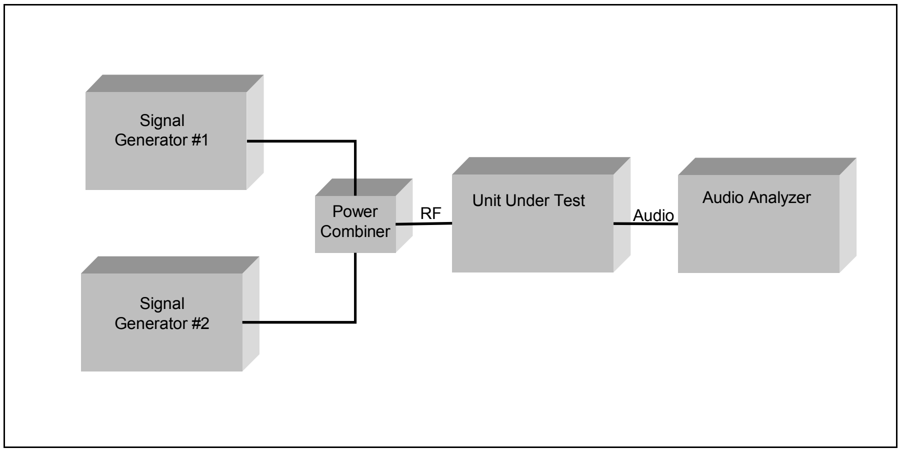

Figure C-18.1. Equipment Configuration for Desensitization Dynamic Range

c. Test Conduct. The procedures for this subtest are listed in table C-18.1.

Table C-18.1. Procedures for Desensitization Dynamic Range

Step	Action	Settings/Action	Result
The following procedure is for reference number 33.			
1	Set up equipment.	See figure C-18.1. Test Frequency: 2.000 MHz	
2	Set up audio analyzer.		
3	Set up signal generators.	Signal Gen #1: 2 MHz + 1 kHz. Signal Gen #2: (Interfering frequency). Use the lowest phase noise signal generator available. Set to 2.4 MHz. Level: < -120 dBm (set increment steps for 1 dB).	
4	Set up receiver.	Set receiver to 2 MHz; USB.	
5	Turn off RF output of signal generator #2. Increase the RF output level of generator #1 to achieve 10-dB SINAD.	Record signal generator #1 RF output level required to obtain 10-dB SINAD.	
6	Turn on RF signal generator #2, and increase the RF output to a level equal to 90 dB (tactical) or 100 dB (fixed site) above the RF output level of signal generator #1.		
7	Observe audio output (10-dB SINAD) on the audio analyzer.	Record frequency and RF output level of signal generator #2 and audio output level (SINAD) on the audio analyzer.	Record results on data collection form, page D-29.
8	Adjust the level of signal generator #2 until SINAD is equal to 10 dB.	Record signal generator #2 output level.	Record results on data collection form, page D-29.

Table C-18.1. Procedures for Desensitization Dynamic Range (continued)

Step	Action	Settings/Action	Result
9	Reset signal generator #2 frequency to minus 5% of the test frequency, set RF level to < -120 dBm and repeat steps 7 and 8.	Record frequency of signal generator #2 at (+5%) and (-5%).	Record results on data collection form, page D-29.
10	Repeat steps 5 through 9 for LSB.		
Legend: dB – decibels; dBm – decibels referenced to one milliwatt; Hz – hertz; kHz – kilohertz; LSB – Lower Sideband; MHz – megahertz; RF – Radio Frequency; SINAD – Signal-plus-noise-plus-distortion to noise-plus-distortion ratio; USB – Upper Sideband			

C-18.4 Presentation of Results. The results will be shown in tabular format (table C-18.2) indicating the requirement and measured value or indications of capability.

Table C-18.2. Desensitization Dynamic Range Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
33	5.4.1.6	<u>Desensitization Dynamic Range</u>. The following requirement shall apply to the receiver in an SSB mode of operation with an IF passband setting providing at least 2750 Hz (nominal 3-kHz bandwidth) at the 2-dB points. With the receiver tuning centered on a sinusoidal input test signal and with the test signal level adjusted to produce an output SINAD of 10 dB, a single interfering sinusoidal signal, offset from the test signal by an amount equal to ±5 percent of the carrier frequency, is injected into the receiver input. The output SINAD shall not be degraded by more than 1 dB as follows:				
33	5.4.1.6a	a. For fixed site radios, the interfering signal is equal to or less than 100 dB above the test signal level.	≤ 100 dB			
33	5.4.1.6b	b. For tactical radios, the interfering signal is equal to or less than 90 dB above the test signal level.	≤ 90 dB			
Legend: dB – decibels; IF – Intermediate Frequency; kHz – kilohertz; MIL-STD – Military Standard; SINAD – Signal-plus-noise-plus-distortion to noise-plus-distortion ratio; SSB – Single Sideband						

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C-19 SUBTEST 19, RECEIVER SENSITIVITY

C-19.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 34.

C-19.2 Criteria. The sensitivity of the receiver over the operating frequency range, in the sideband mode of operation (3-kHz bandwidth), shall be such that a -111 dBm (DO: -121 dBm) unmodulated signal at the antenna terminal, adjusted for a 1000-Hz audio output, produces an audio output with a SINAD of at least 10 dB over the operating frequency range, MIL-STD-188-141B, paragraph 5.4.1.7.

C-19.3 Test Procedures

a. Test Equipment Required

(1) Audio Analyzer

(2) Signal Generator

(3) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figure C-19.1.

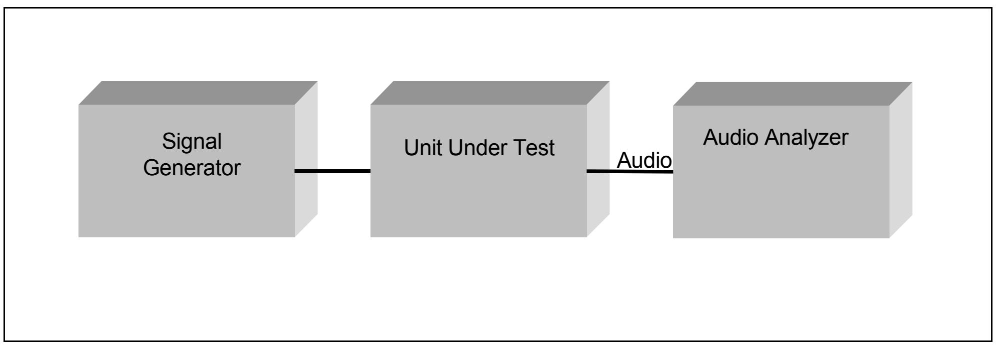

Figure C-19.1. Equipment Configuration for Receiver Sensitivity

c. Test Conduct. The procedures for this subtest are listed in table C-19.1.

Table C-19.1. Procedures for Determining Receiver Sensitivity

Step	Action	Settings/Action	Result
The following procedure is for reference number 34.			
1	Set up equipment.	See figure C-19.1.	
2	Set up audio analyzer.		
3	Tune receiver to 2.000 MHz; USB.	Set RF gain to Maximum. Set AGC to Fast.	
4	Set RF signal generator frequency to produce a 1-kHz tone at receiver audio output (1 kHz above receiver frequency for USB, 1 kHz below receiver frequency for LSB). Adjust output level to -111 dBm.		
5	Record SINAD level measured with the audio analyzer.		
6	Repeat steps 4 and 5 for a test frequency of 8.000 MHz.	As the frequency is changed on the receiver, ensure the frequency on the RF signal generator also changes to stay 1 kHz away from the receive frequency.	
7	Repeat steps 4 and 5 for a test frequency of 20.000 MHz.	As the frequency is changed on the receiver, ensure the frequency on the RF signal generator also changes to stay 1 kHz away from the receive frequency.	
8	Repeat steps 4 and 5 for a test frequency of 29.999 MHz.	As the frequency is changed on the receiver, ensure the frequency on the RF signal generator also changes to stay 1 kHz away from the receive frequency.	
9	Repeat steps 3 through 8 with the UUT in LSB mode.		
Legend: AGC – Automatic Gain Control; dB – decibels; dBm – decibels referenced to one milliwatt; kHz – kilohertz; LSB – Lower Sideband; MHz – megahertz; RF – Radio Frequency; USB – Upper Sideband; UUT – Unit Under Test			

C-19.4 Presentation of Results. The results will be shown in tabular format (table C-19.2) indicating the requirement and measured value or indications of capability.

Table C-19.2. Receiver Sensitivity Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
34	5.4.1.7	Receiver Sensitivity. The sensitivity of the receiver over the operating frequency range, in the sideband mode of operation (3-kHz bandwidth), shall be such that a -111 dBm (DO: -121 dBm) unmodulated signal at the antenna terminal, adjusted for a 1000-Hz audio output, produces an audio output with a SINAD of at least 10 dB over the operating frequency range.	SINAD ≤ 10 dB			
Legend: dB – decibels; dBm – decibels referenced to one milliwatt; DO – Design Objective; Hz – hertz; kHz – kilohertz; MIL-STD – Military Standard; SINAD – Signal-plus-noise-plus-distortion to noise-plus-distortion ratio						

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C-20 SUBTEST 20, RECEIVER OUT-OF-BAND IMD

C-20.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 35.

C-20.2 Criteria. Receiver Out-of-Band IMD. Second-order and higher-order responses shall require a two-tone signal amplitude with each tone at -30 dBm or greater (-36 dBm or greater for tactical applications), to produce an output SINAD equivalent to a single –110-dBm tone. This requirement is applicable for equal-amplitude input signals with the closest signal spaced 30 kHz or more from the operating frequency, MIL-STD-188-141B, paragraph 5.4.1.8.

C-20.3 Test Procedures

a. Test Equipment Required

(1) Audio Analyzer

(2) Signal Generators (2)

(3) Spectrum Analyzers (2)

(4) Power Combiner

(5) 3 decibel Attenuators

(6) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figure C-20.1.

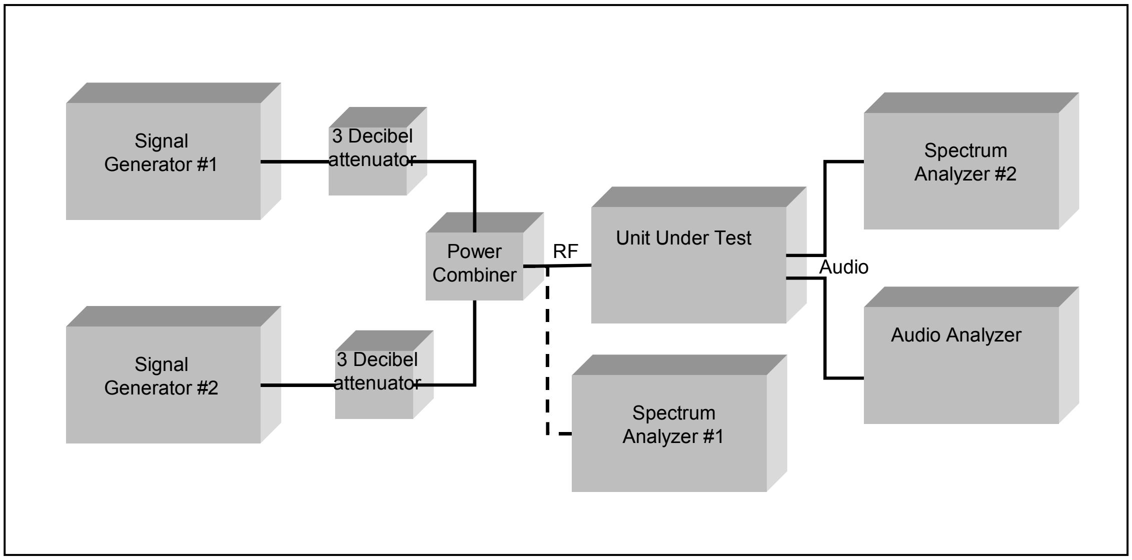

Figure C-20.1. Equipment Configuration for Receiver Out-of-Band IMD

c. Test Conduct. The procedures for this subtest are listed in table C-20.1.

Table C-20.1. Procedures for Receiver Out-of-Band IMD

Step	Action	Settings/Action	Result
The following procedure is for reference number 35.			
1	Set up equipment.	See figure C-20.1. Test Frequency: 14.060 MHz	
2	Set up spectrum analyzer.	Center Frequency: 2.500 kHz Frequency Span: 5000 Hz RBW: 10 Hz VBW: 10 Hz Sweep Time: > 20 seconds Reference Level: As required. Range: 0 dBm Impedance: 1M ohm	
3	Set up audio analyzer.		
4	Set UUT to 14.060 MHz; USB.		
5	Set signal generator #1 to 14.061 MHz. Set RF output level to -110 dBm, applied directly to receiver input.	Measure audio output of receiver and record SINAD level.	
6	Set signal generator #1 to 14.000 MHz. Set RF output level to produce -30 dBm (-36 dBm tactical) at the receiver input (measure with spectrum analyzer #1).		
7	Set signal generator #2 to 14.030 MHz. Set RF output level to produce -30 dBm (-36 dBm tactical) at the receiver input.	Measure audio output of receiver and record SINAD level.	

Table C-20.1. Procedures for Receiver Out-of-Band IMD (continued)

Step	Action	Settings/Action	Result
8	If SINAD level measured in step 7 is greater than SINAD level measured in step 5, reduce both signal generator levels equally until SINAD value drops to level measured in step 5.	Record level of both signal generators.	
Legend: dBm – decibels referenced to one milliwatt; Hz – hertz; kHz – kilohertz; MHz – megahertz; RF – Radio Frequency; SINAD – Signal-plus-noise-plus-distortion to noise-plus-distortion ratio; USB – Upper Sideband; UUT – Unit Under Test			

C-20.4 Presentation of Results. The results will be shown in tabular format (table C-20.2) indicating the requirement and measured value or indications of capability.

Table C-20.2. Receiver Out-of-Band IMD Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
35	5.4.1.8	Receiver Out-of-Band IMD. Second-order and higher-order responses shall require a two-tone signal amplitude with each tone at -30 dBm or greater (-36 dBm or greater for tactical applications), to produce an output SINAD equivalent to a single -110-dBm tone. This requirement is applicable for equal-amplitude input signals with the closest signal spaced 30 kHz or more from the operating frequency.	SINAD equivalent to a single –110-dBm tone.			
Legend: dBm – decibels referenced to one milliwatt; IMD – Intermodulation Distortion; kHz – kilohertz; MIL-STD – Military Standard; SINAD – Signal-plus-noise-plus-distortion to noise-plus-distortion ratio						

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C-21 SUBTEST 21, THIRD ORDER INTERCEPT POINT

C-21.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 36.

C-21.2 Criteria. Using test signals within the first IF passband, the worst case third-order intercept point shall not be less than +10 dBm (+1 dBm for tactical applications), MIL-STD-188-141B, paragraph 5.4.1.9.

C-21.3 Test Procedures

a. Test Equipment Required

(1) Signal Generator (2)

(2) Audio Voltmeter

(3) Power Combiner

(4) Step Attenuator

(5) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figures C-21.1 and C-21.2.

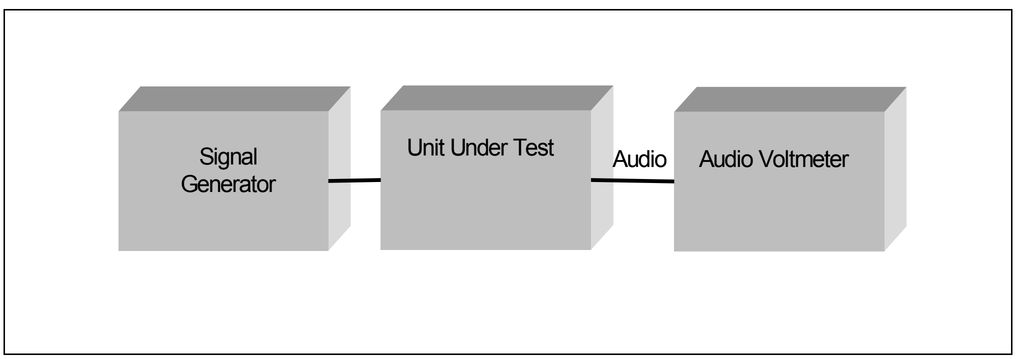

Figure C-21.1. Test Configuration to Measure the Receiver Noise Floor

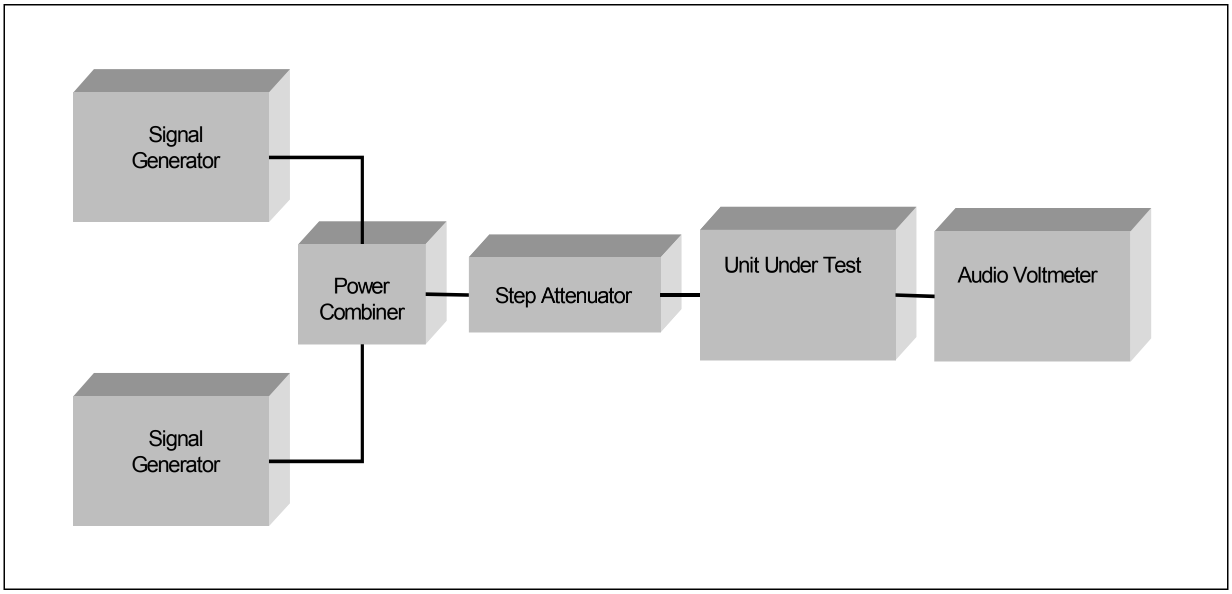

Figure C-21.2. Test Configuration to Measure IMD Dynamic Range

c. Test Conduct. The procedures for this subtest are listed in table C-21.1.

Table C-21.1. Procedures for Third Order Intercept Point

Step	Action	Settings/Action	Result
The following procedure is for reference number 36.			
1	Set up equipment.	See figure C-21.1. Test Frequency: 14.000 MHz	
2	Set up audio voltmeter.	Program audio voltmeter to display audio level in dBm.	
3	Set UUT to 14.000 MHz USB.		
4	Turn the RF output on the signal generator OFF.	Use the audio voltmeter to measure the audio output level of the UUT with no RF input signal.	
5	Set the signal generator to 14.001 MHz. Set the RF output level to –150 dBm.	Slowly increase the RF output level of the signal generator (1 dB steps) until a 3-dB increase is observed on the audio voltmeter. Record the RF output level of the signal generator. This is the noise floor level of the receiver.	
6	Set up equipment as shown in figure C-21.2.		
7	Set signal generator #1 to 14.040 MHz, and signal generator #2 to 14.060 MHz. Set the RF output level to –10 dBm.		
8	Set UUT to 14.020 MHz. Set step attenuators to provide 60 dB of attenuation.	Use the audio voltmeter to measure the audio output level of the UUT. This should be the same level as recorded in step 4. If not, increase the level of attenuation.	
9	Slowly decrease the attenuation level of the step attenuator (1 dB steps) until a 3-dB increase is observed on the audio voltmeter.	Record the signal level at the receiver antenna terminal. This is the IMD level.	
10	Calculate the IMD dynamic range.	Use the following formula: IMD DR = noise floor – IMD level The noise floor level was recorded in step 5, and the IMD level was recorded in step 9.	
11	Calculate the Third-Order Intercept Point.	Use the following formula: IP3 = 1.5(IMD DR in dB) + (Noise Floor in dBm) The IMD DR was recorded in step 10, and the noise floor level was recorded in step 5.	
Legend: dBm – decibels referenced to one milliwatt; DR – Dynamic Range; Hz – hertz; IMD – Intermodulation Distortion; IP3 – third-order intercept point; kHz – kilohertz; MHz – megahertz; RF – Radio Frequency; USB – Upper Sideband; UUT – Unit Under Test			

C-21.4 Presentation of Results. The results will be shown in tabular format (table C-21.2) indicating the requirement and measured value or indications of capability.

Table C-21.2. Third Order Intercept Point Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
36	5.4.1.9	Third order Intercept Point. Using test signals within the first IF passband, the worst case third order intercept point shall not be less than +10 dBm (+1 dBm for tactical applications).	≥ +10 dBm (+1 dBm for tactical applications)			
Legend: dBm – decibels referenced to one milliwatt; IF – Intermediate Frequency; MIL-STD – Military Standard						

C-22 SUBTEST 22, RECEIVER DISTORTION AND INTERNALLY GENERATED SPURIOUS OUTPUTS

C-22.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 37, 38, 39, and 40.

C-22.2 Criteria

a. Overall Intermodulation Distortion (IMD) (in-channel). The total of IMD products, with two equal-amplitude, in-channel tones spaced 110 Hz apart, present at the receiver RF input, shall meet the following requirements. However, for frequency division multiplex (FDM) service, the receiver shall meet the requirements for any tone spacing equal to or greater than the minimum between adjacent tones in any FDM library. The requirements shall be met for any RF input amplitude up to 0-dBm PEP (-6 dBm/tone) at rated audio output. All IMD products shall be at least 35 dB (DO: 45 dB) below the output level of either of the two tones, MIL-STD-188-141B, paragraph 5.4.2.1.

b. Adjacent channel IMD. For multichannel equipment, the overall adjacent channel IMD in each 3-kHz channel being measured shall not be greater than -35 dBm at the 3-kHz channel output with all other channels equally loaded with 0-dBm unweighted white noise, MIL-STD-188-141B, paragraph 5.4.2.2.

c. Audio Frequency Total Harmonic Distortion. The total harmonic distortion produced by any single frequency RF test signal, which produces a frequency within the frequency bandwidth of 300 Hz to 3050 Hz, shall be at least 25 dB (DO: 35 dB) below the reference tone level with the receiver at rated output level. The RF test signal shall be at least 35 dB above the receiver noise threshold, MIL-STD-188-141B, paragraph 5.4.2.3.

d. Internally Generated Spurious Outputs. For 99 percent of the available 3-kHz channels, internally generated spurious signals shall not exceed -112 dBm. For 0.8 percent of the available 3-kHz channels, spurious signals shall not exceed -100 dBm for tactical applications and -106 dBm for fixed applications. For 0.2 percent of the available 3-kHz channels, spurious signals may exceed these levels, MIL-STD-188-141B, paragraph 5.4.2.4.

C-22.3 Test Procedures

a. Test Equipment Required

(1) Spectrum Analyzer

(2) Signal Generator

(3) Distortion Analyzer

(4) Attenuator

(5) Noise Generator

(6) Multichannel Transmitter

(7) Power Combiner

(8) 3 Decibel Attenuators

(9) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figures C-22.1, C-22.2, C-22.3, and C-22.4.

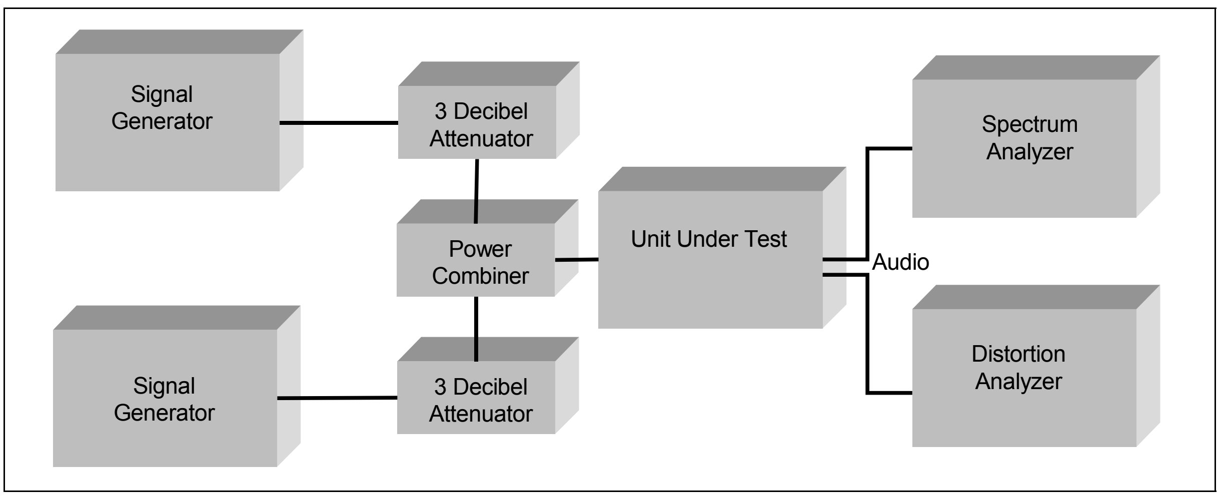

Figure C-22.1. Equipment Configuration for Overall IMD

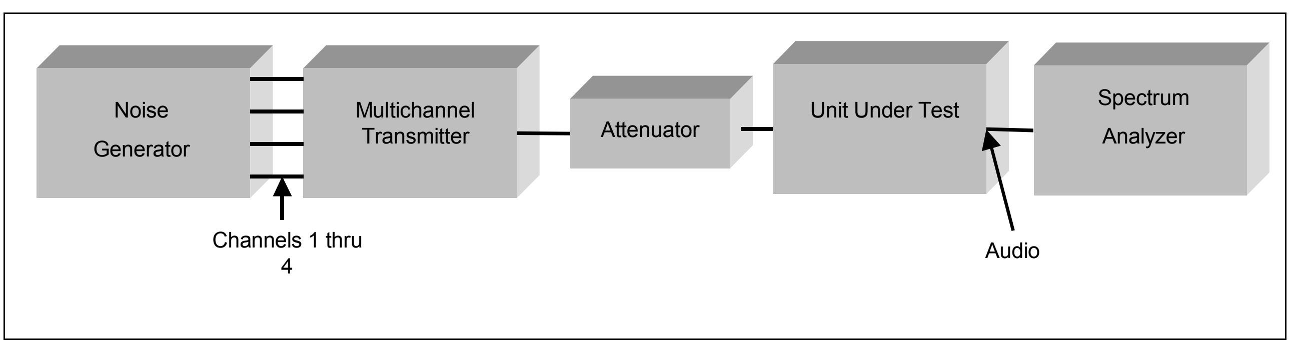

Figure C-22.2. Equipment Configuration for Adjacent Channel IMD

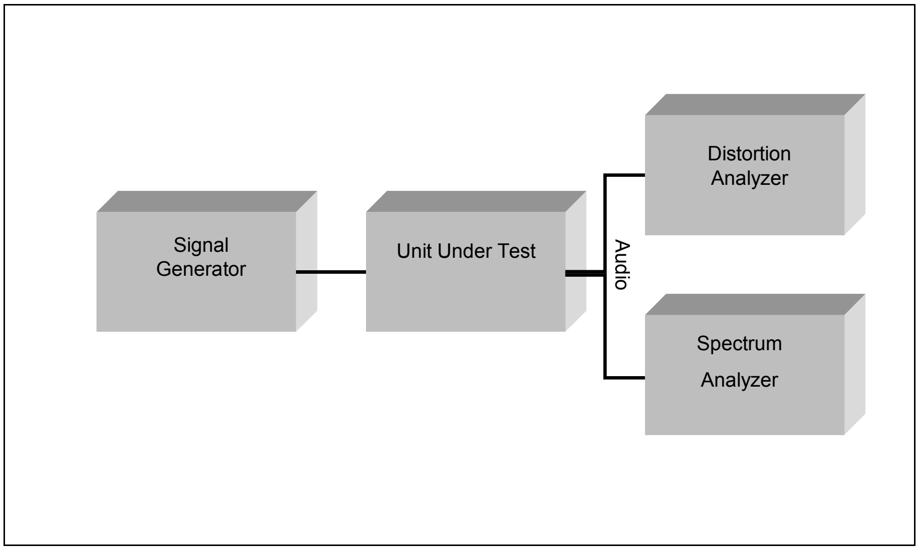

Figure C-22.3. Equipment Configuration for Total Harmonic Distortion

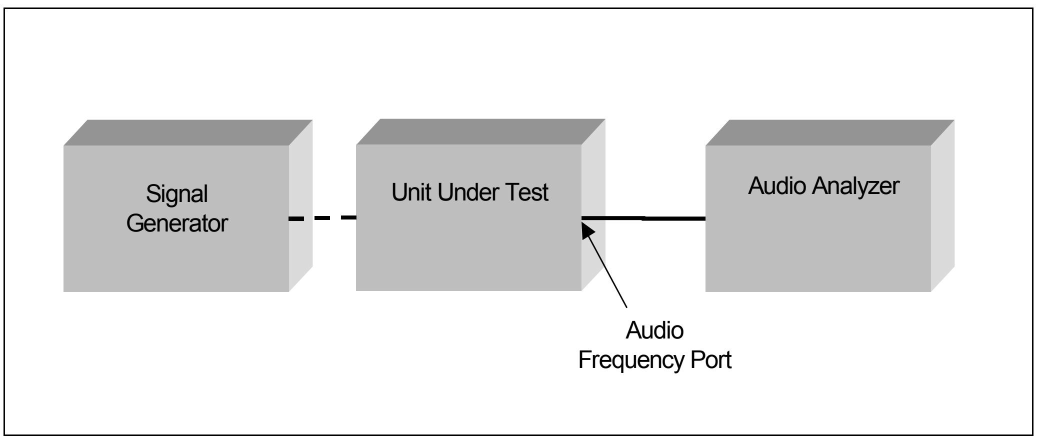

Figure C-22.4. Equipment Configuration for Spurious Outputs

c. Test Conduct. The procedures for this subtest are listed in tables C-22.1 through C-22.4.

Table C-22.1. Procedures for Overall IMD (in channel)

Step	Action	Settings/Action	Result
The following procedure is for reference number 37.			
1	Set up equipment.	See figure C-22.1. Test Frequency: 5.000 MHz	
2	Set up spectrum analyzer.	Center Frequency: 2.500 kHz Frequency Span: 5000 Hz RBW: 10 Hz VBW: 10 Hz Sweep Time: > 20 seconds Reference Level: As required. Range: 0 dBm Impedance: 1 M ohm	
3	Set up distortion analyzer.	Input: Normal Function: Voltmeter Mode: Automatic Termination: 600 ohm	
4	Set receiver to 5.000 MHz.		
5	Set RF signal generator #1 to 5.000935 MHz. Set RF output level to supply a –90-dBm signal to the receiver input.		
6	Set RF signal generator #2 to 5.001045 MHz. Set RF output level to supply a –90-dBm signal to the receiver input.		
7	Connect the spectrum analyzer to the audio output of the receiver.		
8	Increase the output level of both RF signal generators to produce a 0-dBm signal at the UUT output. Ensure that the UUT audio output volume is adjusted to rated level. Place the Ref/Lvl marker of the spectrum analyzer on the peak level of the two audio tones.	Obtain a plot of the two audio tones for reference.	
9	Select manual single sweep on the spectrum analyzer. When the sweep is completed, move the display to the highest IMD product observed during the sweep.	Obtain a plot of the sweep. The difference between the level recorded in step 8 and the level recorded in step 9 is the overall IMD (in channel) of the receiver. Record this result.	
10	Set signal generator channel #1 to 5.001575 MHz and signal generator #2 to 5.001705 MHz.	Repeat steps 8 and 9.	
11	Set signal generator channel #1 to 5.002255 MHz and signal generator #2 to 5.002365 MHz.	Repeat steps 8 and 9.	
Legend: dBm – decibels referenced to one milliwatt; Hz – hertz; IMD – Intermodulation Distortion; kHz – kilohertz; MHz – megahertz; RBW – Resolution Bandwidth; RF – Radio Frequency; UUT – Unit Under Test; VBW – Video Bandwidth			

Table C-22.2. Procedures for Adjacent Channel IMD

Step	Action	Settings/Action	Result
The following procedure is for reference number 38.			
1	Set up equipment.	See figure C-22.2. Test Frequency: 5.000 MHz	
2	Set up spectrum analyzer as shown in step 2 of table C-22.1.		
3	Tune receiver and transmitter to 5.000 MHz.		
4	Inject a 1-kHz tone into each channel of the four channel transmitter.	Use spectrum analyzer to verify that each receiver channel outputs a 0-dBm, 1-kHz tone.	
5	On channels 1, 2, and 3, replace the 1-kHz tone with white noise.	Use spectrum analyzer to verify that the noise floor of channel 4 is at least –35 dBm (measured on either side of the 1-kHz tone).	
6	On channels 2, 3, and 4, replace the 1-kHz tone with white noise.	Use spectrum analyzer to verify that the noise floor of channel 1 is at least –35 dBm (measured on either side of the 1-kHz tone).	
7	On channels 1, 3, and 4, replace the 1-kHz tone with white noise.	Use spectrum analyzer to verify that the noise floor of channel 2 is at least –35 dBm (measured on either side of the 1-kHz tone).	
8	On channels 1, 2, and 4, replace the 1-kHz tone with white noise.	Use spectrum analyzer to verify that the noise floor of channel 3 is at least –35 dBm (measured on either side of the 1-kHz tone).	
Legend: dBm – decibels referenced to one milliwatt; MHz – megahertz			

Table C-22.3. Procedures for Audio Frequency Total Harmonic Distortion

Step	Action	Settings/Action	Result
The following procedure is for reference number 39.			
1	Set up equipment.	See figure C-22.3. Test Frequency: 2.000 MHz	
2	Set up spectrum analyzer and distortion analyzer as stated in steps 2 and 3 in table C-22.1.		
3	Set receiver to 2.000 MHz; USB.		
4	Set RF signal generator to 2.000 MHz + 300 Hz at an RF level of -47 dBm (Note: -47 dBm is a valid level if the UUT passes subtest 19). Adjust the receiver to output the rated audio level (0 dBm).	Using the spectrum analyzer, verify that any harmonics of the 300-Hz tone are at least 25 dB below the reference tone level.	
5	Set RF signal generator to 2.000 MHz + 1000 Hz at an RF level of -47 dBm.	Using the spectrum analyzer, verify that any harmonics of the 1000-Hz tone are at least 25 dB below the reference tone level.	

Table C-22.3. Procedures for Audio Frequency Total Harmonic Distortion (continued)

Step	Action	Settings/Action	Result
6	Set RF signal generator to 2.000 MHz + 3000 Hz at an RF level of -47 dBm.	Using the spectrum analyzer, verify that any harmonics of the 3000-Hz tone are at least 25 dB below the reference tone level.	
Legend: dB – decibels; dBm – decibels referenced to one milliwatt; Hz – hertz; MHz – megahertz; RF – Radio Frequency; USB – Upper Sideband			

Table C-22.4. Procedures for Internally Generated Spurious Outputs

Step	Action	Settings/Action	Result
The following procedure is for reference number 40.			
1	Set up equipment.	See figure C-22.4.	
2	Tune the UUT to 8.000 MHz. Tune the signal generator to 8.001 MHz. Set the level of the signal generator to –112 dBm.	Use audio analyzer to measure SINAD level at receiver output. Record SINAD level.	
3	Disconnect the signal generator and coax from the receiver input. Tune the UUT to 2.000 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
4	Tune the UUT to 2.300 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
5	Tune the UUT to 2.600 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
6	Tune the UUT to 2.900 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
7	Tune the UUT to 3.200 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
8	Tune the UUT to 3.500 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
9	Tune the UUT to 3.800 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
10	Tune the UUT to 4.100 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
11	Tune the UUT to 4.400 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
12	Tune the UUT to 4.700 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
13	Tune the UUT to 5.000 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
14	Tune the UUT to 5.300 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
15	Tune the UUT to 5.600 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
16	Tune the UUT to 5.900 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
17	Tune the UUT to 6.000 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
18	Tune the UUT to 6.300 MHz.	Record the maximum SINAD level measured with the audio analyzer.	

Table C-22.4. Procedures for Internally Generated Spurious Outputs (continued)

Step	Action	Settings/Action	Result
19	Tune the UUT to 6.600 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
20	Tune the UUT to 6.900 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
21	Tune the UUT to 7.200 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
22	Tune the UUT to 7.500 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
23	Tune the UUT to 7.800 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
24	Tune the UUT to 8.100 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
25	Tune the UUT to 8.400 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
26	Tune the UUT to 8.700 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
27	Tune the UUT to 9.000 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
28	Tune the UUT to 9.300 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
29	Tune the UUT to 9.600 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
30	Tune the UUT to 9.900 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
31	Tune the UUT to 10.000 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
32	Tune the UUT to 10.300 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
33	Tune the UUT to 10.600 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
34	Tune the UUT to 10.900 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
35	Tune the UUT to 11.200 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
36	Tune the UUT to 11.500 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
37	Tune the UUT to 11.800 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
38	Tune the UUT to 12.100 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
39	Tune the UUT to 12.400 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
40	Tune the UUT to 12.700 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
41	Tune the UUT to 13.000 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
42	Tune the UUT to 13.300 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
43	Tune the UUT to 13.600 MHz.	Record the maximum SINAD level measured with the audio analyzer.	

Table C-22.4. Procedures for Internally Generated Spurious Outputs (continued)

Step	Action	Settings/Action	Result
44	Tune the UUT to 13.900 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
45	Tune the UUT to 14.000 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
46	Tune the UUT to 14.300 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
47	Tune the UUT to 14.600 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
48	Tune the UUT to 14.900 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
49	Tune the UUT to 15.200 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
50	Tune the UUT to 15.500 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
51	Tune the UUT to 15.800 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
52	Tune the UUT to 16.100 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
53	Tune the UUT to 16.400 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
54	Tune the UUT to 16.700 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
55	Tune the UUT to 17.000 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
56	Tune the UUT to 17.300 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
57	Tune the UUT to 17.600 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
58	Tune the UUT to 17.900 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
59	Tune the UUT to 18.000 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
60	Tune the UUT to 18.300 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
61	Tune the UUT to 18.600 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
62	Tune the UUT to 18.900 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
63	Tune the UUT to 19.200 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
64	Tune the UUT to 19.500 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
65	Tune the UUT to 19.800 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
66	Tune the UUT to 20.100 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
67	Tune the UUT to 20.400 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
68	Tune the UUT to 20.700 MHz.	Record the maximum SINAD level measured with the audio analyzer.	

Table C-22.4. Procedures for Internally Generated Spurious Outputs (continued)

Step	Action	Settings/Action	Result
69	Tune the UUT to 21.000 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
70	Tune the UUT to 21.300 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
71	Tune the UUT to 21.600 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
72	Tune the UUT to 21.900 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
73	Tune the UUT to 22.000 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
74	Tune the UUT to 22.300 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
75	Tune the UUT to 22.600 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
76	Tune the UUT to 22.900 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
77	Tune the UUT to 23.200 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
78	Tune the UUT to 23.500 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
79	Tune the UUT to 23.800 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
80	Tune the UUT to 24.100 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
81	Tune the UUT to 24.400 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
82	Tune the UUT to 24.700 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
83	Tune the UUT to 25.000 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
84	Tune the UUT to 25.300 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
85	Tune the UUT to 25.600 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
86	Tune the UUT to 25.900 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
87	Tune the UUT to 26.000 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
88	Tune the UUT to 26.300 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
89	Tune the UUT to 26.600 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
90	Tune the UUT to 26.900 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
91	Tune the UUT to 27.200 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
92	Tune the UUT to 27.500 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
93	Tune the UUT to 27.800 MHz.	Record the maximum SINAD level measured with the audio analyzer.	

Table C-22.4. Procedures for Internally Generated Spurious Outputs (continued)

Step	Action	Settings/Action	Result
94	Tune the UUT to 28.100 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
95	Tune the UUT to 28.400 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
96	Tune the UUT to 28.700 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
97	Tune the UUT to 29.000 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
98	Tune the UUT to 29.300 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
99	Tune the UUT to 29.600 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
100	Tune the UUT to 29.700 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
101	Tune the UUT to 29.800 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
102	Tune the UUT to 29.900 MHz.	Record the maximum SINAD level measured with the audio analyzer.	
103	Review the results of steps 3 through 102.	Verify that no more than one test frequency had an audio output SINAD larger than the level recorded in step 2.	
Legend: Ω – ohm; kHz – kilohertz; MHz – megahertz; RF – Radio Frequency; RBW – Resolution Bandwidth; UUT – Unit Under Test; VBW – Video Bandwidth			

C-22.4 Presentation of Results. The results will be shown in tabular format (table C-22.5) indicating the requirement and measured value or indications of capability.

Table C-22.5. Receiver Distortion and Internally Generated Spurious Output Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
37	5.4.2.1	Overall IMD (in-channel). The total of IMD products, with two equal-amplitude, in-channel tones spaced 110 Hz apart, present at the receiver RF input, shall meet the following requirements. However, for frequency division multiplex (FDM) service, the receiver shall meet the requirements for any tone spacing equal to or greater than the minimum between adjacent tones in any FDM library. The requirements shall be met for any RF input amplitude up to 0-dBm PEP (-6 dBm/tone) at rated audio output. All IMD products shall be at least 35 dB (DO: 45 dB) below the output level of either of the two tones.	At least 35 dB below the output level of either of the two tones.			
38	5.4.2.2	Adjacent Channel IMD. For multiple-channel equipment, the overall adjacent channel IMD in each 3-kHz channel being measured shall not be greater than -35 dBm at the 3-kHz channel output with all other channels equally loaded with 0-dBm unweighted white noise.	Not greater than -35 dBm.			
39	5.4.2.3	Audio Frequency Total Harmonic Distortion. The total harmonic distortion produced by any single frequency RF test signal, which produces a frequency within the frequency bandwidth of 300 Hz to 3050 Hz shall be at least 25 dB (DO: 35 dB) below the reference tone level with the receiver at rated output level. The RF test signal shall be at least 35 dB above the receiver noise threshold.	At least 25 dB below the reference tone level.			
40	5.4.2.4	Internally Generated Spurious Outputs. For 99 percent of the available 3-kHz channels, internally generated spurious signals shall not exceed -112 dBm.	Not to exceed -112 dBm.			

Table C-22.5. Receiver Distortion and Internally Generated Spurious Output Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
40	5.4.2.4	For 0.8 percent of the available 3 kHz channels, spurious signals shall not exceed -100 dBm for tactical applications and -106 dBm for fixed applications.	Not to exceed -100 dBm for tactical applications and -106 dBm for fixed applications.			
40	5.4.2.4	For 0.2 percent of the available 3-kHz channels, spurious signals may exceed these levels.				

Legend: dB – decibels; dBm – decibels referenced to one milliwatt; DO – Design Objective; FDM – Frequency Division Multiplex; Hz – hertz; IMD – Intermodulation Distortion; kHz – kilohertz; MIL-STD – Military Standard; PEP – Peak Envelope Power; RF – Radio Frequency

C-23 SUBTEST 23, AUTOMATIC GAIN CONTROL CHARACTERISTICS

C-23.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 41, 42, 43, and 44.

C-23.2 Criteria

a. Automatic Gain Control (AGC) Characteristic. The steady-state output level of the receiver (for a single tone) shall not vary by more than 3 dB over an RF input range from -103 dBm to +13 dBm for fixed application or -103 dBm to 0 dBm for tactical application, MIL-STD-188-141B, paragraph 5.4.3.

b. AGC Attack Time (Nondata Modes). The receiver AGC Attack Time shall not exceed 30 msec, MIL-STD-188-141B, paragraph 5.4.3.1.

c. AGC Release Time (Nondata Modes). The receiver AGC Release Time shall be between 800 and 1200 msec for SSB voice and ICW operation. This shall be the period from RF signal downward transition until audio output is within 3 dB of the steady-state output. The final steady-state audio output is simply receiver noise being amplified in the absence of any RF input signal, MIL-STD-188-141B, paragraph 5.4.3.2.

d. AGC Requirements for Data Service. In data service, the receiver AGC Attack Time shall not exceed 10 msec. The AGC Release Time shall not exceed 25 msec, MIL-STD-188-141B, paragraph 5.4.3.3.

C-23.3 Test Procedures

a. Test Equipment Required

(1) Oscilloscope

(2) Signal Generator

(3) Audio Analyzer

(4) Directional Coupler

(5) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figures C-23.1 and C-23.2.

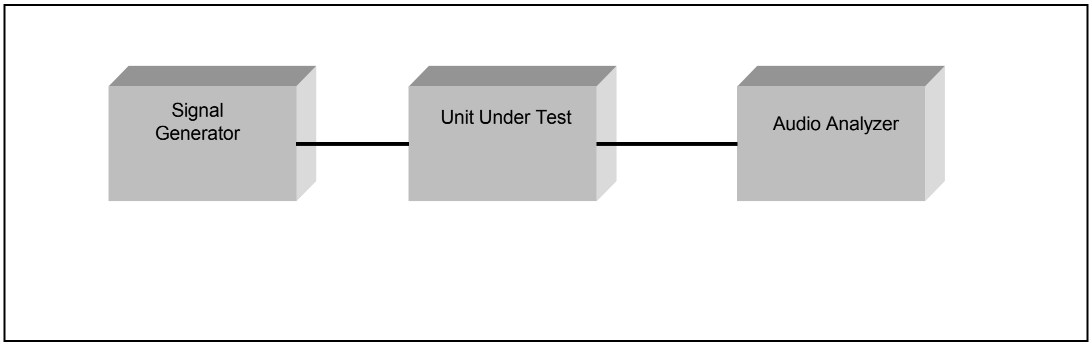

Figure C-23.1. Equipment Configuration for Automatic Gain Control Steady-State

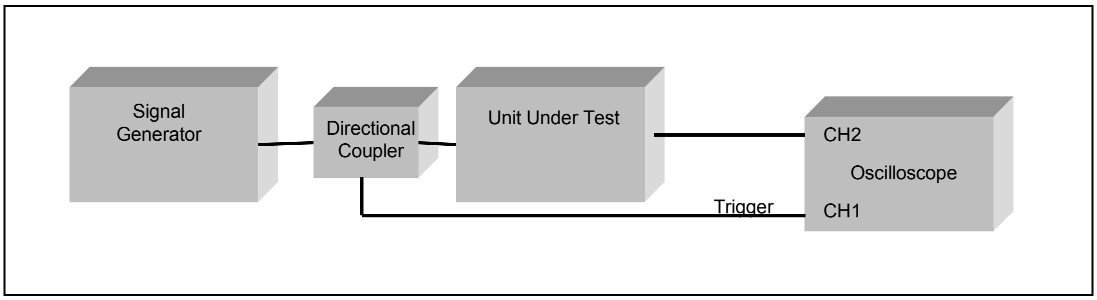

Figure C-23.2. Equipment Configuration for Automatic Gain Control Attack and Release Time

c. Test Conduct. The procedures for this subtest are listed in tables C-23.1 through C-24.4.

Table C-23.1. Procedures for Automatic Gain Control Steady-State

Step	Action	Settings/Action	Result
The following procedure is for reference number 41.			
1	Set up equipment.	See figure C-23.1.	
2	Set up audio analyzer.		
3	Set receiver to 8.000 MHz; USB.	Set the audio output level of the UUT to mid-range.	
4	Set RF signal generator to test frequency + 1 kHz.	Set RF signal generator output level < -120 dBm.	

Table C-23.1. Procedures for Automatic Gain Control Steady-State (continued)

Step	Action	Settings/Action	Result
5	Increase RF signal generator output level in 1-dB steps until AGC threshold triggers. Record RF output level of the signal generator at AGC threshold, and the audio output level of the UUT.	The AGC threshold is found by increasing the level of the RF signal generator until the audio output level of the receiver reaches steady-state.	
6	Set the RF signal generator RF output level to -103 dBm. Increase RF signal generator output level in 3-dBm steps until +13 dBm is reached (0 dBm for tactical applications).	Record the audio output level of the UUT each time the RF output level is incremented.	
		-103 dBm	
		-100 dBm	
		-97 dBm	
		-94 dBm	
		-91 dBm	
		-88 dBm	
		-85 dBm	
		-82 dBm	
		-79 dBm	
		-76 dBm	
		-73 dBm	
		-70 dBm	
		-67 dBm	
		-64 dBm	
		-61 dBm	
		-58 dBm	
		-55 dBm	
		-52 dBm	
		-49 dBm	
		-46 dBm	
		-43 dBm	
		-40 dBm	
		-37 dBm	
		-34 dBm	
		-31 dBm	
		-28 dBm	
		-25 dBm	
		-22 dBm	
		-19 dBm	
		-16 dBm	
		-13 dBm	
		-10 dBm	
		-7 dBm	
		-4 dBm	
		-1 dBm	
		0 dBm	
		+2 dBm (This test point is not required for tactical applications.)	
		+5 dBm (This test point is not required for tactical applications.)	

Table C-23.1. Procedures for Automatic Gain Control Steady-State (continued)

Step	Action	Settings/Action	Result
		+8 dBm (This test point is not required for tactical applications.)	
		+11 dBm (This test point is not required for tactical applications.)	
		+13 dBm (This test point is not required for tactical applications.)	
7	Review the results of step 6, and verify that the change in audio output level of the UUT is less than ±3 dB for each RF input level.		
Legend: AGC – Automatic Gain Control; dBm – decibels referenced to 1 milliwatt; kHz – kilohertz; MHz – megahertz; RF – Radio Frequency; USB – Upper Sideband; UUT – Unit Under Test			

Table C-23.2. Procedures for Automatic Gain Control Attack Time

Step	Action	Settings/Action	Result
The following procedure is for reference number 42.			
1	Set up equipment.	See figure C-23.2.	
2	Set up oscilloscope.	Set horizontal scale to 5 msec/div. Set vertical scale to 0.5 V/div. Set trigger to single sweep, 50 percent, channel 1.	
3	Set receiver to 8.000 MHz; USB.		
4	Set RF signal generator to test frequency +1 kHz.	Set RF signal generator output level to -57 dBm.	
5	Using a directional coupler, trigger the oscilloscope on channel one with the RF ON/OFF of the RF signal generator.		
6	Turn RF output off; select RUN on oscilloscope.	Turn RF output on to capture the Attack Time.	
7	Measure the AGC Attack Time.	The Attack Time Delay is measured by placing vertical marker #1 at the point where the RF output on the signal generator is turned on (measured on channel one), and vertical marker #2 at the point where the amplitude of the audio signal on channel two reaches 90 percent of its steady-state value. The time difference between the two vertical markers is the Attack Time Delay.	
Legend: AGC – Automatic Gain Control; dBm – decibels referenced to one milliwatt; kHz – kilohertz; MHz – megahertz; RF – Radio Frequency; USB – Upper Sideband			

Table C-23.3. Procedures for Automatic Gain Control Release Time

Step	Action	Settings/Action	Result
	The following procedure is for reference number 43.		
1	Set up equipment.	See figure C-23.2.	
2	Set up oscilloscope.	Set horizontal scale to 5 msec/div. Set vertical scale to 0.5 V/div. Set trigger to single sweep, 50 percent, channel 1.	
3	Set receiver to 8.000 MHz; USB.		
4	Set RF signal generator to test frequency + 1 kHz.	Set RF signal generator output level to –57 dBm.	
5	Using a directional coupler, trigger the oscilloscope with the RF ON/OFF of the RF signal generator.	Set trigger DELAY to 1200 msec.	
6	Turn RF output on; select RUN on oscilloscope.	Turn RF output off to capture the Release Time.	
7	Measure the AGC Release Time.	The Release Time is measured by placing vertical marker #1 at the point on channel one where the RF output from the signal generator begins its downward transition, and placing vertical marker #2 at the point where the amplitude of the audio signal on channel two is within 3 dB of the steady-state output. The final steady-state audio output is simply receiver noise being amplified in the absence of any RF input signal. The time difference between the two vertical markers is the Release Time.	
8	Repeat steps 1 through 7 with UUT in ICW mode.		
Legend: AGC – Automatic Gain Control; dB – decibels; dBm – decibels referenced to one milliwatt; kHz – kilohertz; MHz – megahertz; msec – millisecond; RF – Radio Frequency; USB – Upper Sideband; V/div – Volts per division			

Table C-23.4. Procedures for Automatic Gain Control Data Mode

Step	Action	Settings/Action	Result
	The following procedure is for reference number 44.		
1	Set receiver AGC to DATA mode.	Repeat procedures given in tables C-23.2 and C-23.3.	
Legend: AGC – Automatic Gain Control			

C-23.4 Presentation of Results. The results will be shown in tabular format (table C-23.5) indicating the requirement and measured value or indications of capability.

Table C-23.5. Automatic Gain Control Characteristic Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
41	5.4.3	<u>Automatic Gain Control (AGC) Characteristic</u>. The steady-state output level of the receiver (for a single tone) shall not vary by more than 3 dB over an RF input range from -103 dBm to +13 dBm for fixed application or -103 dBm to 0 dBm for tactical application.	Not to vary by more than 3 dB.			
42	5.4.3.1	<u>AGC Attack Time (Nondata Modes)</u>. The receiver AGC Attack Time shall not exceed 30 msec.	< 30 msec			
43	5.4.3.2	<u>AGC Release Time (Nondata Modes)</u>. The receiver AGC Release Time shall be between 800 and 1200 msec for SSB voice and ICW operation. This shall be the period from RF signal downward transition until audio output is within 3 dB of the steady-state output. The final steady-state audio output is simply receiver noise being amplified in the absence of any RF input signal.	800 msec < Release Time < 1200 msec			
44	5.4.3.3	<u>AGC Requirements for Data Service</u>. In data service, the receiver AGC Attack Time shall not exceed 10 msec. The AGC Release Time shall not exceed 25 msec.	Attack Time: < 10 msec Release Time: < 25 msec			

Legend: dB – decibels; dBm – decibels referenced to one milliwatt; ICW – Interrupted continuous wave; MIL-STD – Military Standard; msec – millisecond; RF – Radio Frequency; SSB – Single Sideband

C-24 SUBTEST 24, RECEIVER LINEARITY

C-24.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 45.

C-24.2 Criteria. The following shall apply with the receiver operating at maximum sensitivity, and with a reference input signal that produces a SINAD of 10 dB at the receiver output. The output SINAD shall increase monotonically and linearly within $\pm$ 1.5 dB for a linear increase in input signal level until the output SINAD is equal to at least 30 dB (DO: 40 dB). When saturation occurs, the output SINAD may vary $\pm$3 dB for additional increase in signal level. This requirement shall apply over the operating frequency range of the receiver, MIL-STD-188-141B, paragraph 5.4.4.

C-24.3 Test Procedures

a. Test Equipment Required

(1) Audio Analyzer

(2) Signal Generator

(3) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figure C-24.1.

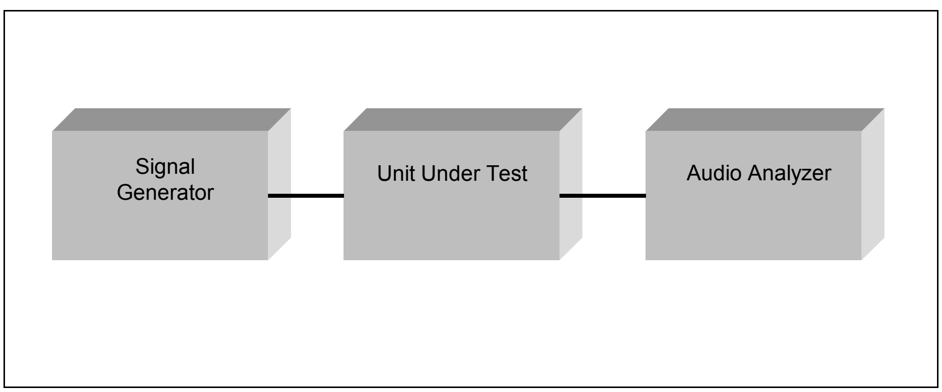

Figure C-24.1. Equipment Configuration for Receiver Linearity

c. Test Conduct. The procedures for this subtest are listed in table C-24.1.

Table C-24.1. Procedures for Receiver Linearity

Step	Action	Settings/Action	Result
The following procedure is for reference number 45.			
1	Set up equipment.	See figure C-24.1.	
2	Set up audio analyzer.		
3	Set receiver to 8.000 MHz; USB.		
4	Set RF signal generator to test frequency + 1 kHz.	Set RF signal generator output level < -125 dBm.	
5	Increase RF signal generator output level until the receiver audio output level measured on the audio analyzer indicates 10 dB SINAD.	Record the signal generator RF output level (dBm).	
6	Increase RF output level in 5-dB steps until a 30-dB SINAD is obtained.	Measure audio output and SINAD for each RF step.	Record results on data collection form, page D-33.
7	Repeat steps 3 through 6 for the 12.000 and 24.000 MHz frequencies.		

Legend: dB – decibels; dBm – decibels referenced to one milliwatt; MHz – megahertz; RF – Radio Frequency; SINAD – Signal-plus-noise-plus-distortion to noise-plus-distortion ratio; USB – Upper Sideband

C-24.4 Presentation of Results. The results will be shown in table C-24.2 indicating the requirement and measured value or indications of capability.

Table C-24.2. Receiver Linearity Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
45	5.4.4	Receiver Linearity. The following shall apply with the receiver operating at maximum sensitivity, and with a reference input signal that produces a SINAD of 10 dB at the receiver output. The output SINAD shall increase monotonically and linearly within ± 1.5 dB for a linear increase in input signal level until the output SINAD is equal to at least 30 dB (DO: 40 dB).				
		When saturation occurs, the output SINAD may vary ±3 dB for additional increase in signal level. This requirement shall apply over the operating frequency range of the receiver.	±3 dB			

Legend: dB – decibels; DO – Design Objective; MIL-STD – Military Standard; SINAD – Signal-plus-noise-plus-distortion to noise-plus-distortion ratio

C-25 SUBTEST 25, INPUT IMPEDANCE

C-25.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 46.

C-25.2 Criteria. The receiver RF input impedance shall be nominally 50 ohm, unbalanced with respect to ground. The input VSWR, with respect to 50 ohm, shall not exceed 2.5:1 over the operating frequency range, MIL-STD-188-141B, paragraph 5.4.5.1.

C-25.3 Test Procedures

a. Test Equipment Required

(1) Impedance/Gain-Phase Analyzer

(2) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figure C-25.1.

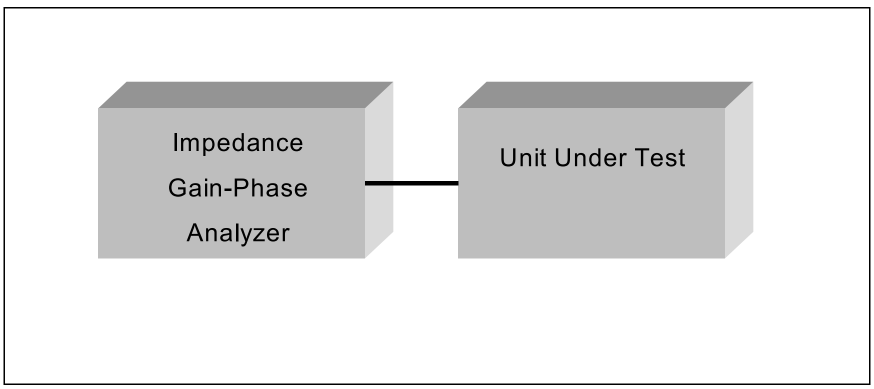

Figure C-25.1. Equipment Configuration for Input Impedance

c. Test Conduct. The procedures for this subtest are listed in table C-25.1.

Table C-25.1. Procedures for Input Impedance

Step	Action	Settings/Action	Result
The following procedure is for reference number 46.			
1	Set up equipment.	See figure C-25.1.	
2	Tune receiver to 2.000 MHz.		
3	Connect the impedance/gain-phase analyzer to the RF input connector of the UUT.	Tune impedance/gain-phase analyzer to the exact frequency of the receiver under test. The receiver's AGC may be disabled for this test.	

Table C-25.1. Procedures for Input Impedance (continued)

Step	Action	Settings/Action	Result
4	Measure the phase angle and magnitude of the RF input impedance in 5.000-MHz steps across the receiver's operating range.	Record result.	Record on data collection form, page D-35.
5	Verify that the magnitude of the RF input impedance (Z_L) is between 20 ohm and 125 ohm over the operating frequency range.	Note: Z_L at 20 ohm or 125 ohm corresponds directly to an input VSWR of 2.5:1, with respect to 50 ohm. This can be verified using the following equation: $VSWR = (1+\lvert\Gamma\rvert)/(1-\lvert\Gamma\rvert)$ Where $\Gamma = (Z_L - Z_0)/(Z_L+Z_0)$, and Z_0 is 50 ohms.	
Legend: AGC – Automatic Gain Control; MHz – megahertz; RF – Radio Frequency; UUT – Unit Under Test; VSWR – Voltage Standing Wave Ratio			

C-25.4 Presentation of Results. The results will be shown in tabular format (table C-25.2) indicating the requirement and measured value or indications of capability.

Table C-25.2. Input Impedance Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
46	5.4.5.1	Input Impedance. The receiver RF input impedance shall be nominally 50 ohm, unbalanced with respect to ground. The input VSWR, with respect to 50 ohm, shall not exceed 2.5:1 over the operating frequency range.	Input VSWR ≤ 2.5:1			
Legend: MIL-STD – Military Standard; RF – Radio Frequency; VSWR – Voltage Standing Wave Ratio						

C-26 SUBTEST 26, OUTPUT IMPEDANCE AND POWER

C-26.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 47.

C-26.2 Criteria. When a balanced output is provided, the receiver output impedance shall be a nominal 600 ohm, balanced with respect to ground, capable of delivering 0 dBm to a 600-ohm load. Electrical symmetry shall be sufficient to suppress longitudinal currents at least 40 dB below reference signal level. The receiver output signal power for operation with a headset or handset shall be adjustable at least over the range from -30 dBm to 0 dBm. For operation with a speaker, the output level shall be adjustable at least over the range of 0 dBm to +30 dBm. As a DO, an additional interface can accommodate speakers ranging from 4 to 16 ohm impedance should be provided, MIL-STD-188-141B, paragraph 5.4.5.2.

C-26.3 Test Procedures

a. Test Equipment Required

(1) Audio Generator

(2) Signal Generator

(3) Resistors

(4) Transformer (2)

(5) Distortion Analyzer

(6) Audio Voltmeter (2)

(7) Unit Under Test

b. Test Configuration. Configure the equipment shown in figures C-26.1 and C-26.2.

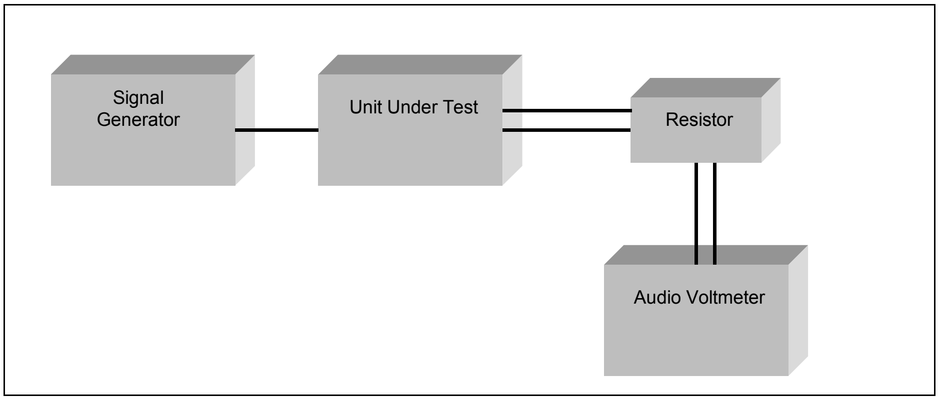

Figure C-26.1. Equipment Configuration for Output Impedance, Power, and Range

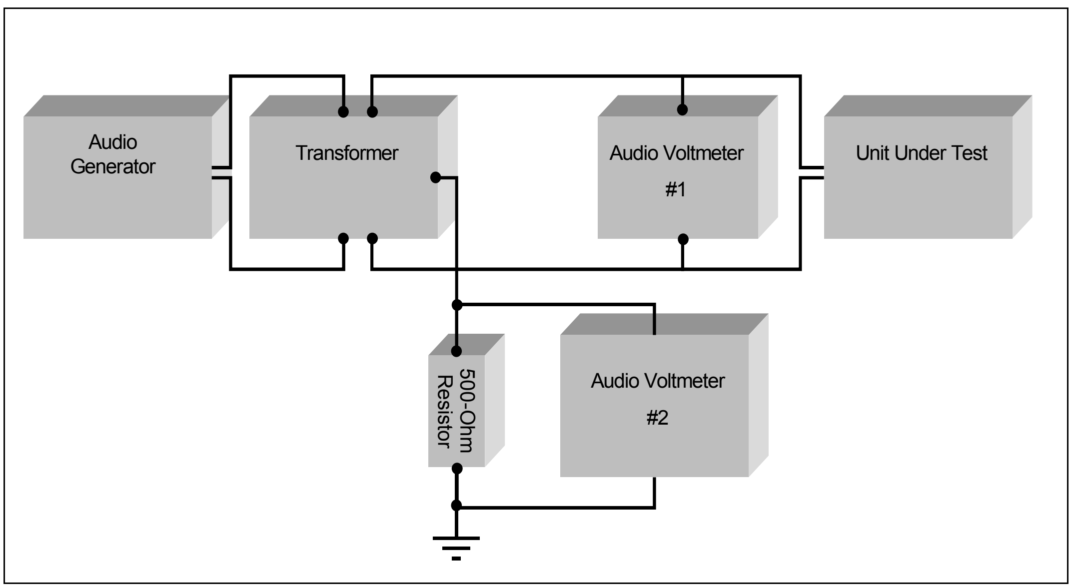

Figure C-26.2. Equipment Configuration for Longitudinal Current Suppression

c. Test Conduct. The procedures for this subtest are listed in tables C-26.1 through C-26.4.

Table C-26.1. Procedures for Output Impedance

Step	Action	Settings/Action	Result
The following procedures are for reference number 47.			
1	Set up equipment.	See figure C-26.1.	
2	Set up audio voltmeter.	Input: High Impedance	
3	Set up UUT.	8.000 MHz, USB.	
4	Set up signal generator.	Frequency: 8.001 MHz Level: -90 dBm	
5	Connect the audio voltmeter across the audio output terminals of the UUT. Do not use the load resistor for this measurement.	Record the output voltage (V).	
6	Connect a 1000-ohm resistor across the audio output.	Again, measure the output voltage (Vo).	
7	Calculate the output impedance (Zo) of the UUT using the given equation.	Zo = 1000(V-Vo)/Vo	
Legend: dB – decibels; dBm – decibels referenced to one milliwatt; kHz – kilohertz; MHz – megahertz; RF – Radio Frequency; USB – Upper Sideband			

Table C-26.2. Procedures for Longitudinal Current Suppression

Step	Action	Settings/Action	Result
The following procedure is for reference number 47.			
1	Set up equipment.	See figure C-26.2.	
2	Set up audio generator.	Frequency: 300 Hz	
3	Turn receiver off. Disconnect power source.		
4	Adjust the audio generator to a -16-dBm signal at 300 Hz.		
5	The difference, in dB, between the voltage reading observed on audio voltmeter #1 and the reading on audio voltmeter #2 is taken as the longitudinal balance indication.	Record frequency and level of audio generator and audio voltmeter readings.	
6	Repeat steps 4 and 5 in 300-Hz steps across the audio range (i.e., 600, 900, 1200 Hz, etc.).		
Legend: dB – decibels; dBm – decibels referenced to one milliwatt; Hz – hertz; TIMS – Transmission Impairment Measurement Set			

Table C-26.3. Procedures for Output Signal Power and Range

Step	Action	Settings/Action	Result
The following procedure is for reference number 47.			
1	Set up equipment.	See figure C-26.1.	
2	Set up distortion analyzer.	Input: Normal Function: Voltmeter Mode: Automatic Termination: 600 ohm	
3	Tune receiver to 15.000 MHz; USB.		
4	Set RF signal generator to 15.000 MHz + 1 kHz at a signal level of -47 dBm.		
5	Connect 600-ohm resistor across the audio output of the receiver. Connect distortion analyzer across the resistor.		
6	Increase the receiver audio gain until the distortion analyzer indicates 0 dBm.		
7	Turn the receiver AF gain control to minimum audio output.	Record output level. (The audio output should drop less than -30 dBm.)	
Legend: AF – Audio Frequency; dBm – decibels referenced to one milliwatt; kHz – kilohertz; MHz – megahertz; RF – Radio Frequency; USB – Upper Sideband			

Table C-26.4. Procedure for Speaker Interface

Step	Action	Settings/Action	Result
1	Review technical documentation for the receiver's ability to accommodate speakers ranging from 4 to 16 ohm impedance.	Record results of documentation review.	

C-26.4 Presentation of Results. The results will be shown in tabular format (table C-26.5) indicating the requirement and measured value or indications of capability.

Table C-26.5. Output Impedance and Power Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
47	5.4.5.2	Output Impedance and Power. When a balanced output is provided, the receiver output impedance shall be a nominal 600 ohm, balanced with respect to ground	Nominal 600 ohm, balanced with respect to ground.			
		capable of delivering 0 dBm to a 600-ohm load.	0 dBm			
		Electrical symmetry shall be sufficient to suppress longitudinal currents at least 40 dB below reference signal level.	At least 40 dB.			
		The receiver output signal power for operation with a headset or handset shall be adjustable at least over the range from -30 dBm to 0 dBm.	Adjustable from -30 dBm to 0 dBm.			
		For operation with a speaker, the output level shall be adjustable at least over the range of 0 dBm to +30 dBm. As a DO, an additional interface can accommodate speakers ranging from 4- to 16-ohm impedance should be provided.	Adjustable from 0 dBm to +30 dBm.			
Legend: DO – Design Objective; dB – decibels; dBm – decibels referenced to one milliwatt; MIL-STD – Military Standard						

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C-27 SUBTEST 27, MEMORY

C-27.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 57, 58, 59, 60, 63, and 84.

C-27.2 Criteria

a. Channel Memory. The equipment shall be capable of storing, retrieving, and employing at least 100 different sets of information concerning channel data to include receive and transmit frequencies with associated mode information. See MIL-STD-188-141B table A-III. The channel data storage shall be nonvolatile. Any channel (a) shall be capable of being recalled manually or under the direction of any associated automated controller, and (b) shall be capable of having its information altered after recall without affecting the original stored information settings, MIL-STD-188-141B, paragraph A.4.3.1.

b. Self-Address Memory. The radio shall be capable of storing, retrieving, and employing at least 20 different sets of information concerning self-addressing. The self-address information storage shall be nonvolatile. These sets of information include self (its own personal)-address(es), valid channels that are associated for use, and net addressing. Net addressing information shall include (for each "net member" self address, as necessary) the net address and the associated slot wait time (in multiples of T_w). See MIL-STD-188-141B table A-IV and paragraph A.5.5.4.1. The slot wait time values are T_{swt}(slot number (SN)) from the formula, T_{swt} (SN) = T_{sw} x SN, MIL-STD-188-141B, paragraph A.4.3.2.

c. Other Station Table. The radio shall be capable of storing, retrieving, and employing at least 100 different sets of information concerning the addresses of other stations and nets, channel quality data to those stations and nets (measurements or predictions), and equipment settings specific to links with each station or net. DO: any excess capacity that is not programmed with preplanned other station information should be automatically filled with any addresses heard on any of the scanned or monitored channels. When the excess capacity is filled, it should be kept current by replacing the oldest heard addresses with the latest ones heard. This information should be used for call initiation to stations (if needed), and for activity evaluation, MIL-STD-188-141B, paragraph A.4.3.3.

d. Other Station Address Storage. Individual station addresses shall be stored in distinct table entries, and shall be associated with a specific wait for reply time (T_{wr}) if not the default value. Net information shall include own net and net member associations, relative slot sequence, and own net wait for reply times (T_{wrn}) for use when calling. See MIL-STD-188-141B figure A-4. The storage for addresses and settings shall be nonvolatile, MIL-STD-188-141B, paragraph A.4.3.3.1.

e. Message Memory. Storage for preprogrammed, operator entered, and incoming messages shall be provided in the equipment. This storage shall be retained in memory for not less than one hour during power down or loss of primary power. Storage for at least 12 messages (DO: 100 messages) and a total capacity of at least 1000 characters (DO: 10,000 characters) shall be provided, MIL-STD-188-141B, paragraph A.4.3.5.

f. Introduction. The ALE system deploys a digital addressing structure based upon the standard 24-bit (three character) word and the Basic 38 character subset. As described below, ALE stations have the capability and flexibility to link or network with one or many prearranged or as-needed single or multiple stations. All ALE stations shall have the capacity to store and use at least 20 self-addresses of up to 15 characters each in any combination of individual and net calls. There are three basic addressing methods that will be presented: individual station, multiple station, and special modes.

NOTE: Certain alphanumeric address combinations may be interpreted to have special meanings for emergency or specific functions, such as “SOS,” “MAYDAY,” “PANPAN,” “SECURITY,” “ALL,” “ANY,” and “NULL.” These should be carefully controlled or restricted, MIL-STD-188-141B, paragraph A.5.2.4.1.

C-27.3 Test Procedures

a. Test Equipment Required

(1) Attenuators

(2) Personal Computer (PC) with Soundcard

(3) Receiver monitoring 12.000 MHz, USB

(4) Directional Coupler

(5) UUT plus two radios similar to UUT

b. Test Parameters

(1) Table C-27.1, Channel data programming information.

(2) Tables C-27.2, C-27.3, and C-27.4, Address programming information systems A, B, and C.

(3) Table C-27.5, Net address and member programming information.

(4) Table C-27.6, Group address non-slotted members programming information.

Table C-27.1. Channel Data Programming Information

Channel	Frequency TX (MHz)	Frequency RX (MHz)	TX Mode	RX Mode	TX/RX
00	12.000	12.000	USB	USB	TX/RX
01	12.000	12.000	USB	USB	TX/RX
02	12.000	12.000	USB	USB	TX/RX
03	12.000	12.000	USB	USB	TX/RX
04	12.000	12.000	USB	USB	TX/RX
05	12.000	12.000	USB	USB	TX/RX
06	12.000	12.000	USB	USB	TX/RX
07	12.000	12.000	USB	USB	TX/RX
08	12.000	12.000	USB	USB	TX/RX
09	12.000	12.000	USB	USB	TX/RX
10	12.000	12.000	USB	USB	TX/RX
11	2.551	2.551	LSB	LSB	TX/RX
12	4.551	4.551	USB	USB	TX/RX
13	12.001	12.001	LSB	LSB	TX/RX
14	9.331	9.331	LSB	LSB	TX/RX
15	11.111	11.111	LSB	LSB	TX/RX
16	6.441	6.441	USB	USB	TX/RX
17	5.221	5.221	USB	USB	TX/RX
18	3.661	3.661	LSB	LSB	TX/RX
19	7.881	7.881	USB	USB	TX/RX
20	29.992	29.992	USB	USB	TX/RX
21	2.552	2.552	LSB	LSB	TX/RX
22	4.552	4.552	USB	USB	TX/RX
23	12.002	12.002	LSB	LSB	TX/RX

Table C-27.1. Channel Data Programming Information (continued)

Channel	Frequency TX (MHz)	Frequency RX (MHz)	TX Mode	RX Mode	TX/RX
24	9.332	9.332	LSB	LSB	TX/RX
25	11.112	11.112	LSB	LSB	TX/RX
26	6.442	6.442	USB	USB	TX/RX
27	5.222	5.222	USB	USB	TX/RX
28	3.662	3.662	LSB	LSB	TX/RX
29	7.882	7.882	USB	USB	TX/RX
30	29.993	29.993	USB	USB	TX/RX
31	2.553	2.553	LSB	LSB	TX/RX
32	4.553	4.553	USB	USB	TX/RX
33	12.003	12.003	LSB	LSB	TX/RX
34	9.333	9.333	LSB	LSB	TX/RX
35	11.113	11.113	LSB	LSB	TX/RX
36	6.443	6.443	USB	USB	TX/RX
37	5.223	5.223	USB	USB	TX/RX
38	3.663	3.663	LSB	LSB	TX/RX
39	7.883	7.883	USB	USB	TX/RX
40	29.994	29.994	USB	USB	TX/RX
41	2.554	2.554	LSB	LSB	TX/RX
42	4.554	4.554	USB	USB	TX/RX
43	12.004	12.004	LSB	LSB	TX/RX
44	9.334	9.334	LSB	LSB	TX/RX
45	11.114	11.114	LSB	LSB	TX/RX
46	6.444	6.444	USB	USB	TX/RX
47	5.224	5.224	USB	USB	TX/RX

Table C-27.1. Channel Data Programming Information (continued)

Channel	Frequency TX (MHz)	Frequency RX (MHz)	TX Mode	RX Mode	TX/RX
48	3.664	3.664	LSB	LSB	TX/RX
49	7.884	7.884	USB	USB	TX/RX
50	29.995	29.995	USB	USB	TX/RX
51	2.555	2.555	LSB	LSB	TX/RX
52	4.555	4.555	USB	USB	TX/RX
53	12.005	12.005	LSB	LSB	TX/RX
54	9.335	9.335	LSB	LSB	TX/RX
55	11.115	11.115	LSB	LSB	TX/RX
56	6.445	6.445	USB	USB	TX/RX
57	5.225	5.225	USB	USB	TX/RX
58	3.665	3.665	LSB	LSB	TX/RX
59	7.885	7.885	USB	USB	TX/RX
60	29.996	29.996	USB	USB	TX/RX
61	2.556	2.556	LSB	LSB	TX/RX
62	4.556	4.556	USB	USB	TX/RX
63	12.006	12.006	LSB	LSB	TX/RX
64	9.336	9.336	LSB	LSB	TX/RX
65	11.116	11.116	LSB	LSB	TX/RX
66	6.446	6.446	USB	USB	TX/RX
67	5.226	5.226	USB	USB	TX/RX
68	3.666	3.666	LSB	LSB	TX/RX
69	7.886	7.886	USB	USB	TX/RX
70	29.997	29.997	USB	USB	TX/RX
71	2.557	2.557	LSB	LSB	TX/RX

Table C-27.1. Channel Data Programming Information (continued)

Channel	Frequency TX (MHz)	Frequency RX (MHz)	TX Mode	RX Mode	TX/RX
72	4.557	4.557	USB	USB	TX/RX
73	12.007	12.007	LSB	LSB	TX/RX
74	9.337	9.337	LSB	LSB	TX/RX
75	11.117	11.117	LSB	LSB	TX/RX
76	6.447	6.447	USB	USB	TX/RX
77	5.227	5.227	USB	USB	TX/RX
78	3.667	3.667	LSB	LSB	TX/RX
79	7.887	7.887	USB	USB	TX/RX
80	29.998	29.998	USB	USB	TX/RX
81	2.558	2.558	LSB	LSB	TX/RX
82	4.558	4.558	USB	USB	TX/RX
83	12.008	12.008	LSB	LSB	TX/RX
84	9.338	9.338	LSB	LSB	TX/RX
85	11.118	11.118	LSB	LSB	TX/RX
86	6.448	6.448	USB	USB	TX/RX
87	5.228	5.228	USB	USB	TX/RX
88	3.668	3.668	LSB	LSB	TX/RX
89	7.888	7.888	USB	USB	TX/RX
90	29.999	29.999	USB	USB	TX/RX
91	2.559	2.559	LSB	LSB	TX/RX
92	4.559	4.559	USB	USB	TX/RX
93	12.009	12.009	LSB	LSB	TX/RX
94	9.339	9.339	LSB	LSB	TX/RX
95	11.119	11.119	LSB	LSB	TX/RX

Table C-27.1. Channel Data Programming Information (continued)

Channel	Frequency TX (MHz)	Frequency RX (MHz)	TX Mode	RX Mode	TX/RX
96	6.449	6.449	USB	USB	TX/RX
97	5.229	5.229	USB	USB	TX/RX
98	3.669	3.669	LSB	LSB	TX/RX
99	7.889	7.889	USB	USB	TX/RX

Table C-27.2. Address Programming Information for System A

Self Address		Other Station Address		Net Address	
	Address		**Address**		**Address**
	A01		B01		NA1
	A02		B02		NA2
	A03		B03		NA3
	A04		B04		NA4
	A01		C01		NA5
	A02		C02		NA6
	A03		C03		NA7
	A04		C04		NA8
	A01		D01		NA9
	A02		D02		NA10
	A03		D03		NA11
	A04		D04		NA12
	A01		E01		NA13
	A02		E02		NA14
	A03		E03		NA15
	A04		E04		NA16
	A01		F01		NA17
	A02		F02		NA18
	A03		F03		NA19
	15CHARACTERSELF		F04		NA20

Table C-27.3. Address Programming Information for System B

Self Address		Other Station Address		Net Address	
	Address		**Address**		**Address**
	B01		A01		NA1
	B02		A02		NA2
	B03		A03		NA3
	B04		A04		NA4
	B01		C01		NA5
	B02		C02		NA6
	B03		C03		NA7
	B04		C04		NA8
	B01		D01		NA9
	B02		D02		NA10
	B03		D03		NA11
	B04		D04		NA12
	B01		E01		NA13
	B02		E02		NA14
	B03		E03		NA15
	B04		E04		NA16
	B01		F01		NA17
	B02		F02		NA18
	B03		F03		NA19
	B04		F04		NA20

Table C-27.4. Address Programming Information for System C

Self Address		Other Station Address		Net Address	
	Address		**Address**		**Address**
	C01		A01		NA1
	C02		A02		NA2
	C03		A03		NA3
	C04		A04		NA4
	C01		B01		NA5
	C02		B02		NA6
	C03		B03		NA7
	C04		B04		NA8

Table C-27.4. Address Programming Information for System C (continued)

Self Address		Other Station Address		Net Address	
	Address		Address		Address
	C01		D01		NA9
	C02		D02		NA10
	C03		D03		NA11
	C04		D04		NA12
	C01		E01		NA13
	C02		E02		NA14
	C03		E03		NA15
	C04		E04		NA16
	C01		F01		NA17
	C02		F02		NA18
	C03		F03		NA19
	C04		F04		NA20

Table C-27.5. Net Address and Member Programming Information

Net Address	Slot 1 Address	Slot 2 Address	Slot 3 Address	Slot 4 Address	Slot 5 Address	Slot 6 Address
NA1	A01	B01	C01	D01	E01	F01
NA2	A02	B02	C02	D02	E02	F02
NA3	A03	B03	C03	D03	E03	F03
NA4	A04	B04	C04	D04	E04	F04

Table C-27.6. Group Address Non-Slotted Members Programming Information

Group Address	Member 1 Address	Member 2 Address	Member 3 Address	Member 4 Address	Member 5 Address
G01	A01	B01	C01	D01	E01
G02	A01	B01	C01	D01	E01
G03	A01	B01	C01	D01	E01
G04	A01	B01	C01	D01	E01
Note: The Unit Under Test is not required to store group addresses in memory.					

c. Test Configuration. Configure the equipment as shown in figure C-27.1.

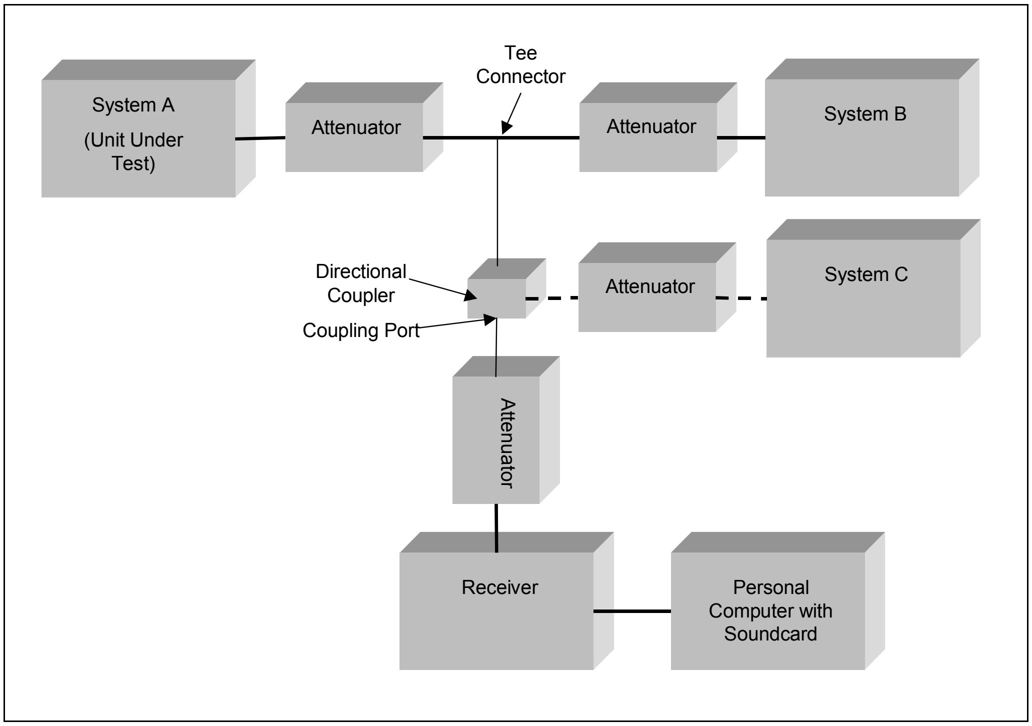

Figure C-27.1. Equipment Configuration for Memory Subtest

d. Test Conduct. The procedures for this subtest are listed in tables C-27.7 through C-27.10.

Table C-27.7. Procedures for Channel Memory

Step	Action	Settings/Action	Result
The following procedure is for reference number 57.			
1	Set up equipment.	See figure C-27.1.	
2	Program all 3 radios with channel information contained in table C-27.1.	Review UUT channel information. Record observations. Expected: UUT stores all channel information from table C-27.1.	
3	Power down system A, and disconnect main power source. Wait for a minimum of 1 hour.		
4	Power up system, review all preprogrammed channels, and record observations.	Expected: UUT should retain all channel information.	
5	Recall channel 20. Change modulation of UUT to LSB for both TX and RX.	The radio should be capable of having this information altered without affecting the original stored information setting.	
6	Recall channel 20, again.	Record the modulation mode of the UUT. Expected: USB	
Legend: ALE – Automatic Link Establishment; LSB – Lower Sideband; TX – Transmit; RX – Receive; USB – Upper Sideband; UUT – Unit Under Test			

Table C-27.8. Procedures for Self Address Memory

Step	Action	Settings/Action	Result
The following procedure is for reference numbers 58, 60, and 84.			
1	Set up equipment.	See figure C-27.1.	
2	Program system A with information contained in table C-27.2. Net addressing information shall include (for each "net member" self address, as necessary) the associated slot wait time.		Record on data collection form, pages D-37, and D-39.
3	Power down system A, and disconnect main power source. Wait for a minimum of 1 hour.		
4	Power up system, review all preprogrammed channels, and verify that the UUT has retained all self-address memory information.	Record observations.	
5	Configure the PC to record audio files in WAV format.	All WAV files must be sampled at 44.1 kHz, 16 bits, mono.	
6	Place net call.	System A (callsign: A01) places a net call to address NA1. Radios should be scanning channels 1 through 10. Do not request LQA, or any CMDs. Record call.	
7	Use wave editor software to review the captured WAV file. A program such as Creative Labs Wave studio™ should be used.	Use software to measure the slot wait times of the call placed in the previous step. Expected slot wait times: $T_{swt}(SN) = T_{sw} \times SN$ where T_{sw} (min) = $14T_w$ = 1,829.33 msec (for standard replies). Also, measure the net wait for reply time. Expected net wait for reply time: $T_{wrn} = T_{swt}(NS)$.	
8	Place Net call with LQA request.	System A (callsign: A01) places a net call to address NA1. System A should request LQA information. Radios should be scanning channels 1 through 10. Record call.	
9	Use wave editor software to review the captured WAV file.	Use software to measure the slot wait times of the call placed in the previous step. Expected slot wait times: $T_{swt}(SN) = T_{sw} \times SN$ where T_{sw} = $17T_w$ = 2221.33 msec (for LQA replies). Also, measure the net wait for reply time. Expected net wait for reply time: $T_{wrn} = T_{swt}(NS)$.	

Legend: ALE – Automatic Link Establishment; CMD – Command; kHz – kilohertz; LQA – Link Quality Analysis; msec – milliseconds; min – minimum; NS – total number of slots (including slot 0); PC – Personal Computer; SN – Slot Number

Table C-27.9. Procedures for Other Address Memory

Step	Action	Settings/Action	Result
The following procedure is for reference numbers 59, and 60.			
1	Set up equipment.	See figure C-27.1.	
2	Program all 3 radios with information contained in tables C-27.1 through C-27.6.		
3	After programming is complete, exercise the network by making 35 net calls, 35 group calls, and 35 sounding calls. Stations in the network should link up.		
4	Review individual, net, and group information for any information that was not previously programmed and verify that the UUT has retained all preprogrammed net, and group address memory information.	Radio should be capable of storing, retrieving, and employing at least 100 different sets of information concerning the addresses of other stations and nets including channel quality data and equipment settings specific to links with each station or net.	Record on data collection form, pages D-37, and D-39.
5	Power down system A, and disconnect main power source. Wait for a minimum of 1 hour.		
6	Power up system and review all channels to ensure that the UUT has retained all other address memory information.	Record observations.	
Legend: ALE – Automatic Link Establishment; UUT – Unit Under Test			

Table C-27.10. Procedures for Message Memory

Step	Action	Settings/Action	Result
The following procedure is for reference number 63.			
1	Set up equipment.	See figure C-27.1.	
2	Program 12 messages of varying length into the UUT totaling at least 1000 characters.	UUT should be capable of storing a total capacity of at least 1000 characters. Record observations of the storage capacity of the UUT.	
3	Power down system A, and disconnect main power source. Wait for a minimum of 1 hour.		
4	Power up system and review memory to ensure that the UUT has retained all memory information.	***Record observations.***	
Legend: ALE – Automatic Link Establishment; UUT – Unit Under Test			

C-27.4 Presentation of Results. The results will be shown in tabular format (table C-27.11) indicating the requirement and measured value or indications of capability.

Table C-27.11. Memory Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
57	A.4.3.1	Channel Memory. The equipment shall be capable of storing, retrieving, and employing at least 100 different sets of information concerning channel data to include receive and transmit frequencies with associated mode information. See table A-III of MIL-STD-188-141B.	UUT stores information from table C-27.1.			
		The channel data storage shall be nonvolatile.	Retain channel data for 1 hour.			
		Any channel (a) shall be capable of being recalled manually or under the direction of any associated automated controller, and (b) shall be capable of having its information altered after recall without affecting the original stored information settings.	Channel 20 recalled. UUT in USB mode.			
58	A.4.3.2	Self Address Memory. The radio shall be capable of storing, retrieving, and employing at least 20 different sets of information concerning self addressing.	UUT stores information from table C-27.2.			
		The self-address information storage shall be nonvolatile. These sets of information include self (its own personal) address(es), valid channels which are associated for use, and net addressing.	Retain information for 1 hour.			
		Net addressing information shall include (for each "net member" self address, as necessary) the net address and the associated slot wait time (in multiples of T_w). See table A-IV and A.5.5.4.1. The slot wait time values are T_{swt}(slot number (SN)) from the formula, T_{swt} (SN) = T_{sw} x SN .	Net information: address, and slot wait time. T_{swt} (SN) = T_{sw} x SN			

Table C-27.11. Memory Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
59	A.4.3.3	Other Station Table. The radio shall be capable of storing, retrieving, and employing at least 100 different sets of information concerning the addresses of other stations and nets, channel quality data to those stations and nets (measurements or predictions), and equipment settings specific to links with each station or net.	UUT stores information from tables C-27.1 through C-27.6.			
60	A.4.3.3.1	Other Station Address Storage. Individual station addresses shall be stored in distinct table entries, and shall be associated with a specific wait for reply time (T_{wr}) if not the default value.	UUT stores information from tables C-27.1 through C-27.6.			
		Net information shall include own net and net member associations, relative slot sequences, and own net wait for reply times (T_{wrn}) for use when calling. See figure A-4.	Net information includes associations, and wait for reply times.			
		The storage for addresses and settings shall be nonvolatile.	Retain address and setting information for 1 hour.			

Table C-27.11. Memory Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
63	A.4.3.5	Message Memory. Storage for preprogrammed, operator entered, and incoming messages shall be provided in the equipment. This storage shall be retained in memory for not less than one hour during power down or loss of primary power. Storage for at least 12 messages (DO: 100 messages), and a total capacity of at least 1000 characters (DO: 10,000 characters) shall be provided.	Retain memory for 1 hour.			
84	A.5.2.4.1	Introduction. The ALE system deploys a digital addressing structure based upon the standard 24-bit (three character) word and the Basic 38 character subset. As described below, ALE stations have the capability and flexibility to link or network with one or many prearranged or as-needed single or multiple stations. All ALE stations shall have the capacity to store and use at least 20 self addresses of up to 15 characters each in any combination of individual and net calls. There are three basic addressing methods which will be presented: Individual station Multiple station Special modes	UUT stores and uses at least 20 self addresses, 15 characters each.			
Legend: DO – Design Objective; SN – slot number; Tw – Word Time; Tswt – Slot Wait Time						

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C-28 SUBTEST 28, SCANNING

C-28.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 48, 50, and 62.

C-28.2 Criteria

a. Scanning. The radio system shall be capable of repeatedly scanning selected channels stored in memory (in the radio or controller) under either manual control or under the direction of any associated automated controller. The radio shall stop scanning and wait on the most recent channel upon the occurrence of any of the following selectable events: automatic controller decision to stop scan (the normal mode of operation), manual input of stop scan, and activation of external stop-scan line (if provided). The scanned channels should be selectable by groups (often called "scan lists"), and also individually within the groups, to enable flexibility in channel and network scan management, MIL-STD-188-141B, paragraph A.4.1.2.

b. Scanning Rate. Stations designed to this appendix shall incorporate selectable scan rates of two and five channels per second, and may also incorporate other scan rates DO: 10 channels per second), MIL-STD-188-141B, paragraph A.4.2.1.

c. The following ALE operating parameters shall be programmable by the operator or an external automated controller. Complete definitions of the parameters are provided in appendix H of MIL-STD-188-141B.

ScanRate	RequestLQA	OtherAddr	LqaStatus
MaxScanRate	AutoPowerAdj	OtherAddrStatus	LqaAge
MaxTuneTime	SelfAddrTable	OhterAddrNetMembers	LqaMultipath
TurnAroundTime	SelfAddrEntry	OtherAddrValidChannels	LqaSINAD
ActivityTimeout	SelfAddr	OtherAddrAnt	LqaBer
AcceptAnyCall	SelfAddrStatus	OtherAddrAntAzimuth	ScanSet
AcceptAllCall	NetAddr	OtherAddrPower	ConnectionTable
AcceptAMD	SlotWaitTime	LqaMatrix	Connection Addr
AcceptDTM	SelfAddrValidChannels	LqaEntry	ConnectedStatus
AcceptDBM	OtherAddrEntry	LqaChannel	

(MIL-STD-188-141B, paragraph A.4.3.4, Operating Parameters)

C-28.3 Test Procedures

a. Test Equipment Required

(1) Oscilloscope

(2) Attenuator

(3) Signal Generators

(4) Combiner

(5) UUT plus one additional outstation

b. Test Configuration. Configure the equipment as shown in figures C-28.1 and C-28.2.

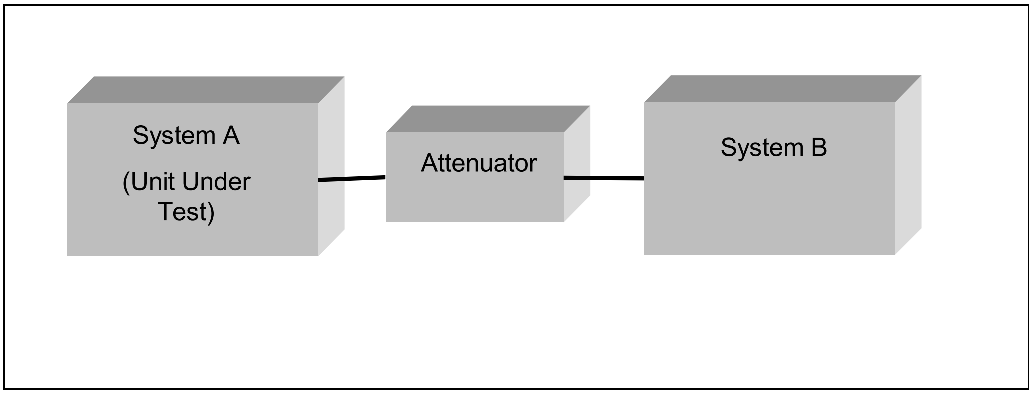

Figure C-28.1. Equipment Configuration for Scan Subtest

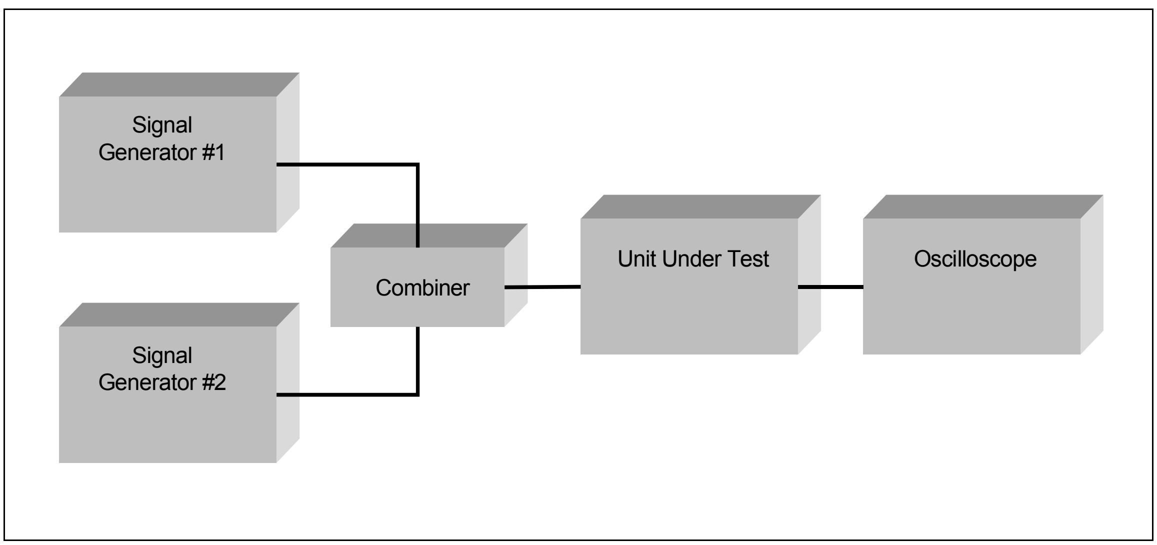

Figure C-28.2. Equipment Configuration for Scan Rate Test

c. Test Conduct. The procedures for this subtest are listed in table C-28.1.

Table C-28.1. Procedures for Scan Subtest

Step	Action	Settings/Action	Result
The following procedure is for reference number 48.			
1	Set up equipment.	See figure C-28.1.	
2	Program system A in accordance with table 27.1 and 27.2.		
3	Program system B in accordance with tables 27.1 and 27.3.		
4	Place UUT in scan mode.		
5	Program/select five channels to scan.	Observe system's ability to scan these selected channels. Record observations.	
6	Program/select ten channels to scan.	Observe system's ability to scan these selected channels. Record observations.	
7	Program/select twenty channels to scan.	Observe system's ability to scan these selected channels. Record observations.	
8	Continue adding channels in increments of ten until maximum channel capacity is reached.	Observe the system's ability to scan these selected channels. Record the minimum and maximum scan set capacity.	Min: Max:
9	Research the vendor's operation/programming procedures to determine if scanned channels are selectable by groups.	Record the maximum number of channels per group, and the maximum number of groups.	Max Channels/Group: Max Groups:
10	Manually program the radio to stop scanning.	The radio should stop scanning and wait on the most recent channel. Record the channel number that the UUT stops on.	
11	If the UUT provides an external stop-scan line, program the radio to stop scanning using this external line.	The radio should stop scanning and wait on the most recent channel. Record the channel number that the UUT stops on.	

Table C-28.1. Procedures for Scan Subtest (continued)

Step	Action	Settings/Action	Result
The following procedure is for reference number 62.			
12	Research the vendor's operation/programming procedures to verify that each of the following ALE operating parameters are programmable by the operator or an external automated controller: ScanRate; RequestLQA MaxScanChan; AutoPowerAdj MaxTuneTime; SelfAddrTable; LqaAge TurnAroundTime; SelfAddrEntry; LqaMultipath ActivityTimeout; SelfAddr; LqaSINAD ListenTime; SelfAddrStatus; LqaBER AcceptAnyCall; NetAddr; ScanSet AcceptAllCall; SlotWaitTime AcceptAMD; SelfAddrValidChannels AcceptDTM; OtherAddrTable AcceptDBM; OtherAddrEntry OtherAddrValidChannels; OtherAddr OtherAddrAnt; OtherAddrStatus OtherAddrAntAzimuth; OtherAddrNetMembers OtherAddrPower; LqaStatus LqaMatrix; ConnectionTable LqaEntry; ConnectionEntry; ConnectedAddr LqaAddr; ConnectionStatus; LqaChannel	List any operating parameters that are NOT programmable.	
The following procedure is for reference number 50.			
13	Set up equipment	See figure C-28.2.	
14	Program UUT to scan channels one and two (2.6550 MHz and 4.550 MHz).	Set up signal generators: Generator #1: 2.6550 MHz - 500 Hz Generator #2: 4.550 MHz + 2120 Hz	
15	Set up oscilloscope.	Horizontal scale: 500 msec/div	
16	Program UUT to scan two channels per second.	The oscilloscope display should switch between a 500-Hz sinusoid and a 2120--Hz sinusoid as the UUT scans these two channels.	
17	Using the run/stop button and the vertical delta markers on the oscilloscope, measure the length of time taken for the UUT to scan two channels.		

Table C-28.1. Procedures for Scan Subtest (continued)

Step	Action	Settings/Action	Result
18	Program the UUT to scan five channels per second.	Using the run/stop button and the vertical delta markers on the oscilloscope, measure the length of time taken for the UUT to scan five channels.	
19	Repeat step 6 for any other scan rate available.		
Legend: ALE – Automatic Link Establishment; Hz – Hertz; MHz – megahertz; msec – millisecond; UUT – Unit Under Test			

C-28.4 Presentation of Results. The results will be shown in tabular format (table C-28.2) indicating the requirement and measured value or indications of capability.

Table C-28.2. Scan Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
48	A.4.1.2	Scanning. The radio system shall be capable of repeatedly scanning selected channels stored in memory (in the radio or controller) under either manual control or under the direction of any associated automated controller.	Scan channels selected in steps 5 through 8 of table C-28.1.			
		The radio shall stop scanning and wait on the most recent channel upon the occurrence of any of the following selectable events: 1. Automatic controller decision to stop scan (the normal mode of operation) 2. Manual input of stop scan 3. Activation of external stop-scan line (if provided)	Stop scanning during: a) Automatic controller decision to stop scan. b) Manual input of stop scan. c) Activation of external stop-scan line (if provided).			
		4. The scanned channels should be selectable by groups (often called "scan lists") and also individually within the groups, to enable flexibility in channel and network scan management.	Scanned channels selectable by groups and individually within the group.			
50	A.4.2.1	Scanning Rate. Stations designed to this appendix shall incorporate selectable scan rates of two and five channels per second, and may also incorporate other scan rates (Design Objective (DO): 10 channels per second).	Scan: 2 channels per second, 5 channels per second			

Table C-28.2. Scan Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
62	A.4.3.4	Operating parameters. The following ALE operating parameters shall be programmable by the operator or an external automated controller. Complete definitions of the parameters are provided in appendix H. ScanRate RequestLQA MaxScanChan AutoPowerAdj MaxTuneTime SelfAddrTable LqaAge TurnAroundTime SelfAddrEntry LqaMultipath ActivityTimeout SelfAddr LqaSINAD ListenTime SelfAddrStatus LqaBER AcceptAnyCall NetAddr ScanSet AcceptAllCall SlotWaitTime AcceptAMD SelfAddrValidChannels AcceptDTM	Operating parameters identified in MIL-STD-188-141B paragraph A.4.3.4 are available and programmable.			

Table C-28.2. Scan Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
62 (continued)	A.4.3.4	OtherAddrTable AcceptDBM OtherAddrEntry OtherAddrValidChannels OtherAddr OtherAddrAnt OtherAddrStatus OtherAddrAntAzimuth OtherAddrNetMembers OtherAddrPower LqaStatus LqaMatrix ConnectionTable LqaEntry ConnectionEntry ConnectedAddr LqaAddr ConnectionStatus LqaChannel	Operating parameters identified in MIL-STD-188-141B paragraph A.4.3.4 are available and programmable.			
Legend: ALE – Automatic Link Establishment; DO – Design Objective; MIL-STD – Military Standard						

C-29 SUBTEST 29, WAVEFORM

C-29.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 65, 66, and 67.

C-29.2 Criteria

a. Tones. The waveform shall be an 8-ary frequency shift-keying (FSK) modulation with eight orthogonal tones, one tone (or symbol) at a time. Each tone shall represent three bits of data as follows (least significant bit (LSB) to the right):

750 Hz	000
1000 Hz	001
1250 Hz	011
1500 Hz	010
1750 Hz	110
2000 Hz	111
2250 Hz	101
2500 Hz	100

The transmitted bits shall be encoded and interleaved data bits constituting a word, as described in paragraphs A.5.2.2 and A.5.2.3. The transitions between tones shall be phase continuous and shall be at waveform maxima or minima (slope zero), MIL-STD-188-141B, paragraph A.5.1.2.

b. Timing. The tones shall be transmitted at a rate of 125 tones (symbols) per second, with a resultant period of 8 msec per tone. Figure A-5 shows the frequency and time relationships. The transmitted bit rate shall be 375 bits per second (bps). The transitions between adjacent redundant (tripled) transmitted words shall coincide with the transitions between tones, resulting in an integral 49 symbols (or tones) per redundant (tripled) word. The resultant single word period (T_w) shall be 130.66... msec (or 16.33... symbols), and the triple word (basic redundant format) period (3 T_w) shall be 392 msec, MIL-STD-188-141B, paragraph A.5.1.3.

c. Accuracy. At baseband audio, the generated tones shall be within $\pm$1.0 Hz. At RF, all transmitted tones shall be within the range of 2.0 dB in amplitude. Transmitted symbol timing, and, therefore, the bit and word rates shall be within ten parts per million, MIL-STD-188-141B, paragraph A.5.1.4.

C-29.3 Test Procedures

a. Test Equipment Required

(1) Oscilloscopes

(2) Attenuators

(3) PC with Soundcard

(4) Receiver monitoring 12.000 MHz, USB

(5) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figures C-29.1, C-29.2, and C-29-3.

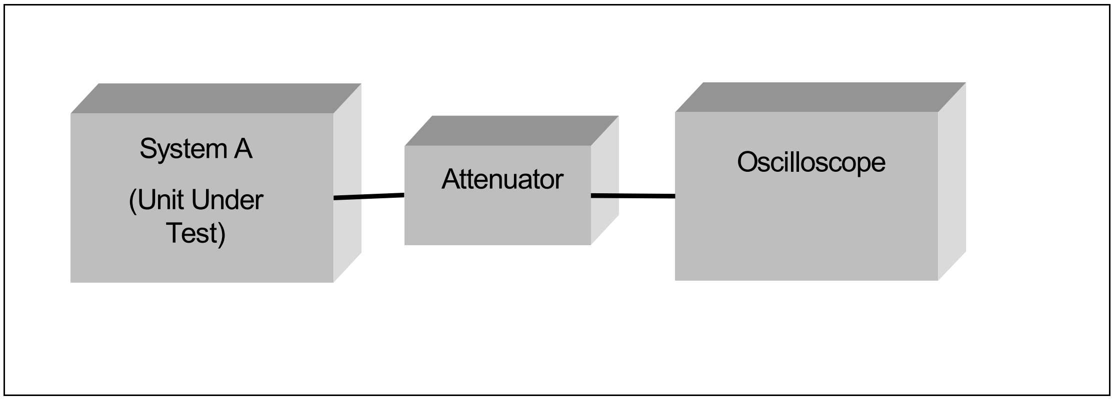

Figure C-29.1. Equipment Configuration for Tone Amplitude

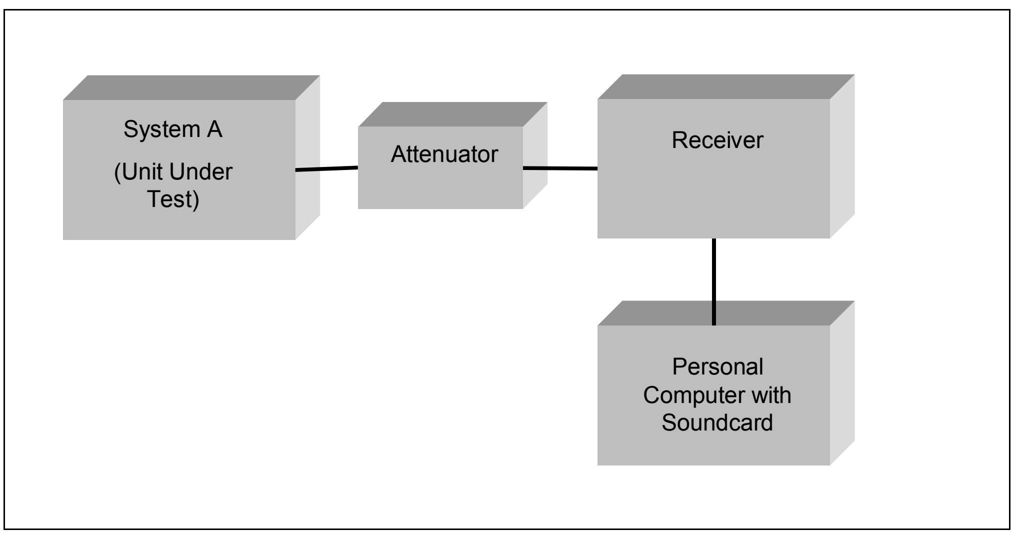

Figure C-29.2. Equipment Configuration for Waveform Subtest

c. Test Conduct. The procedures for this subtest are listed in table C-29.1.

Table C-29.1. Procedures for Waveform Subtest

Step	Action	Settings/Action	Result
The following procedure is for reference number 67.			
1	Set up equipment as shown in figure C-29.1.	Program radios in accordance with tables C-27.1 through C-27.6.	
2	Set up oscilloscope.	Channel 1: 5 mV/div, 200 μs/div	
3	Initialize the transmitter for single channel operation.		
4	Initiate an ALE call from system A (callsign: A01) to individual address B01.	Capture the waveform from the call on the oscilloscope.	
5	Measure and record the peak-to-peak amplitude of each of the transmitted tones (at RF) using the horizontal markers on the oscilloscope.	Print the oscilloscope display.	750-Hz tone: 1000-Hz tone: 1250-Hz tone: 1500-Hz tone: 1750-Hz tone: 2000-Hz tone: 2250-Hz tone: 2500-Hz tone: Plot Number:

Table C-29.1. Procedures for Waveform Subtest (continued)

Step	Action	Settings/Action	Result
6	Use the following formula to find the difference (in dB) of the highest amplitude tone (in volts) and the lowest amplitude tone (in volts): $20LOG_{10}(V_{high}/V_{low})$ = Difference in dB For example: If the tone with the highest amplitude tone has a peak-to-peak voltage of 20.6mV, and the tone with the lowest amplitude tone has a peak-to-peak voltage of 16.4mV, then the amplitude difference in dB is calculated as follows: $20LOG_{10}(20.6/16.4) = 1.98$ dB	Record the difference between the highest amplitude tone and the lowest amplitude tone.	
7	Set up equipment as shown in figure C-29.2.		
8	Configure the personal computer to record audio files in WAV format.	All WAV files must be sampled at 44.1 kHz, 16 bits, mono.	
9	Initiate an ALE call from system A (callsign: A01) to individual address B01. Record call in WAV format.	Use wave editor software to review the captured WAV file. A program such as Creative Labs Wave studio™ should be used to measure the period of each tone, and use this to calculate frequency. (Note: frequency = 1/period)	750-Hz tone: 1000-Hz tone: 1250-Hz tone: 1500-Hz tone: 1750-Hz tone: 2000-Hz tone: 2250-Hz tone: 2500-Hz tone:
The following procedure is for reference number 65.			
10	Set up equipment as shown in figure C-29.2.		
11	Configure the personal computer to record audio files in WAV format.	All WAV files must be sampled at 44.1 kHz, 16 bits, mono.	
12	Initiate an ALE call from system A (callsign: A01) to individual address B01.		

Table C-29.1. Procedures for Waveform Subtest (continued)

Step	Action	Settings/Action	Result
13	At the receiver audio output, use the PC to record the complete set of tones in WAV format.	Record file name.	
14	Recall WAV file using wave editor software to view the signal in the time domain. Set frame size to produce a 64-msec window. Use this to determine frequency accuracy and transmission rate.	The transition between tones should be phase continuous and occur at waveform maxima or minima. Record waveform observations.	
The following procedure is for reference numbers 66 and 67.			
15	Set frame size to produce an 8-msec window. Observe one frame at each of the eight different frequencies. This will be used to determine frequency and time relationships.	There should be a period of 8 msec per tone. This gives 125 tones (symbols) per second and a bit rate of 375 bits per second. This gives a triple word period of 392 msec. Record the tone period. If the tone period is not 8 msec, also record the number of tones per second, the bit rate, and the triple word period.	Tone period:
The following procedure is for reference number 65.			
16	Use ALEOOWPP software to decode WAV file. ALEOOWPP software and instructions are available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm.	The ALEOOWPP software will be used to decode the call. Successful decode verifies that the waveform is 8-ary frequency shift-keyed modulation with eight orthogonal tones, one tone (or symbol) at a time. It also verifies that each tone is representing three bits of data, and the encoding and interleaving is in accordance with MIL-STD-188-141B. Record results of WAV file decode.	
Legend: ALE – Automatic Link Establishment; dB – decibel; div – division; Hz – hertz; JITC – Joint Interoperability Test Command; kHz – kilohertz; LQA – Link Quality Analysis; MIL-STD – Military Standard; msec – millisecond; mV – millivolt; PC – Personal Computer; RF – Radio Frequency; V – Volt; WAV – Wave			

C-29.4 Presentation of Results. The results will be shown in tabular format (table C-29.2) indicating the requirement and measured value or indications of capability.

Table C-29.2. Waveform Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
65	A.5.1.2	<u>Tones</u>. The waveform shall be an 8-ary frequency shift-keying (FSK) modulation with eight orthogonal tones, one tone (or symbol) at a time. Each tone shall represent three bits of data as follows (least significant bit (LSB) to the right): 750 Hz 000 1000 Hz 001 1250 Hz 011 1500 Hz 010 1750 Hz 110 2000 Hz 111 2250 Hz 101 2500 Hz 100 The transmitted bits shall be encoded and interleaved data bits constituting a word, as described in paragraphs A.5.2.2 and A.5.2.3.	Successful WAV file decode with ALEOOWPP: TO A01 (repeated) TIS B01.			
		The transitions between tones shall be phase continuous	Phase continuous.			
		and shall be at waveform maxima or minima (slope zero).	Maxima/ minima			
66	A.5.1.3	<u>Timing</u>. The tones shall be transmitted at a rate of 125 tones (symbols) per second, with a resultant period of 8 msec per tone. Figure A-5 shows the frequency and time relationships. The transmitted bit rate shall be 375 bits per second (bps). The transitions between adjacent redundant (tripled) transmitted words shall coincide with the transitions between tones, resulting in an integral 49 symbols (or tones) per redundant (tripled) word. The resultant single word period (T_w) shall be 130.66... msec (or 16.33... symbols), and the triple word (basic redundant format) period (3 T_w) shall be 392 msec.	Period of 8 msec per tone. Successful WAV file decode with ALEOOWPP: TO AAA (repeated) TIS BBB.			

Table C-29.2. Waveform Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
67	A.5.1.4	Accuracy. At baseband audio, the generated tones shall be within ±1.0 Hz. At RF, all transmitted tones shall be within the range of 2.0 dB in amplitude. Transmitted symbol timing, and therefore, the bit and word rates shall be within ten parts per million.	Audio tones: within ±1.0 Hz; within 2.0 dB. Symbol timing: within 10 ppm			
Legend: bps – bits per second; dB – decibels; FSK – Frequency Shift Keying; Hz – hertz; LSB – Lower Sideband; MIL-STD – Military Standard; msec – millisecond; ppm – parts per million; RF – Radio Frequency; Tw – Slot Wait Time						

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C-30 SUBTEST 30, LINK ESTABLISHMENT

C-30.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 54.

C-30.2 Criteria. Linking attempts made with a test setup configured as shown in figure A-3, using the specified ALE signal created in accordance with this appendix, shall produce a probability of linking as shown in MIL-STD-188-141B table A-II.

The receive audio input to the ALE controller shall be used to simulate the three channel conditions. The modified International Radio Consultative Committee (CCIR) good channel shall be characterized as having 0.52 msec (modified from 0.50 ms) Multipath (MP) delay and a fading (two sigma) bandwidth of 0.1 Hz. The modified CCIR poor channel, normally characterized as consisting of a circuit having 2.0 msec MP delay with a fading (two sigma) bandwidth of 1.0 Hz, shall be modified to have 2.2 msec MP delay and a fading (two sigma) bandwidth of 1.0 Hz. Doppler shifts of ±60 Hz shall produce no more than a 1.0-dB performance degradation from the requirements of table A-II for the modified CCIR good and poor channels.

NOTE: This modification is necessary because the constant 2-msec MP delay (an unrealistic fixed condition) of the CCIR poor channel results in a constant nulling of certain tones of the ALE tone library. Other tone libraries would also have some particular MP value, which would result in continuous tone cancellation during simulator testing.

Each of the signal-to-noise (SNR) ratio values shall be measured in a nominal 3-kHz bandwidth. Performance tests of this capability shall be conducted in accordance with ITU-R F.520-2, Use of High Frequency Ionospheric Channel Simulators employing the C.C. Watterson Model. This test shall use the individual scanning calling protocol described in paragraph A.5.5.3. The time for performance of each link attempt shall be measured from the initiation of the calling transmission until the successful establishment of the link. Performance testing shall include the following additional criteria:

a. The protocol used shall be the individual scanning calling protocol with only TO and TIS preambles.

b. Addresses used shall be alphanumeric, one word (three characters) in length from the 38-character basic American Standard Code for Information Interchange (ASCII) subset.

c. UUTs shall be scanning 10 channels at two channels per second, and repeated at five channels per second.

d. Call initiation shall be performed with the UUT transmitter stopped and tuned to the calling frequency.

e. Maximum time from call initiation (measured from the start of UUT RF transmission, not from activation of the ALE protocol) to link establishment shall not exceed 14.000 seconds, plus simulator delay time. The call shall not exceed 23 redundant words; the response three redundant words; and the acknowledgement , three redundant words (see paragraph A.5.2.2.4 and annex A).

NOTE: Performance at the higher scan rates shall also meet the foregoing requirements and shall meet or exceed the probability of linking as shown in table A-II, MIL-STD-188-141B, paragraph A.4.2.3.

Table 30.1. Probability of Linking

Signal-to-Noise Ratio (dB in 3 kHz)			
Probability of Linking (PL)	Gaussian Noise Channel	Modified CCIR Good Channel	Modified CCIR Poor Channel
≥ 25% ≥ 50% ≥ 85% ≥ 95%	-2.5 -1.5 -0.5 0.0	+0.5 +2.5 +5.5 +8.5	+1.0 +3.0 +6.0 +11.0
Multipath (millisecond) Doppler spread (hertz)	0.0 0.0	0.52 0.10	2.2 1.0
Legend: CCIR – International Radio Consultative Committee; dB – decibels; kHz – kilohertz; PL – Probability of Linking			

C-30.3 Test Procedures

a. Test Equipment Required

(1) Channel Simulator

(2) Transmitters/Receivers

(3) PC with Soundcard

(4) Attenuators

(5) Spectrum Analyzer

(6) Directional Coupler

(7) UUT plus one additional outstation

b. Test Configuration. Configure the equipment as shown in figure C-30.1.

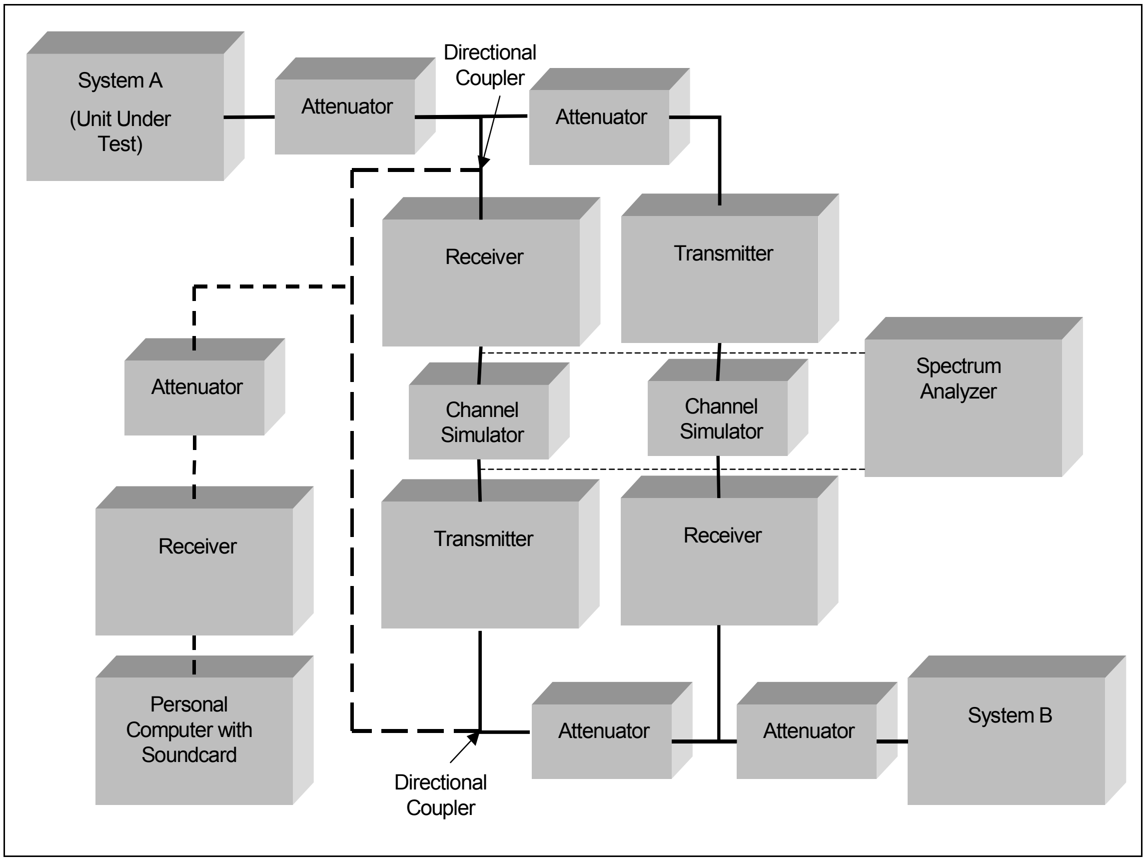

Figure C-30.1. Equipment Configuration for Link Establishment

c. Test Conduct. The procedures for this subtest are listed in table C-30.2.

Table C-30.2. Procedures for Link Establishment Subtest

Step	Action	Settings/Action	Result
The following procedure is for reference number 54.			
1	Set up equipment as shown in figure C-30.1.	Program radios in accordance with tables C-27.1 through C-27.6.	
2	Command LQA should be off.		
3	Establish 0-dB input level into the channel simulators.	Use spectrum analyzer to measure level.	
4	Configure simulator for Gaussian noise.	Simulator settings: Single path Signal-to-Noise Ratio: See table C-30.1. Multipath 0.0 milliseconds (msec) Fading Bandwidth: 0.0 Hz	

Table C-30.2. Procedures for Link Establishment Subtest (continued)

Step	Action	Settings/Action	Result
5	Program the UUT is scanning channels 1 through 10 at the rate of two channels per second.		
6	Initiate an individual ALE call from system A (callsign: ABC) to system B (callsign: DEF).	Record success/failure of linking attempt.	Record on data collection form, pages D-41 through D-47.
7	Configure the personal computer to record audio files in WAV format. Record the first call. The length of the transmitted call for the first completed linking attempt must be measured. (Use WAV editor software to view and quantify the length of the call.)	Measure the total link establishment time for the first completed linking attempt. The time for performance of the link attempt shall be measured from the initiation of the calling transmission until the successful establishment of the link. Verify that the link establishment time does not exceed 14.000 seconds, plus simulator delay time.	Record on data collection form, pages D-41 through D-47.
8	When linking is complete, terminate the link. Ensure that the receiving ALE returns to scan.		
9	Repeat steps 6 through 8 an additional 99 times.		
10	Repeat steps 5 through 9 for each Gaussian SNR (see table A-II).		
11	Configure simulator for the modified CCIR Good channel.	Simulator settings: Two paths SNR: See table A-II. Multipath: 0.52 msec (second channel only) Fading Bandwidth: 0.1 Hz	
12	Repeat steps 5 through 9 for each CCIR Good SNR (see table A-II).		
13	Configure simulator for the modified CCIR Poor channel.	Simulator settings: Two paths SNR: See table A-II. Multipath: 2.2 msec (second channel only) Fading Bandwidth: 1.0 Hz	
14	Repeat steps 5 through 9 for each CCIR Poor SNR (see table A-II).		
15	If linking protection has been implemented, steps 1 through 14 must be repeated with linking protection turned on (see subtest 53.)		
Legend: ALE – Automatic Link Establishment; CCIR – International Radio Consultative Committee; dB – decibel; Hz – hertz; kHz – kilohertz; LQA – Link Quality Analysis; MHz – megahertz; msec – millisecond; RF – Radio Frequency; SNR – Signal to Noise Ratio; UUT – Unit Under Test; WAV – Wave			

C-30.4 Presentation of Results. The results will be shown in tabular format (table C-30.3) indicating the requirement and measured value or indications of capability.

Table C-30.3. Link Establishment Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
54	A.4.2.3	Linking attempts made with a test setup configured as shown in figure A-3, using the specified ALE signal created in accordance with this appendix, shall produce a probability of linking as shown in table A-II.	Probability of linking as shown in table A-II.			
		Maximum time from call initiation (measured from the start of UUT RF transmission -- not from activation of the ALE protocol) to link establishment shall not exceed 14.000 seconds, plus simulator delay time. NOTE: Performance at the higher scan rates shall also meet the foregoing requirements and shall meet or exceed the probability of linking as shown in table A-II.	Link establish-ment time ≤ 14.000 seconds, plus simulator delay time.			

Legend: ALE – Automatic Link Establishment; MIL-STD – Military Standard; RF – Radio Frequency; UUT – Unit Under Test

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C-31 SUBTEST 31, LQA OPERATION

C-31.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 49, 61, 105, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, and 119.

C-31.2 Criteria

a. Channel Quality Display. If an operator display is provided, the display shall have a uniform scale, 0-30 with 31 being unknown, all based on signal-plus-noise-plus-distortion to noise-plus-distortion (SINAD), MIL-STD-188-141B, paragraph A.4.1.5.

b. Link Quality Memory. The equipment shall be capable of storing, retrieving, and employing at least 4000 (DO: 10,000) sets of connectivity and Link Quality Analysis (LQA) information associated with the channels and the other addresses in an LQA memory. The connectivity and LQA information storage shall be retained in memory for not less than one hour during power down or loss of primary power. The information in each address/channel "cell" shall include as a minimum, bilateral SINAD values of (a) the signals received at the station, and (b) the station's signals received at, and reported by, the other station. It shall also include either an indicator of the age of the information (for discounting old data), or an algorithm for automatically reducing the weight of data with time, to compensate for changing propagation conditions. (DO: the cells of the LQA memory should also include bilateral bit error rate (BER) and bilateral MP information derived by suitably equipped units.) The information within the LQA memory shall be used to select channels and manage networks as stated in this document. See figure A-4, MIL-STD-188-141B, paragraph A.4.3.3.2.

c. Channel Selection. Channel selection is based on the information stored within the LQA memory (such as BER, SINAD, and MP) and this information is used to speed connectivity and to optimize the choice of quality channels. When initiating scanning (multichannel) calling attempts, the sequence of channels to be tried shall be derived from information in the LQA memory with the channel(s) with the "best score(s)" being tried first (unless otherwise directed by the operator or controller) until all the LQA scored channels are tried. However, if LQA or other such information is unavailable (or it has been exhausted and other valid channels remain available and untried), the station shall continue calling on those channels until successful or until all the remaining (untried valid) channels have been tried, MIL-STD-188-141B, paragraph A.5.4.

d. LQA. LQA data shall be used to score the channels and to support selection of a "best" (or an acceptable) channel for calling and communication. LQA shall also be used for continual monitoring of the link(s) quality during communications that use ALE signaling. The stored values shall be available to be transmitted upon request, or as the network manager shall direct. Unless specifically and otherwise directed by the operator or controller, all ALE stations shall automatically insert the CMD LQA word (t) in the message section of their signals and handshakes when requested by the handshaking station(s), when prearranged in a network, or when specified by the protocol. See MIL-STD-188-141B paragraph A.5.4.2. If an ALE station requires, and is capable of using LQA information (polling-capable), it may request the data from another station by setting the control bit KA1 to “1” in the CMD LQA word. If an ALE station, which is sending CMD LQA in response to a request, is incapable of using such information itself (not polling-capable), it shall set the control bit KA1 to “0.” It will be a network management decision to determine if the LQA is to be active or passive. For human factor considerations, LQA scores that may be presented to the operator should have higher (number) scores for better channels, MIL-STD-188-141B, paragraph A.5.4.1.

e. BER. Analysis of the BER on RF channels, with respect to poor channels and the 8-ary modulation, plus the design and use of both redundancy and Golay Forward Error Correction (FEC), shows that a coarse estimate of BER may be obtained by counting the number of non-unanimous (2/3) votes (out of 48) in the majority vote decoder. The range of this measure is 0 through 48. Correspondence to actual BER values is shown in MIL-STD-188-141B table A-XIII. After an ALE receiver achieves word synchronization (see paragraph A.5.2.6.2), all received words in a frame shall be measured, and a linear average BER/LQA shall be computed as follows: If the Golay decoder reports no uncorrectable errors in both halves of the ALE word, the number of non-unanimous votes detected in the word shall be added to the total. If at least one half of the ALE word contained uncorrectable errors, the number of non-unanimous votes detected shall be discarded, and 48 (the maximum value) shall be added to the total. At the end of the transmission, the total shall be divided by the number of words received, and the total shall be stored in the Link Quality Memory as the most current BER code for the station sending the measured transmission and the channel that carried it, MIL-STD-188-141B, paragraph A.5.4.1.1.

f. SINAD. The signal-to-noise and distortion measurement shall be a SINAD measurement ((S+N+D)/(N+D)) averaged over the duration of each received ALE signal. The SINAD values shall be measured on all ALE signals, MIL-STD-188-141B, paragraph A.5.4.1.2.

g. Operator Display (optional). Display of SINAD values shall be in dB, MIL-STD-188-141B, paragraph A.5.4.1.4.

h. Local Noise Report CMD (optional). The Local Noise Report CMD provides a broadcast alternative to sounding that permits receiving stations to approximately predict the bilateral link quality for the channel carrying the report. An example application of this optional technique is networks in which most stations are silent but need to have a high probability of linking on the first attempt with a base station. A station receiving a Local Noise Report can compare the noise level at the transmitter to its own local noise level, and thereby estimate the bilateral link quality from its own LQA measurement of the received noise report transmission. The CMD reports the mean and maximum noise power measured on the channel in the past 60 minutes.

The Local Noise Report CMD shall be formatted as shown in MIL-STD-188-141B figure A-26. Units for the Max and Mean fields are dB relative to 0.1 µV 3 KHz noise. If the local noise measurement to be reported is 0 dB or less, a 0 is sent. For measured noise ratios of 0 dB to +126 dB, the ratio in dB is rounded to an integer and sent. For noise ratios greater than +126 dB, 126 is sent. The code 127 (all 1s) is sent when no report is available for a field. By comparing the noise levels reported by a distant station on several channels, the station receiving the noise reports can select a channel for linking attempts based upon knowledge of both the propagation characteristics and the interference situation at that destination, MIL-STD-188-141B, paragraph A.5.4.4.

i. Single Station Channel Selection. All stations shall be capable of selecting the (recent) best channel for calling or listening for a single station based on the values in the LQA memory, MIL-STD-188-141B, paragraph A.5.4.5.

j. Multiple-Station Channel Selection. A station shall also be capable of selecting the (recent) best channel to call or listen for multiple stations, based on the values in the LQA memory.

NOTES:
1) In the example shown in MIL-STD-188-141B figure A-27, if a multiple station handshake is required with stations "B" and "C," C5 is the best choice as the total score is 12 (2+5+3+2), followed by C4 (20) and C3 (35). Next would be C2 (34+) and C6 (36+), this ranking being due to their unknown handshake capability (which had not been tried). C1(x) is the last to be tried because recent handshake attempts had failed for both "B" and "C." To call the three stations "A," "B," and "C," the sequence would be C5 (24), C3 (38), C2 (46+), C6 (62+), C4 (one x) (recently failed attempt), and finally C1 (two x). If an additional selection factor is used, it will change the channel selection sequence.
2) In the example, to call "D" and "E," the sequence would be C2, C3, C4, C5, C1, and C6. If a maximum limit of LQA $\leq$ 14 is imposed on any path (to achieve a minimum circuit quality), only C2 and C3 would be initially selected for the linking attempt. Further, if the LQA limit was "lowered" to 10, C3 would be selected before C2 for the linking attempt. If a broadcast to multiple stations is required, the TO section ("to" the station) scores are given priority.
3) In the example, to broadcast to "B" and "C," the sequence would be C5(7), C4(9), C3(21), C2(7+), C6(12+), and C1(two x). To select channels for listening for multiple stations, the FROM section ("from" the station) scores are given priority.
4) In the example, to listen for "A" and "B," channel C2 (2) would be best, and if only four channels could be scanned, they should be C2, C3, C4, and C5, MIL-STD-188-141B, paragraph A.5.4.6.

k. Sounding uses the standard ALE signaling, and any station can receive sounding signals. As a minimum, the signal (address) information shall be displayed to the operator and, for stations equipped with connectivity and LQA memories, the information shall be stored and used later for linking, MIL-STD-188-141B, paragraph A.5.3.1.

l. Current Channel Quality Report (LQA CMD). This mandatory function is designed to support the exchange of current LQA information among ALE stations. The CMD LQA word shall be constructed as shown in MIL-STD-188-141B table A-XIV. The preamble shall be CMD (110) in bits P3 through P1 (W1 through W3). The first character shall be "a" (1100001) in bits C1-7 through C1-1 (W4 through W10), which shall identify the LQA function "analysis." It carries three types of analysis information (BER, SINAD, and MP) that are separately generated by the ALE analysis capability. Note that when the control bit KA1 (W11) is set to "1," the receiving station shall respond with an LQA report in the handshake. If KA1 is set to "0," the report is not required, MIL-STD-188-141B, paragraph A.5.4.2.

m. BER Field in LQA CMD. Measurement and reporting of BER is mandatory. The BER field in the LQA CMD shall contain five bits of information, BE5 through BE1 (W20 through W24). See MIL-STD-188-141B table A-XIII for the assigned values, MIL-STD-188-141B, paragraph A.5.4.2.1.

n. SINAD. SINAD shall be reported in the CMD LQA word as follows. The SINAD is represented as five bits of information SN5 through SN1 (W15 through W19). The range is 0 to 30 dB in 1-dB steps. 00000 is 0 dB or less, and 11111 is no measurement, MIL-STD-188-141B, paragraph A.5.4.2.2.

o. MP. If implemented, MP measurements shall be reported in CMD LQA words in the three bits, MP3 through MP1 (W12 through W14). The measured value in msec shall be reported rounded to the nearest integer, except that values greater than 6 msec shall be reported as 6 (110). When MP is not measured, the reported MP value shall be 7 (111), MIL-STD-188-141B, paragraph A.5.4.2.3.

p. Multiple-station channel selection. A station shall also be capable of selecting the (recent) best channel to call or listen for multiple stations, based on the values in the LQA memory.

NOTE: In the example shown in MIL-STD-188-141B figure A-27, if a multiple-station handshake is required with stations "B" and "C," C5 is the best choice as the total score is 12 (2+5+3+2), followed by C4 (20) and C3 (35). Next would be C2 (34+) and C6 (36+), this ranking being due to their unknown handshake capability (which had not been tried). C1(x) is the last to be tried because recent handshake attempts had failed for both "B" and "C." To call the three stations "A," "B," and "C," the sequence would be C5 (24), C3 (38), C2 (46+), C6 (62+), C4 (one x) (recently failed attempt), and finally C1 (two x).

If an additional selection factor is used, it will change the channel selection sequence.

NOTE: In the example, to call “D” and “E,” the sequence would be C2, C3, C4, C5, C1, and C6. If a maximum limit of LQA $\leq$ 14 is imposed on any path (to achieve a minimum circuit quality), only C2 and C3 would be initially selected for the linking attempt. Further, if the LQA limit was “lowered” to 10, C3 would be selected before C2 for the linking attempt.

If a broadcast to multiple stations is required, the TO section (“to” the station) scores are given priority.

NOTE: In the example, to broadcast to “B” and “C,” the sequence would be C5(7), C4(9), C3(21), C2(7+), C6(12+), and C1(two x).

To select channels for listening for multiple stations, the FROM section (“from” the station) scores are given priority.

NOTE: In the example, to listen for “A” and “B,” channel C2 (2) would be best, and if only four channels could be scanned, they should be C2, C3, C4, and C5.

C-31.3 Test Procedures

a. Test Equipment Required

(1) Channel Simulator

(2) Transmitters/Receivers

(3) Attenuators

(4) PC with Soundcard

(5) Spectrum Analyzer

(6) Directional Coupler

(7) UUT plus one additional outstation

b. Test Configuration. Configure the equipment as shown in figure C-31.1.

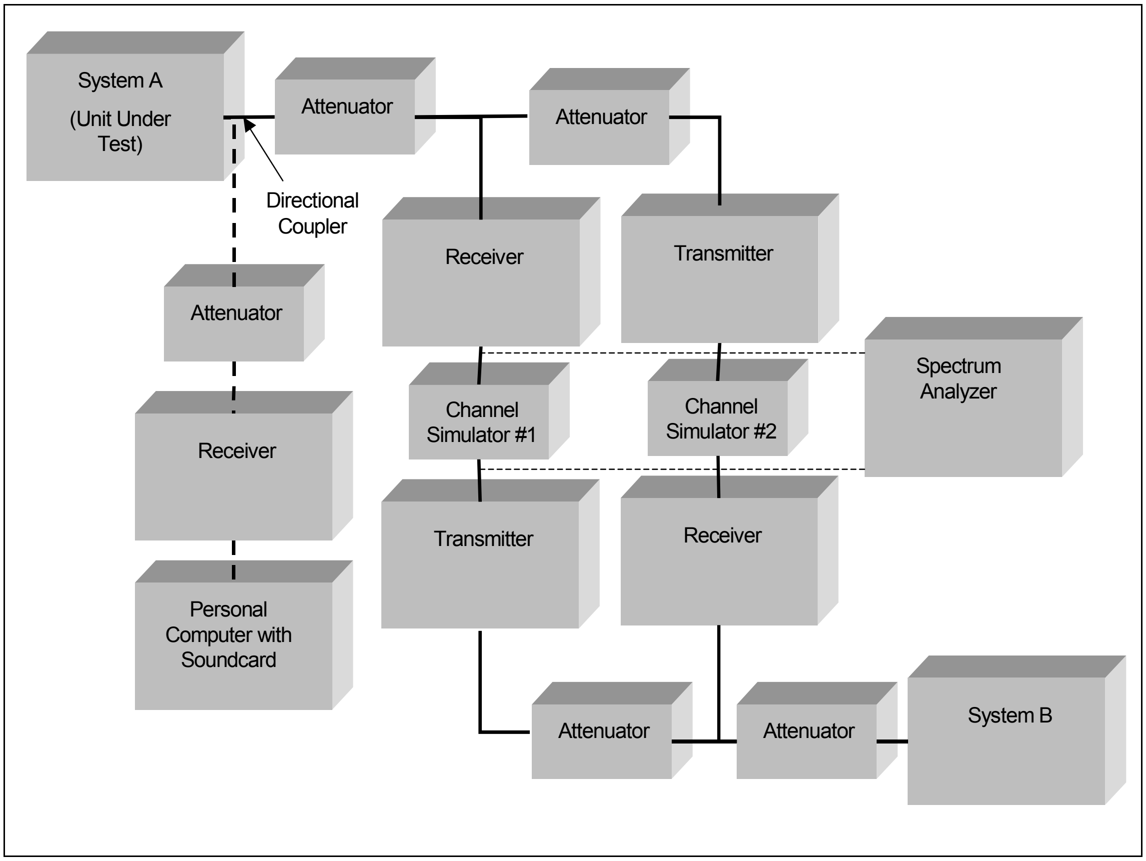

Figure C-31.1. Equipment Configuration for LQA Operation

c. Test Conduct. The procedures for this subtest are listed in table C-31.1.

Table C-31.1. Procedures for LQA Operation Subtest

Step	Action	Settings/Action	Result
The following procedure is for reference number 61.			
1	Set up equipment as shown in figure C-31.1.	Program radios in accordance with tables C-27.1 through C-27.6.	
2	Power up systems.		
3	Research the manufacturer's operating/programming procedures to verify that the equipment is capable of storing, retrieving, and employing at least 4000 sets of connectivity and LQA information associated with the channels and the other addresses in an LQA memory.	Record findings.	

Table C-31.1. Procedures for LQA Operation Subtest (continued)

Step	Action	Settings/Action	Result
4	Perform pre-test measurements and setup.	Measure audio output level of the ALE tones to the radio. These levels will be used to set path levels (0 dBm ± 1 dB input) to the simulator. Place system A transmitter in local mode, modulate with a 1-kHz tone at the measured level, and add or remove attenuation to provide 0-dBm level to simulator 1. Place another 1-kHz tone on the audio out path of system B at the measured level, and then add or remove attenuation to provide 0 dBm to simulator 2.	
The following procedure is for reference numbers 105, 108, 118, and 119.			
5	View the LQA data stored in system A's memory from previous tests.	Record previously stored LQA data.	
6	Place system A in scan mode, and place an individual call to system B.	Record the channel number that system A uses to call system B. Expected: channel with highest LQA score from step 5.	
7	Place system A in scan mode, and place a Net call to address NA1.	Record the channel number that system A uses to call NA1. Expected: channel with highest LQA score from step 5.	
The following procedure is for reference number 49, 109, and 112.			
8	Clear all LQA entries in the LQA table of both ALE radios.		
9	Start simulator.	Program simulator for Gaussian noise channel with an SNR of +12.0 dB.	
10	Program system A with the following self-addresses: A01, A02, A03, A04, and A05.		
11	Configure the personal computer to record audio files in WAV format.	Record calls placed in steps 12 through 16.	
12	Place a SOUND call from system A using self-address A01.		
13	Program simulator for Gaussian noise channel with a SNR of 9 dB.	Place a SOUND call from system A using self-address A02.	
14	Program simulator for Gaussian noise channel with a SNR of 6 dB.	Place a SOUND call from system A using self-address A03.	
15	Program simulator for Gaussian noise channel with a SNR of 3 dB.	Place a SOUND call from system A using self-address A04.	
16	Program simulator for Gaussian noise channel with a SNR of 0 dB.	Place a SOUND call from system A using self-address A05.	
17	At system B, request an LQA ranking on all five channels.	Record results on data collection form. (Note: it may be necessary to place an ALE call to the desired address to "see" the ranking of the channels.)	Record on data collection form, page D-49.

Table C-31.1. Procedures for LQA Operation Subtest (continued)

Step	Action	Settings/Action	Result
18	Wait 20 minutes and rank all five channels.	It may be necessary to place an ALE call to the desired address to "see" the ranking of the channels.	Record on data collection form, page D-49.
19	Wait an additional 20 minutes and rank all five channels again.	It may be necessary to place an ALE call to the desired address to "see" the ranking of the channels.	Record on data collection form, page D-49.
20	Compare cumulative LQA data obtained in steps 17, 18, and 19.		
21	Power down UUT for one hour. Request LQA ranking data. Compare results with those obtained in step 20.		Record on data collection form, page D-49.
22	Research the manufacturer's operating/programming instructions to determine if the UUT provides an (optional) operator channel quality display.	If an operator channel quality display is provided, it should have a uniform scale, 0-30 with 31 being unknown all based on SINAD. SINAD values should be displayed in dB. Record the SINAD values given for each self-address.	
23	Program system A to request LQA data from system B.	Record this call in WAV format.	
The following procedure is for reference numbers 61, 110, 111, 113, 114, 115, and 116.			
24	Use ALEOOWPP software to decode WAV files captured in steps 12 through 16, and step 23. ALEOOWPP software is available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	Record the BER, SINAD, and LQA values from all decoded ALE calls. Also, record the values of the KA1 bits.	
The following procedure is for reference number 117.			
25	Research the manufacturer's operating/programming instructions to determine if the optional Local Noise Report Command is implemented by the UUT.	If this command is implemented, it should be formatted as shown in figure A-26 of MIL-STD-188-141B.	
Legend: ALE – Automatic Link Establishment; BER – Bit Error Rate; dB – decibels; dBm – decibels referenced to 1 milliwatt; JITC – Joint Interoperability Test Command; kHz – kilohertz; LQA – Link Quality Analysis; MHz – megahertz; MIL-STD – Military Standard; SINAD – Signal-plus-noise-plus-distortion to noise-plus-distortion; SNR – Signal to Noise Ratio; UUT – Unit Under Test; WAV – Wave			

C-31.4 Presentation of Results. The results will be shown in tabular format (table C-31.2) indicating the requirement and measured value or indications of capability.

Table C-31.2. LQA Operation Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
49	A.4.1.5	Channel Quality Display. If an operator display is provided, the display shall have a uniform scale, 0-30 with 31 being unknown all based on signal-plus-noise-plus-distortion to noise-plus-distortion (SINAD).	Uniform scale, 0-30 with 31 being unknown, all based on SINAD.			
61	A.4.3.3.2	Link Quality Memory. The equipment shall be capable of storing, retrieving, and employing at least 4000 (DO: 10,000) sets of connectivity and LQA information associated with the channels and the other addresses in an LQA memory. The connectivity and LQA information storage shall be retained in memory for not less than one hour during power down or loss of primary power. The information in each address/channel “cell” shall include as a minimum, bilateral SINAD values of (a) the signals received at the station, and (b) the station’s signals received at, and reported by, the other station. It shall also include either an indicator of the age of the information (for discounting old data), or an algorithm for automatically reducing the weight of data with time, to compensate for changing propagation conditions. (DO: the cells of the LQA memory should also include bilateral bit-error ratio (BER) and bilateral MP information derived by suitably equipped units.) The information within the LQA memory shall be used to select channels and manage networks as stated in this document. See figure A-4.	Store, retrieve, and employ 4000 sets of connectivity and LQA information. Each call includes bilateral SINAD values, and an age indicator.			
105	A.5.3.1	Sounding uses the standard ALE signaling, and any station can receive sounding signals. As a minimum, the signal (address) information shall be displayed to the operator and, for stations equipped with connectivity and LQA memories, the information shall be stored and used later for linking.	Address information displayed to operator.			

Table C-31.2. LQA Operation Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
108	A.5.4	Channel Selection. Channel selection is based on the information stored within the LQA memory (such as BER, SINAD, and MP) and this information is used to speed connectivity and to optimize the choice of quality channels. When initiating scanning (multichannel) calling attempts, the sequence of channels to be tried shall be derived from information in the LQA memory with the channel(s) with the "best score(s)" being tried first (unless otherwise directed by the operator or controller) until all the LQA scored channels are tried. However, if LQA or other such information is unavailable (or it has been exhausted and other valid channels remain available and untried) the station shall continue calling on those channels until successful or until all the remaining (untried valid) channels have been tried.	UUT calls on channel with the best ranking.			

Table C-31.2. LQA Operation Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
109	A.5.4.1	LQA. LQA data shall be used to score the channels and to support selection of a “best” (or an acceptable) channel for calling and communication. LQA shall also be used for continual monitoring of the link(s) quality during communications that use ALE signaling. The stored values shall be available to be transmitted upon request, or as the network manager shall direct. Unless specifically and otherwise directed by the operator or controller, all ALE stations shall automatically insert the CMD LQA word (t) in the message section of their signals and handshakes when requested by the handshaking station(s), when prearranged in a network, or when specified by the protocol. If an ALE station requires, and is capable of using LQA information (polling-capable), it may request the data from another station by setting the control bit KA1 to “1” in the CMD LQA word. If an ALE station, which is sending CMD LQA in response to a request, is incapable of using such information itself (not polling-capable), it shall set the control bit KA1 to “0.” It will be a network management decision to determine if the LQA is to be active or passive. For human factor considerations, LQA scores that may be presented to the operator should have higher (number) scores for better channels.	LQA data used to score channels. During LQA request, KA1 bit must be set to “1.”			

Table C-31.2. LQA Operation Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
110	A.5.4.1.1	Analysis of the BER on RF channels, with respect to poor channels and the 8-ary modulation, plus the design and use of both redundancy and Golay Forward Error Correction (FEC), shows that a coarse estimate of BER may be obtained by counting the number of non-unanimous (2/3) votes (out of 48) in the majority vote decoder. The range of this measure is 0 through 48. Correspondence to actual BER values is shown in table A-XIII. After an ALE receiver achieves word synchronization (see paragraph A.5.2.6.2), all received words in a frame shall be measured, and a linear average BER/LQA shall be computed as follows: If the Golay decoder reports no uncorrectable errors in both halves of the ALE word, the number of non-unanimous votes detected in the word shall be added to the total. If at least one half of the ALE word contained uncorrectable errors, the number of non-unanimous votes detected shall be discarded, and 48 (the maximum value) shall be added to the total. At the end of the transmission, the total shall be divided by the number of words received, and the total shall be stored in the Link Quality Memory as the most current BER code for the station sending the measured transmission and the channel that carried it.	UUT provides BER/LQA information.			
111	A.5.4.1.2	SINAD. The signal-to-noise and distortion measurement shall be a SINAD measurement ((S+N+D)/(N+D)) averaged over the duration of each received ALE signal. The SINAD values shall be measured on all ALE signals.	SINAD values correspond to simulator settings.			
112	A.5.4.1.4	Operator Display (optional). Display of SINAD values shall be in dB.	SINAD displayed in dB.			

Table C-31.2. LQA Operation Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
117	A.5.4.4	Local Noise Report CMD (optional). The Local Noise Report CMD provides a broadcast alternative to sounding that permits receiving stations to approximately predict the bilateral link quality for the channel carrying the report. An example application of this optional technique is networks in which most stations are silent but need to have a high probability of linking on the first attempt with a base station. A station receiving a Local Noise Report can compare the noise level at the transmitter to its own local noise level, and thereby estimate the bilateral link quality from its own LQA measurement of the received noise report transmission. The CMD reports the mean and maximum noise power measured on the channel in the past 60 minutes. The Local Noise Report CMD shall be formatted as shown in figure A-26 of MIL-STD-188-141B. Units for the Max and Mean fields are dB relative to 0.1 μV 3 KHz noise. If the local noise measurement to be reported is 0 dB or less, a 0 is sent. For measured noise ratios of 0 dB to +126 dB, the ratio in dB is rounded to an integer and sent. For noise ratios greater than +126 dB, 126 is sent. The code 127 (all 1s) is sent when no report is available for a field. By comparing the noise levels reported by a distant station on several channels, the station receiving the noise reports can select a channel for linking attempts based upon knowledge of both the propagation characteristics and the interference situation at that destination.	Local Noise Report CMD formatted as shown in MIL-STD-188-141B, figure A-26.			
118	A.5.4.5	Single-Station Channel Selection. All stations shall be capable of selecting the (recent) best channel for calling or listening for a single station based on the values in the LQA memory.	Select best channel.			

Table C-31.2. LQA Operation Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
119	A.5.4.6	Multiple-station channel selection. A station shall also be capable of selecting the (recent) best channel to call or listen for multiple stations, based on the values in the LQA memory.	Select best channel.			
105	A.5.3.1	Multiple-Station Channel Selection. A station shall also be capable of selecting the (recent) best channel to call or listen for multiple stations, based on the values in the LQA memory.	Select best channel.			
113	A.5.4.2	Current Channel Quality Report (LQA CMD). This mandatory function is designed to support the exchange of current LQA information among ALE stations. The CMD LQA word shall be constructed as shown in table A-XIV of MIL-STD-188-141B.	CMD LQA word constructed as shown in MIL-STD-188-141B table A-XIV.			
114	A.5.4.2.1	BER Field in LQA CMD. Measurement and reporting of BER is mandatory. The BER field in the LQA CMD shall contain five bits of information, BE5 through BE1 (W20 through W24). Refer to table A-XIII for the assigned values.	Measure and report BER. BER should correspond with simulator SNR setting.			
115	A.5.4.2.2	SINAD. SINAD shall be reported in the CMD LQA word as follows: the SINAD is represented as five bits of information SN5 through SN1 (W15 through W19). The range is 0 to 30 dB in 1-dB steps. 00000 is 0 dB or less, and 11111 is no measurement.	SINAD represented as five bits, between 00000 and 11111.			
116	A.5.4.2.3	MP. If implemented, MP measurements shall be reported in CMD LQA words in the three bits, MP3 through MP1 (W12 through W14). The measured value in msec shall be reported rounded to the nearest integer, except that values greater than 6 msec shall be reported as 6 (110). When MP is not measured, the reported MP value shall be 7 (111).	MP measurements reported in accordance with paragraph A.5.4.2.3.			

Legend: ALE – Automatic Link Establishment; BER – Bit Error Rate; CMD – Command; dB – decibels; DO – Design Objective; FEC – Forward Error Correction; kHz – kilohertz; LQA – Link Quality Analysis; MIL-STD – Military Standard; MP – Multipath; RF – Radio Frequency; SINAD – Signal-plus-noise-plus-distortion to noise-plus-distortion; μV - microvolt

C-32 SUBTEST 32, SIGNAL STRUCTURE AND CODING

C-32.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 54, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 85, 90, and 91.

C-32.2 Criteria

a. The call shall not exceed 23 redundant words, the response three redundant words and the acknowledgement three redundant words, MIL-STD-188-141B, paragraph A.4.2.3.

b. General. The effective performance of stations, while communicating over adverse RF channels, relies on the combined use of FEC, interleaving, and redundancy. These functions shall be performed within the transmit encoder and receive decoder, MIL-STD-188-141B, paragraph A.5.2.2.1.

c. Golay Coding. The Golay (24, 12, 3) FEC code is prescribed for this standard. The FEC code generator polynomial shall be: $g(x) = x^{11} + x^9 + x^7 + x^6 + x^5 + x + 1$. The generator matrix G, derived from g(x), shall contain an identity matrix I_{12} and a parity matrix P as shown in figure A-6. The corresponding parity check matrix H shall contain a transposed matrix p^T and an identity matrix I_{12} as shown in figure A-7, MIL-STD-188-141B, paragraph A.5.2.2.2.

d. Encoding. Encoding shall use the fundamental formula x = uG, where the code word x shall be derived from the data word u and the generator matrix G. Encoding is performed using the G matrix by summing (modulo-2) the rows of G for which the corresponding information bit is a “1.” See figures A-6, A-8, and A-9a, MIL-STD-188-141B, paragraph A.5.2.2.2.1.

e. Interleaving and Deinterleaving. The basic word bits W1 Most Significant Bit (MSB) through W24 Least Significant Bit (LSB), and resultant Golay FEC bits G1 through G24 (with G13 through G24 inverted), shall be interleaved before transmission using the pattern shown in figure A-10. The 48 interleaved bits plus a 49th stuff bit S49, (value = 0) shall constitute a transmitted word and they shall be transmitted A1, B1, A2, B2... A24, B24, S49 using 16-1/3 symbols (tones) per word (T_w) as described in paragraph A.5.1.3. At the receiver, and after 2/3 voting (see paragraph A.5.2.2.4), the first 48 received bits of the majority word (including remaining errors) shall be deinterleaved as shown in figure A-10 and then Golay FEC decoded to produce a correct(ed) 24 bit basic word (or an uncorrected error flag). The 49th stuff bit (S49) is ignored, MIL-STD-188-141B, paragraph A.5.2.2.3.

f. Redundant Words. Each of the transmitted 49 bit (or 16-1/3 symbol) (T_w) words shall be sent redundantly (times 3) to reduce the effects of fading, interference, and noise, MIL-STD-188-141B, paragraph A.5.2.2.4.

g. ALE Word Format. The basic ALE word shall consist of 24 bits of information, designated W1 (MSB) through W24 (LSB). The bits shall be designated as shown in figure A-12, MIL-STD-188-141B, paragraph A.5.2.3.1.

h. Structure. The word shall be divided into two parts: a 3-bit preamble and a 21-bit data field (which often contains three 7-bit characters). The MSB for all parts, and the word, is to the left in figure A-12 and is sent earliest. Before transmission, the word shall be divided into two 12-bit halves (Golay code A and B in figure A-10) for FEC encoding as described in paragraph A.5.2.2, MIL-STD-188-141B, paragraph A.5.2.3.1.1.

i. Word Types. The leading three bits, W1 through W3, are designated preamble bits P3 through P1, respectively. These preamble bits shall be used to identify one of eight possible word types, MIL-STD-188-141B, paragraph A.5.2.3.1.2.

j. Preambles. The word types (and preambles) shall be as shown in MIL-STD-188-141B table A-VIII and as described herein, MIL-STD-188-141B, paragraph A.5.2.3.1.3.

k. TO. The TO word (010) shall be used as a routing designator which shall indicate the address of the present destination station(s) which is (are) to directly receive the call. TO shall be used in the individual call protocols for single stations and in the net call protocols for multiple net-member stations that are called using a single net address. The TO word itself shall contain the first three characters of an address. For extended addresses, the additional address words (and characters) shall be contained in alternating DATA and REP words, which shall immediately follow. The sequence shall be TO, DATA, REP, DATA, and REP, and shall be only long enough to contain the address, up to a maximum capacity of five address words (15 characters), MIL-STD-188-141B, paragraph A.5.2.3.2.1.

l. THIS IS (TIS). The TIS word (101) shall be used as a routing designator which shall indicate the address of the present calling (or sounding) station which is directly transmitting the call (or sound). Except for the use of THIS WAS (TWAS), TIS shall be used in all ALE protocols to terminate the ALE frame and transmission. It shall indicate the continuation of the protocol or handshake, and shall direct, request, or invite (depending on the specific protocol) responses or acknowledgments from other called or receiving stations. The TIS shall be used to designate the call acceptance sound. The TIS word itself shall contain the first three characters of the calling stations address. For extended addresses, the additional address words (and characters) shall be contained in alternating DATA and REP words which shall immediately follow, exactly as described for whole addresses using the TO word and sequence. The entire address (and the required portion of the TIS, DATA, REP, DATA, REP sequence, as necessary) shall be used only in the conclusion section of the ALE frame (or shall constitute an entire sound). TWAS shall not be used in the same frame as TIS, as they are mutually exclusive, MIL-STD-188-141B, paragraph A.5.2.3.2.2.

m. THIS WAS (TWAS). The TWAS word (011) shall be used as a routing designator exactly as the TIS, with the following variations. It shall indicate the termination of the ALE protocol or handshake, and shall reject, discourage, or not invite (depending on the specific protocol) responses or acknowledgments from other called or receiving stations. The TWAS shall be used to designate the call rejection sound. TIS shall not be used in the same frame as TWAS, as they are mutually exclusive, MIL-STD-188-141B, paragraph A.5.2.3.2.3.

n. THRU. The THRU word (001) shall be used in the scanning call section of the calling cycle only with group call protocols. The THRU word shall be used alternately with REP, as routing designators, to indicate the address first word of stations that are to be directly called. Each address first word shall be limited to one basic address word (three characters) in length. A maximum of five different address first words shall be permitted in a group call. The sequence shall only be alternations of THRU, REP. The THRU shall not be used for extended addresses, as it will not be used within the leading call section of the calling cycle. When the leading call starts in the group call, the entire group of called stations shall be called with their whole addresses, which shall be sent using the TO preambles and structures, as described in paragraph A.5.2.3.2.1.

NOTES:
1) The THRU word is also reserved for future implementation of indirect and relay protocols, in which cases it may be used elsewhere in the ALE frame and with whole addresses and other information. Stations designed in compliance with this nonrelay standard should ignore calls to them that employ their address in a THRU word in other than the scanning call.
2) The THRU preamble value is also reserved for the AQC-ALE protocol, MIL-STD-188-141B, paragraph A.5.2.3.2.4.

o. FROM. The FROM word (100) is an optional designator which shall be used to identify the transmitting station without using an ALE frame termination, such as TIS or TWAS. It shall contain the whole address of the transmitting station, using the FROM, and if required, the DATA and REP words, exactly as described in the TO address structure in paragraph A.5.2.3.2.1. It should be used only once, in each ALE frame, and it shall be used only immediately preceding a command (CMD) in the message section. Under direction of the operator or controller, it should be used to provide a “quick ID” of the transmitting station when the normal conclusion may be delayed, such as when a long message section is to be used in an ALE frame.

NOTES:
1) The FROM word is also reserved for future implementation of indirect and relay protocols, in which cases it may be used elsewhere in the ALE frame and with multiple addresses and other information. Stations designed in compliance with this nonrelay standard should ignore sections of calls to them that employ FROM words in any other sequence than immediately before the CMD word.

2) The FROM preamble value is also reserved for the AQC-ALE protocol, MIL-STD-188-141B, paragraph A.5.2.3.2.5.

p. CMD. The CMD word (110) is a special orderwire designator that shall be used for system-wide coordination, command, control, status, information, interoperation, and other special purposes. CMD shall be used in any combination between ALE stations and operators. CMD is an optional designator that is used only within the message section of the ALE frame, and it shall have (at some time in the frame) a preceding call and a following conclusion, to ensure designation of the intended receivers and identification of the sender. The first CMD terminates the calling cycle and indicates the start of the message section of the ALE frame. The orderwire functions are directed with the CMD itself, or when combined with the REP and DATA words. See MIL-STD-188-141B paragraph A.5.6 for message words (orderwire messages) and functions, MIL-STD-188-141B, paragraph A.5.2.3.3.1.

q. DATA. The DATA word (000) is a special designator that shall be used to extend the data field of any previous word type (except DATA itself) or to convey information in a message. When used with the routing designators TO, FROM, TIS, or TWAS, DATA shall perform address extension from the basic three characters to six, nine, or more (in multiples of three) when alternated with REP words. The selected limit for address extension is a total of 15 characters. When used with CMD, its function is predefined as specified in MIL-STD-188-141B paragraph A.5.6 for message words (orderwire messages) and functions, MIL-STD-188-141B, paragraph A.5.2.3.4.1.

r. REP. The REP word (111) is a special designator that shall be used to duplicate any previous preamble function or word meaning while changing the data field contents (bits W4 through W24). See MIL-STD-188-141B table A-VIII. Any change of words or data field bits requires a change of preamble bits (P_3 through P_1) to preclude uncertainty and errors. If a word is to change, even if the data field is identical to that in the previous word, the preamble shall be changed, thereby clearly designating a word change. When used with the routing designator TO, REP performs address expansion, which enables more than one address to be specified. See MIL-STD-188-141B paragraph A.5.2.3.2.4 for use with THRU. With DATA, REP may be used to extend and expand address, message, command, and status fields. REP shall be used to perform these functions, and it may directly follow any other word type except for itself, and except for TIS or TWAS, as there cannot be more than one transmitter for a specific call at a given time.

NOTES:
1) REP is used in T_{sc} of group calls directed to units with different first word addresses.
2) REP is not used in T_{sc} of calls directed to groups with same first word addresses. Also REP is not used in T_{sc} of calls directed to individuals and nets, MIL-STD-188-141B, paragraph A.5.2.3.4.2.

s. Basic 38 Subset. The Basic 38 subset shall include all capital alphabetics (A-Z) and all digits (0-9), plus designated utility and wildcard symbols "@" and "?," as shown in MIL-STD-188-141B figure A-13. The Basic 38 subset shall be used for all basic addressing functions. To be a valid basic address, the word shall contain a routing preamble from MIL-STD-188-141B paragraph A.5.2.3.2 (such as TO...), plus three alphanumeric characters (A-Z, 0-9) from the Basic 38 subset in any combination. In addition, the "@" and "?" symbols shall be used for special functions. Digital discrimination of the Basic 38 subset shall not be limited to examination of only the three MSBs (b_7 through b_5), as a total of 48 digital bit combinations would be possible (including ten invalid symbols which would be improperly accepted), MIL-STD-188-141B, paragraph A.5.2.4.2.

t. Net Addresses. The purpose of a net call is to rapidly and efficiently establish contact with multiple prearranged (net) stations (simultaneously if possible) by the use of a single net address, which is an additional address assigned to all net members in common. When a net address type function is required, a calling ALE station shall use an address structure identical to the individual station address, basic or extended, as necessary. For each net address at a net member's station, there shall be a response slot identifier, plus a slot width modifier if directed by the specific standard protocol. As described in MIL-STD-188-141B paragraphs A.5.5.3 and A.5.5.4, additional information concerning the assigned response slots (and size) must be available, and the mixing of individual, net, and group addresses and calls is restricted, MIL-STD-188-141B, paragraph A.5.2.4.5.

u. Group Addresses. The purpose of a group call is to establish contact with multiple nonprearranged (group) stations (simultaneously if possible) rapidly and efficiently by the use of a compact combination of their own addresses that are assigned individually. When a group address type function is required, a calling ALE station shall use a sequence of the actual individual station addresses of the called stations, in the manner directed by the specific standard protocol. A station's address shall not appear more than once in a group calling sequence, except as specifically permitted in the group calling protocols described in MIL-STD-188-141B paragraph A.5.5.4.

NOTE: The group feature is not available in the AQC-ALE protocol, MIL-STD-188-141B, paragraph A.5.2.4.6.

C-32.3 Test Procedures

a. Test Equipment Required

(1) Receiver monitoring 12.000 MHz, USB

(2) PC with Soundcard

(3) Attenuators

(4) Directional Coupler

(5) Tee Connector

(6) UUT plus two radios similar to UUT

b. Test Configuration. Configure the equipment as shown in figure C-32.1.

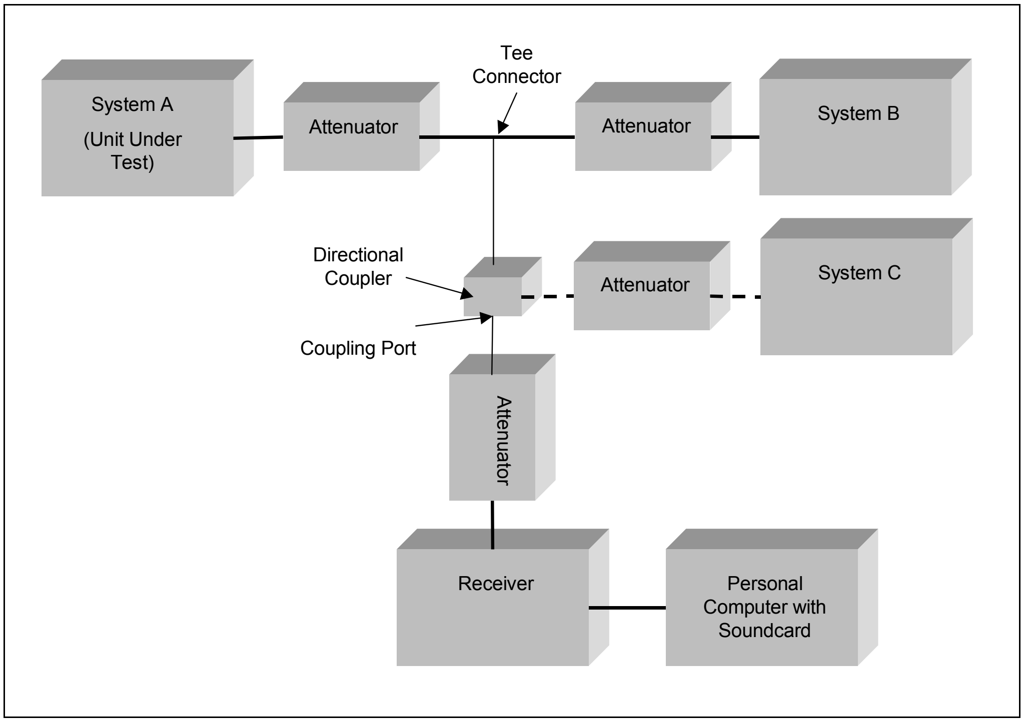

Figure C-32.1. Equipment Configuration for Signal Structure and Coding

c. Test Conduct. The procedures for this subtest are listed in table C-32.1.

Table C-32.1. Procedures for Signal Structure and Coding Subtest

Step	Action	Settings/Action	Result
The following procedure is for reference numbers 54, 68 through 83, 85, 90, and 91.			
1	Set up equipment as shown in figure C-32.1.	Program radios in accordance with tables C-27.1 through C-27.6.	
2	Initialize the systems for operation. Use preprogrammed channel information from subtest 27.	“Group call” Radios required: UUT plus systems B and C.	
3	Configure the PC to record audio files in WAV format.	All WAV files must be sampled at 44.1 kHz, 16 bits, mono.	
4	Place call.	System A (callsign: A01) places call to group address GA6. Radios should be scanning channels 1 through 10. Group address GA6 should contain the following 1-word addresses: B01, C01, D01, and E01.	

Table C-32.1. Procedures for Signal Structure and Coding Subtest (continued)

Step	Action	Settings/Action	Result
5	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled later using ALEOOWPP software for analysis of the word content data.	
6	After the link is established, observe system B and record the callsign(s) of the station(s) that appear to be linked with system B.		
7	Initialize the systems for operation. Use preprogrammed channel information from subtest 27.	"Net call" Radios required: UUT plus systems B and C.	
8	Place call.	System A (callsign: A01) places call to net address NA1. Radios should be scanning channels 1 through 10. Net address NA1 should contain the following 1-word addresses: A01, B01, C01, D01, and E01.	
9	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled using ALEOOWPP software for analysis of the word content data.	
10	After the link is established, observe system B and record the callsign(s) of the station(s) that appear to be linked with system B.		
11	Initialize the systems for operation. Use preprogrammed channel information from subtest 27.	"Individual call" Radios required: UUT plus System B.	
12	Program system B with the callsign 8BSYSTEM. Place call.	System A (callsign: A01) places call to system B (callsign: 8BSYSTEM). Radios should be in non-scan mode.	
13	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled using ALEOOWPP software for analysis of the word content data.	
14	After the link is established, observe system B and record the callsign(s) of the station(s) that appear to be linked with system B.	Expected link: A01	
15	Change scanning to ten channel scanning. Program system B with the callsign 123.	Place an individual call from system A (callsign: A01) to system B (callsign: 123).	
16	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled later using ALEOOWPP software for analysis of the word content data.	
17	With system A and system B in the linked state, terminate the link.		
18	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled later using ALEOOWPP software for analysis of the word content data.	
19	Initialize the systems for operation. Use preprogrammed channel information from subtest 27.	"Quick ID" (OPTIONAL) Radios Required: UUT plus system B.	

Table C-32.1. Procedures for Signal Structure and Coding Subtest (continued)

Step	Action	Settings/Action	Result
20	Send “quick ID.”	Program system A (callsign: A01) to provide a “quick ID”.	
21	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled later using ALEOOWPP software for analysis of the word content data.	
22	Initialize the systems for operation. Use preprogrammed channel information from subtest 27.	“AMD call” Radios Required: UUT plus System B.	
23	Place call.	System A (callsign: A01) places AMD call to system B (callsign: B01). Radios should be in non-scan mode. AMD Message: “THE BROWN FOX”	
24	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled later using ALEOOWPP software for analysis of the word content data.	
25	After the link is established, observe system B and record the AMD message that system B received from system A.	Expected message: THE BROWN FOX	
26	Verify that system A can send, and system B can receive the given AMD messages. These calls should not be recorded.	1) “THE QUICK RED FOX JUMPED OVER THE LAZY BROWN DOG” 2) “01234567890@?”	
27	Record the messages received by system B.		
28	Use ALEOOWPP software to decode each wave file captured in this subtest.	ALEOOWPP software and instructions are available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	
29	Use ALEOOWPP software to check for redundant word failure.	Record results.	
30	Review decoded “Group call” recorded in step 5.	Expected scanning call: THRU B01 REP C01 THRU D01 REP E01 (repeated for T_{sc}) Expected leading call: TO B01 REP C01 TO D01 REP E01 TO B01 REP C01 TO D01 REP E01 TIS A01 Record actual results.	
31	Review decoded “Net call” recorded in step 8.	Expected scanning call: TO NA1 (repeated for T_{sc}) Expected leading call: TO NA1 TO NA1 TIS A01 Record actual results.	
32	Review decoded “Individual call” recorded in step 13.	Expected leading call: TO 8BS DATA YST REP EM@ TO 8BS DATA YST REP EM@ TIS A01 Record actual results.	

Table C-32.1. Procedures for Signal Structure and Coding Subtest (continued)

Step	Action	Settings/Action	Result
33	Review decoded "Individual call" recorded in step 16.	Expected scanning call: TO 123 (repeated for T_{sc}) Expected leading call: TO 123 TO 123 TIS A01 Record actual results.	
34	Use ALEOOWPP software to review the first 16 tones that were transmitted in the individual call recorded in step 16.	Expected tones: 1250, 750, 1250, 1500, 1500, 2500, 2500, 2000, 1500, 2000, 1500, 1000, 2000, 1250, 2000, 2000. These tones equate to bits W1 to W24: 011000011010010100100111 and bits G1 to G24: 010111010001111011111111 Record actual tones.	
35	Review decoded call recorded in step 18.	Expected call: TO B01 TO B01 TWAS A01 Record actual results.	
36	Review decoded "quick ID" recorded in step 21.	Record decoded call.	
37	Review decoded "AMD call" recorded in step 24.	Expected message: CMD THE DATA (sp)QU REP ICK DATA (sp)BR REP OWN DATA (sp)FO REP X.@ Record actual results.	

Legend: AMD – Automatic Message Display; JITC – Joint Interoperability Test Command; kHz – kilohertz; PC – Personal Computer; RF – Radio Frequency; T_{sc} – Length of Scanning Call; UUT – Unit Under Test; WAV – Wave

C-32.4 Presentation of Results. The results will be shown in tabular format (table C-32.2) indicating the requirement and measured value or indications of capability.

Table C-32.2. Signal Structure and Coding Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
54	A.4.2.3	The call shall not exceed 23 redundant words, the response three redundant words and the acknowledgement three redundant words. (See A.5.2.2.4 and annex A).	≤ 23 redundant words/call, ≤ 3 redundant words/ response, ≤ 3 redundant words/ acknowledgement			
68	A.5.2.2.2	Golay Coding. The Golay (24, 12, 3) FEC code is prescribed for this standard. The FEC code generator polynomial shall be: $g(x) = x^{11} + x^9 + x^7 + x^6 + x^5 + x + 1$ The generator matrix G, derived from g(x), shall contain an identity matrix I_{12} and a parity matrix P as shown in figure A-6. The corresponding parity check matrix H shall contain a transposed matrix p^T and an identity matrix I_{12} as shown in figure A-7.	bits W1 to W24: 011000011010010100100111 bits G1 to G24: 010111010001111011111111			

Table C-32.2. Signal Structure and Coding Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
69	A.5.2.2.2.1	Encoding. Encoding shall use the fundamental formula x = uG, where the code word x shall be derived from the data word u and the generator matrix G. Encoding is performed using the G matrix by summing (modulo-2) the rows of G for which the corresponding information bit is a "1." See figures A-6, A-8, and A-9a.	bits W1 to W24: 01100001101 00101001001 11 bits G1 to G24: 01011101000 11110111111 11			
70	A.5.2.2.3	Interleaving and Deinterleaving. The basic word bits W1 (most significant bit (MSB)) through W24 (LSB), and resultant Golay FEC bits G1 through G24 (with G13 through G24 inverted), shall be interleaved, before transmission using the pattern shown in figure A-10. The 48 interleaved bits plus a 49th stuff bit S49, (value = 0) shall constitute a transmitted word and they shall be transmitted A1, B1, A2, B2... A24, B24, S49 using 16-1/3 symbols (tones) per word (T_w) as described in A.5.1.3. At the receiver, and after 2/3 voting (see A.5.2.2.4), the first 48 received bits of the majority word (including remaining errors) shall be deinterleaved as shown in figure A-10 and then Golay FEC decoded to produce a correct(ed) 24 bit basic word (or an uncorrected error flag). The 49th stuff bit (S49) is ignored.	Successful ALEOOWPP decode. For example: TO 123 TO 123 TIS A01 bits W1 to W24: 01100001101 00101001001 11 bits G1 to G24: 01011101000 11110111111 11			

Table C-32.2. Signal Structure and Coding Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
71	A.5.2.2.4	Redundant Words. Each of the transmitted 49 bit (or 16-1/3 symbol) (T_w) words shall be sent redundantly (times 3) to reduce the effects of fading, interference, and noise.	No ALEOOWPP redundant word failure.			
72	A.5.2.3.1	ALE Word Format. The basic ALE word shall consist of 24 bits of information, designated W1 (MSB) through W24 (LSB). The bits shall be designated as shown in figure A-12.	bits W1 to W24: 01100001101 00101001001 11 correspond to tones: 1250, 750, 1250, 1500, 1500, 2500, 2500, 2000			
73	A.5.2.3.1.1	Structure. The word shall be divided into two parts: a three-bit preamble and a 21 bit data field (which often contains three 7-bit characters). The MSB for all parts, and the word, is to the left in figure A-12 and is sent earliest. Before transmission, the word shall be divided into two 12-bit halves (Golay code A and B in figure A-10) for FEC encoding as described in 5.2.2.	bits W1 to W24: 01100001101 00101001001 11 bits G1 to G24: 01011101000 11110111111 11 ALEOOWPP decode: TO 123 TO 123 TIS A01			
74	A.5.2.3.1.2	Word Types. The leading three bits, W1 through W3, are designated preamble bits P3 through P1, respectively. These preamble bits shall be used to identify one of eight possible word types.	THRU (001) TO (010) CMD (110) FROM (100) TIS (101) TWAS (011) DATA (000) REP (111)			
75	A.5.2.3.1.3	Preambles. The word types (and preambles) shall be as shown in table A-VIII and as described herein.	THRU TO CMD FROM TIS TWAS DATA REP			

Table C-32.2. Signal Structure and Coding Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
76	A.5.2.3.2.1	TO. The TO word (010) shall be used as a routing designator which shall indicate the address of the present destination station(s) which is (are) to directly receive the call. TO shall be used in the individual call protocols for single stations and in the net call protocols for multiple net-member stations which are called using a single net address. The TO word itself shall contain the first three characters of an address. For extended addresses, the additional address words (and characters) shall be contained in alternating DATA and REP words, which shall immediately follow.	Individual call: TO Net call: TO Group call: TO			
77	A.5.2.3.2.2	THIS IS (TIS). The TIS word (101) shall be used as a routing designator which shall indicate the address of the present calling (or sounding) station which is directly transmitting the call (or sound). Except for the use of TWAS, TIS shall be used in all ALE protocols to terminate the ALE frame and transmission. It shall indicate the continuation of the protocol or handshake, and shall direct, request, or invite (depending on the specific protocol) responses or acknowledgments from other called or receiving stations. The TIS shall be used to designate the call acceptance sound. The TIS word itself shall contain the first three characters of the calling stations address. For extended addresses, the additional address words (and characters) shall be contained in alternating DATA and REP words which shall immediately follow, exactly as described for whole addresses using the TO word and sequence.	Individual call: TIS Net call: TIS Group call: TIS			

Table C-32.2. Signal Structure and Coding Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
78	A.5.2.3.2.3	THIS WAS (TWAS). The TWAS word (011) shall be used as a routing designator exactly as the TIS, with the following variations. It shall indicate the termination of the ALE protocol or handshake, and shall reject, discourage, or not invite (depending on the specific protocol) responses or acknowledgments from other called or receiving stations. The TWAS shall be used to designate the call rejection sound. TIS shall not be used in the same frame as TWAS, as they are mutually exclusive.	Terminate link: TWAS			
79	A.5.2.3.2.4	NOTE: 1. The THRU word is also reserved for future implementation of indirect and relay protocols, in which cases it may be used elsewhere in the ALE frame and with whole addresses and other information. Stations designed in compliance with this nonrelay standard should ignore calls to them which employ their address in a THRU word in other than the scanning call.	Group call: THRU			
80	A.5.2.3.2.5	FROM. The FROM word (100) is an optional designator which shall be used to identify the transmitting station without using an ALE frame termination, such as TIS or TWAS. It shall contain the whole address of the transmitting station, using the FROM, and if required, the DATA and REP words, exactly as described in the TO address structure in A.5.2.3.2.1. It should be used only once in each ALE frame, and it shall be used only immediately preceding a command (CMD) in the message section. Under direction of the operator or controller, it should be used to provide a "quick ID" of the transmitting station when the normal conclusion may be delayed, such as when a long message section is to be used in an ALE frame.	Quick ID: FROM			

Table C-32.2. Signal Structure and Coding Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
81	A.5.2.3.3.1	CMD. The CMD word (110) is a special orderwire designator which shall be used for system-wide coordination, command, control, status, information, interoperation, and other special purposes. CMD shall be used in any combination between ALE stations and operators. CMD is an optional designator which is used only within the message section of the ALE frame, and it shall have (at some time in the frame) a preceding call and a following conclusion, to ensure designation of the intended receivers and identification of the sender. The first CMD terminates the calling cycle and indicates the start of the message section of the ALE frame. The orderwire functions are directed with the CMD itself, or when combined with the REP and DATA words. See A.5.6 for message words (orderwire messages) and functions.	AMD Call: CMD			
82	A.5.2.3.4.1	DATA. The DATA word (000) is a special designator which shall be used to extend the data field of any previous word type (except DATA itself) or to convey information in a message. When used with the routing designators TO, FROM, TIS, or TWAS, DATA shall perform address extension from the basic three characters to six, nine, or more (in multiples of three) when alternated with REP words. The selected limit for address extension is a total of 15 characters. When used with CMD, its function is predefined as specified in A.5.6 for message words (orderwire messages) and functions.	Individual call extended address: DATA AMD Call: DATA			

Table C-32.2. Signal Structure and Coding Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
83	A.5.2.3.4.2	REP. The REP word (111) is a special designator which shall be used to duplicate any previous preamble function or word meaning while changing the data field contents (bits W4 through W24). See table A-VIII. Any change of words or data field bits requires a change of preamble bits (P_3 through P_1) to preclude uncertainty and errors. If a word is to change, even if the data field is identical to that in the previous word, the preamble shall be changed, thereby clearly designating a word change. When used with the routing designator TO, REP performs address expansion, which enables more than one address to be specified. See A.5.2.3.2.4 for use with THRU. With DATA, REP may be used to extend and expand address, message, command, and status fields. REP shall be used to perform these functions, and it may directly follow any other word type except for itself, and except for TIS or TWAS, as there cannot be more than one transmitter for a specific call at a given time.	Group call: REP Individual call extended address: REP AMD Call: REP			
85	A.5.2.4.2	Basic 38 Subset. The Basic 38 subset shall include all capital alphabetics (A-Z) and all digits (0-9), plus designated utility and wildcard symbols "@" and "?," as shown in figure A-13. The Basic 38 subset shall be used for all basic addressing functions. To be a valid basic address, the word shall contain a routing preamble from A.5.2.3.2 (such as TO...), plus three alphanumeric characters (A-Z, 0-9) from the Basic 38 subset in any combination. In addition, the "@" and "?" symbols shall be used for special functions. Digital discrimination of the Basic 38 subset shall not be limited to examination of only the three MSBs (b_7 through b_5), as a total of 48 digital bit combinations would be possible (including ten invalid symbols which would be improperly accepted).	THE QUICK RED FOX JUMPED OVER THE LAZY BROWN DOG 01234567890 @?			

Table C-32.2. Signal Structure and Coding Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
90	A.5.2.4.5	<u>Net Addresses</u>. The purpose of a net call is to rapidly and efficiently establish contact with multiple prearranged (net) stations (simultaneously if possible) by the use of a single net address, which is an additional address assigned to all net members in common. When a net address type function is required, a calling ALE station shall use an address structure identical to the individual station address, basic or extended as necessary. For each net address at a net member's station, there shall be a response slot identifier, plus a slot width modifier if directed by the specific standard protocol. As described in paragraphs A.5.5.3 and A.5.5.4, additional information concerning the assigned response slots (and size) must be available, and the mixing of individual, net, and group addresses and calls is restricted.	TO NA1 TO NA1 TIS A01			
91	A.5.2.4.6	<u>Group Addresses</u>. The purpose of a group call is to establish contact with multiple nonprearranged (group) stations (simultaneously if possible) rapidly and efficiently by the use of a compact combination of their own addresses which are assigned individually. When a group address type function is required, a calling ALE station shall use a sequence of the actual individual station addresses of the called stations, in the manner directed by the specific standard protocol. A station's address shall not appear more than once in a group calling sequence, except as specifically permitted in the group calling protocols described in A.5.5.4.	Expected scanning call: THRU B01 REP C01 THRU D01 REP E01 (repeated for T_{sc}) Expected leading call: TO B01 REP C01 TO D01 REP E01 TO B01 REP C01 TO D01 REP E01 TIS A01			
Legend: ALE – Automatic Link Establishment; CMD – Command; FEC – Forward Error Correction; LSB – Least Significant Bit; MIL-STD – Military Standard; MSB – Most Significant Bit; Tw – Slot Wait Time; UUT – Unit Under Test						

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C-33 SUBTEST 33, WORD FRAMING AND SYNCHRONIZATION

C-33.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 98, 99, 100, 101, 102, and 103.

C-33.2 Criteria

a. Frame Structure. All ALE transmissions are based on the tones, timing, bit, and word structures described in MIL-STD-188-141B paragraphs A.5.1 and A.5.2.3. All calls shall be composed of a “frame,” which shall be constructed of contiguous redundant words in valid sequence(s) as described in MIL-STD-188-141B figure A-14, as limited in table A-VII, and in formats as described in MIL-STD-188-141B paragraph A.5.5. There are three basic frame sections: calling cycle, message, and conclusion. See paragraph A.5.2.5.5 for basic frame structure examples, MIL-STD-188-141B, paragraph A.5.2.5.

b. Calling Cycle. The initial section of all frames (except sounds) is termed a calling cycle (T_{cc}), and it is divided into two parts: a scanning call (T_{sc}) and a leading call (T_{lc}). The scanning call shall be composed of TO words if an individual or net call (or THRU and REP words, alternating, if a group call), which contain only the first word(s) of the called station(s) or net address. The leading call shall be composed of TO (and possibly DATA and REP) words containing the whole address(es) for the called station(s), from initiation of the leading call until the start of the message section or the conclusion (thus the end of the calling cycle). See MIL-STD-188-141B figure A-15. The use of REP and DATA is described in MIL-STD-188-141B paragraph A.5.2.4. The set of different address first words (T_{cl}) may be repeated as necessary for scanning calling (T_{sc}), to exceed the scan period (T_s). There is no unique “flag word” or “sync word” for frame synchronization (as discussed below). Therefore, stations may acquire and begin to read an ALE signal at any point after the start. The transmitter shall have reached at least 90 percent of the selected RF power within 2.5 msec of the first tone transmission following call initiation. The end of the calling cycle may be indicated by the start of the optional quick-ID, which occupies the first words in the message section, after the leading call and before the start of the rest of the message (or conclusion, if no message) section.

NOTES:
1) The frame time may need to be delayed (equipment manufacturer dependent) to avoid loss of the leading words if the transmitter Attack Time is significantly long. Alternatively, the modem may transmit repeated duplicates of the scanning cycle (set of) first word(s) to be sent (not to be counted in the frame) as the transmitter rises to full power (and may even use the ALE signal momentarily instead of a tuning tone for the tuner), and then start the frame when the power is up.
2) The 2.5-msec permissible delay of the first ALE tone, after the transmitter has reached 90 percent of selected power, is in addition to the allowable Attack Time delay specified in paragraph A.5.3.5.1.

3) Non-compliance with the 90 percent of power parameter will impact the probability of linking. Compliance testing for this can be construed to be met if the probability of linking criteria is met (see MIL-STD-188-141B table A-I), MIL-STD-188-141B, paragraph A.5.2.5.1.

c. Message Section. The second and optional section of all frames (except sounds) is termed a "message." Except for the quick-ID, it shall be composed of CMD (and possibly REP and DATA) words from the end of the calling cycle until the start of the conclusion (thus the end of the message). The optional quick-ID shall be composed of FROM (and possibly REP and DATA) word(s), containing the transmitter's whole address. It shall only be used once at the start of the CMD message section sequences. The quick-ID enables prompt transmitter identification and should be used if the message section length is a concern. It is never used without a following (CMD...) message(s). The message section shall always start with the first CMD (or FROM with later CMD(s)) in the call. See figure A-16. The use of REP and DATA is described in paragraph A.5.7.3. The message section is not repeated within the call (although messages or information itself, within the message section, may be). For AQC-ALE, the message section in AQC-ALE is available when in a link. The acknowledgement leg (third leg) of a call may be used as an inlink entry condition. See paragraph A.5.8.2.3, MIL-STD-188-141B, paragraph A.5.2.5.2.

d. Conclusion. The third section of all frames is termed a "conclusion." It shall be composed of either TIS or TWAS (but not both) (and possibly DATA and REP) words, from the end of the message (or calling cycle sections, if no message) until the end of the call. See figure A-17. Sounds and exception shall start immediately with TIS (or TWAS) words as described in paragraph A.5.3. REP shall not immediately follow TIS or TWAS. Both conclusions and sounds contain the whole address of the transmitting station, MIL-STD-188-141B, paragraph A.5.2.5.3.

e. Valid Sequences. The eight ALE word types that have been described shall be used to construct frames and messages only as permitted in figures A-18, A-19, and A-20. The size and duration of ALE frames, and their parts, shall be limited as described in table A-XII, MIL-STD-188-141B, paragraph A.5.2.5.4.

f. The ALE transmit modulator accepts digital data from the encoder and provides modulated baseband audio to the transmitter. The signal modulation is strictly timed as described in paragraphs A.5.1.3 and A.5.1.4. After the start of the first transmission by a station, the ALE transmit modulator shall maintain a constant phase relationship, within the specified timing accuracy, among all transmitted triple redundant words at all times until the final frame in the transmission is terminated. Specifically,

$$T_{(later\ triple\ redundant\ word)} - T_{(early\ triple\ redundant\ word)} = n \times T_{rw}$$

where $T_{(\,)}$ is the event time of a given triple redundant word within any frame, T_{rw} is the period of three words (392 msec), and n is any integer.

NOTE: Word phase tracking will only be implemented within a transmission and not between transmissions. The internal word phase reference of the transmit modulator shall be independent of the receiver (which tracks incoming signals) and shall be self-timed (within its required accuracy). See paragraph A.5.1.4.

NOTE: In some applications, a single transmission may contain several frames, MIL-STD-188-141B, paragraph A.5.2.6.1.

C-33.3   Test Procedures

a. Test Equipment Required

(1) Oscilloscope

(2) PC with Soundcard

(3) Attenuators

(4) Directional Coupler

(5) Receiver monitoring 12.000 MHz, USB

(6) Tee Connector

(7) UUT plus two radios similar to UUT

b. Test Configuration. Configure the equipment as shown in figures C-33.1 and C-33.2.

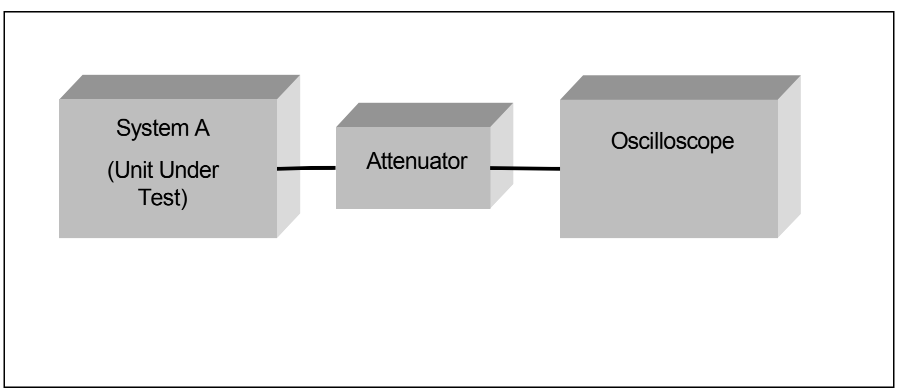

Figure C-33.1. Equipment Configuration to Measure RF Output Power

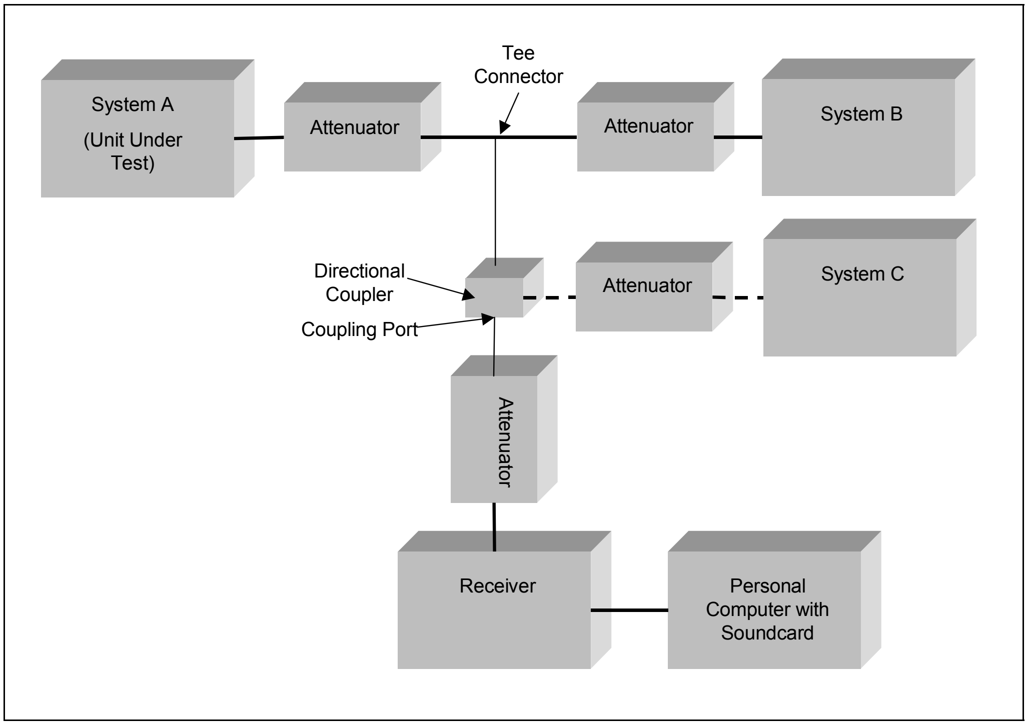

Figure C-33.2. Equipment Configuration for Word Framing and Synchronization

c. Test Conduct. The procedures for this subtest are listed in table C-33.1.

Table C-33.1. Procedures for Word Framing and Synchronization Subtest

Step	Action	Settings/Action	Result
The following procedure is for reference number 99.			
1	Set up equipment as shown in figure C-33.1.	Program radios in accordance with tables C-27.1 through C-27.6.	
2	Place an individual call from system A (callsign: A01) to address B01.	Set up oscilloscope to trigger on the rising edge of the RF transmission. Set horizontal scale to 1 msec/div. Store a single sweep.	
3	Using the oscilloscope's vertical delta markers, measure the time it took for the transmitter to reach 90 percent of its full RF output power.		
The following procedure is for reference numbers 98, 102, and 103.			
4	Set up equipment.	See figure C-33.2.	
5	Initialize the systems for operation. Use preprogrammed channel information from subtest 27.	"Individual call" Radios required: UUT plus system B.	
6	Configure the PC to record audio files in WAV format.	All WAV files must be sampled at 44.1 kHz, 16 bits, mono.	

Table C-33.1. Procedures for Word Framing and Synchronization Subtest (continued)

Step	Action	Settings/Action	Result
7	Place call.	System A (callsign: A01) places call to system B (callsign: B01). Radios should be in non-scan mode. Program system A to send CMD LQA.	
8	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled later using ALEOOWPP software for analysis of the word content data.	
9	After the link is established, observe system B and record the callsign(s) of the station(s) that appear to be linked with system B.	Expected link: A01	
10	Initialize the system for operation in a new scenario. Use preprogrammed channel information from subtest 27.	"Group call" Radios required: UUT plus systems B and C	
11	Program system A with self address 3AS, system B with self address 3BS, and system C with self address 3CS. Place call.	System A (callsign: 3AS) places group call to address GA6. Radios should be in non-scan mode. Group address GA6 should contain the following 1-word addresses: 3BS, 3CS, 3DS, and 3ES.	
12	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled later using ALEOOWPP software for analysis of the word content data.	
13	After the link is established, observe system B and record the callsign(s) of the station(s) that appear to be linked with system B.		
The following procedure is for reference numbers 98, 99, 100, 101, and 102.			
14	Use ALEOOWPP software to decode each file captured in this subtest. ALEOOWPP software and instructions are available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	Also, review all decoded calls from subtest 32. Subtest 32 calls will be used to validate the criteria from this subtest.	
15	Review decoded "Individual call" recorded in step 8.	Expected call: TO B01 TO B01 (CMD LQA) TIS A01 Record actual results.	
16	Review decoded "Group call" recorded in step 12.	Expected call: TO 3BS REP 3CS TO 3DS REP 3ES TO 3BS REP 3CS TO 3DS REP 3ES TIS 3AS Record actual results.	
17	Use wave editor software to review the WAV file captured in step 12.	Use this software to measure the length of the group call, in seconds.	
18	Program system A (callsign: A01) to place an individual call to system B (callsign: 15CHARACTERSELF)	Record call in WAV format.	

Table C-33.1. Procedures for Word Framing and Synchronization Subtest (continued)

Step	Action	Settings/Action	Result
19	Use wave editor software to review the WAV file captured in step 18.	Use this software to measure the length of the call, in seconds.	
20	Program system A (callsign: A01) to place an individual call to system B (callsign: 16CHARACTERSELF2)	Record action of UUT.	
21	Program system A (callsign: A01) to place a 90 character AMD call to system B (callsign: B01)	Record call in WAV format.	
22	Use wave editor software to review the WAV file captured in step 21.	Use this software to measure the length of the call, in seconds.	
23	Program system A (callsign: A01) to place a 91 character AMD call to system B (callsign: B01)	Record action of UUT.	
24	Program system A (callsign: A01) to place a 1053 character DTM call (if available) to system B (callsign: B01)	Record call in WAV format.	
25	Use wave editor software to review the WAV file captured in step 24.	Use this software to measure the length of the call, in seconds.	
26	Program system A (callsign: A01) to place a 1054 character DTM call (if available) to system B (callsign: B01)	Record action of UUT.	
27	Program system A (callsign: A01) to place a 37377 character DBM call (if available) to system B (callsign: B01)	Record call in WAV format.	
28	Use wave editor software to review the WAV file captured in step 27.	Use this software to measure the length of the call, in seconds.	
29	Program system A (callsign: A01) to place a 37378 character DBM call (if available) to system B (callsign: B01)	Record action of UUT.	
30	Use a stopwatch to measure the maximum scan period of the UUT.		
Legend: JITC – Joint Interoperability Test Command; PC – Personal Computer; RF – Radio Frequency; UUT – Unit Under Test; WAV – Wave			

C-33.4 Presentation of Results. The results will be shown in tabular format (table C-33.2) indicating the requirement and measured value or indications of capability.

Table C-33.2. Word Framing and Synchronization Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
98	A.5.2.5	Frame Structure. All ALE transmissions are based on the tones, timing, bit, and word structures described in paragraphs A.5.1 and A.5.2.3. All calls shall be composed of a "frame," which shall be constructed of contiguous redundant words in valid sequence(s) as described in figure A-14, as limited in table A-VII, and in formats as described in A.5.5. There are three basic frame sections: calling cycle, message, and conclusion. See A.5.2.5.5 for basic frame structure examples.	TO B01 TO B01 (CMD LQA) TIS A01			

Table C-33.2. Word Framing and Synchronization Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
99	A.5.2.5.1	Calling Cycle. The initial section of all frames (except sounds) is termed a calling cycle (T_{cc}), and it is divided into two parts: a scanning call (T_{sc}) and a leading call (T_{lc}). The scanning call shall be composed of TO words if an individual or net call (or THRU and REP words, alternating, if a group call), which contain only the first word(s) of the called station(s) or net address.	Net call: TO NA1 (repeated for T_{sc}) (Call decoded in subtest 32.)			
		The leading call shall be composed of TO (and possibly DATA and REP) words containing the whole address(es) for the called station(s), from initiation of the leading call until the start of the message section or the conclusion (thus the end of the calling cycle). See figure A-15. The use of REP and DATA is described in A.5.2.4. The set of different address first words (T_{cl}) may be repeated as necessary for scanning calling (T_{sc}), to exceed the scan period (T_s). There is no unique "flag word" or "sync word" for frame synchronization (as discussed below). Therefore, stations may acquire and begin to read an ALE signal at any point after the start.	Net call: TO NA1 TO NA1 TIS A01 Individual call: TO 8BS DATA YST REP EM@ TO 8BS DATA YST REP EM@ TIS A01 (Call decoded in subtest 32.)			
		The transmitter shall have reached at least 90 percent of the selected RF power within 2.5 msec of the first tone transmission following call initiation. The end of the calling cycle may be indicated by the start of the optional quick-ID, which occupies the first words in the message section, after the leading call and before the start of the rest of the message (or conclusion, if no message) section.	2.5 msec			

Table C-33.2. Word Framing and Synchronization Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
100	A.5.2.5.2	Message Section. The second and optional section of all frames (except sounds) is termed a "message." Except for the quick-ID, it shall be composed of CMD (and possibly REP and DATA) words from the end of the calling cycle until the start of the conclusion (thus the end of the message). The optional quick-ID shall be composed of FROM (and possibly REP and DATA) word(s), containing the transmitter's whole address. It shall only be used once at the start of the CMD message section sequences. The quick-ID enables prompt transmitter identification and should be used if the message section length is a concern. It is never used without a following (CMD...) message(s). The message section shall always start with the first CMD (or FROM with later CMD(s)) in the call. See figure A-16. The use of REP and DATA is described in A.5.7.3. The message section is not repeated within the call (although messages or information itself, within the message section, may be).	CMD THE DATA (sp)QU REP ICK DATA (sp)BR REP OWN DATA (sp)FO REP X.@ (Call decoded in subtest 32.)			
101	A.5.2.5.3	Conclusion. The third section of all frames is termed a "conclusion." It shall be composed of either TIS or TWAS (but not both) (and possibly DATA and REP) words, from the end of the message (or calling cycle sections, if no message) until the end of the call. See figure A-17. Sounds and exception shall start immediately with TIS (or TWAS) words as described in A.5.3. REP shall not immediately follow TIS or TWAS. Both conclusions and sounds contain the whole address of the transmitting station.	TO B01 TO B01 TWAS A01			

Table C-33.2. Word Framing and Synchronization Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
102	A.5.2.5.4	Valid Sequences. The eight ALE words types that have been described shall be used to construct frames and messages only as permitted in figures A-18, A-19, and A-20. The size and duration of ALE frames, and their parts, shall be limited as described in table A-XII.	THRU (001) TO (010) CMD (110) FROM (100) TIS (101) TWAS (011) DATA (000) REP (111) Address size limited to 5 words (15 characters). Maximum call time: 4704 msec. Maximum scan period: 50 sec. AMD limited to 90 characters, 11.76 sec. DTM limited to 1053 characters, 2.29 min. DBM limited to 37377 characters, 23.26 min.			

Table C-33.2. Word Framing and Synchronization Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
103	A.5.2.6.1	The ALE transmit modulator accepts digital data from the encoder and provides modulated baseband audio to the transmitter. The signal modulation is strictly timed as described in A.5.1.3 and A.5.1.4. After the start of the first transmission by a station, the ALE transmit modulator shall maintain a constant phase relationship, within the specified timing accuracy, among all transmitted triple redundant words at all times until the final frame in the transmission is terminated. Specifically, $T_{(later\ triple\ redundant\ word)} - T_{(early\ triple\ redundant\ word)} = n \times T_{rw}$ where $T_{(\ )}$ is the event time of a given triple redundant word within any frame, T_{rw} is the period of three words (392 msec), and n is any integer. NOTE: Word phase tracking will only be implemented within a transmission and not between transmissions. The internal word phase reference of the transmit modulator shall be independent of the receiver (which tracks incoming signals) and shall be self timed (within its required accuracy). See A.5.1.4.	Messages exchanged between linked stations. Length of call recorded in step 12 is multiple of 392 msec.			

Note: Some calls used to validate these criteria were decoded in Subtest 32.
Legend: ALE – Automatic Link Establishment; CMD – Command; LQA – Link Quality Analysis; MIL-STD – Military Standard; min – minute; msec – millisecond; sec – second

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C-34 SUBTEST 34, ADDRESSING

C-34.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 86, 88, 89, 92, 93, 94, 95, 96, and 97.

C-34.2 Criteria

a. Basic Size. The basic address word shall be composed of a routing preamble (TO, or possibly a REP which follows a TO, in T_{lc} of group call, or a TIS or TWAS) plus three address characters, all of which shall be alphanumeric numbers of the Basic 38 subset. The three characters in the basic individual address provide a Basic 38-address capacity of 46,656, using only the 36 alphanumerics. This three-character single word is the minimum structure. In addition, all ALE stations shall associate specific timing and control information with all own addresses, such as prearranged delays for slotted net responses. As described in paragraph A.5.5, the basic individual addresses of various station(s) may be combined to implement flexible linking and networking.

NOTE: All ALE stations shall be assigned at least one (DO: several) single-word address for automatic use in one-word address protocols, such as slotted (multistation type) responses. This is a mandatory user requirement, not a design requirement. However, nothing in the design shall preclude using longer addresses, MIL-STD-188-141B, paragraph A.5.2.4.4.1.

b. Extended Size. Extended addresses provide address fields which are longer than one word (three characters), up to a maximum system limit of five words (15 characters). See table A-X. This 15-character capacity enables Integrated Services Digital Network (ISDN) address capability. Specifically, the ALE extended address word structure shall be composed of an initial basic address word, such as TO or TIS, as described above, plus additional words as necessary to contain the additional characters in the sequence DATA, REP, DATA, REP, for a maximum total of five words. All address characters shall be the alphanumeric members of the Basic 38 subset.

NOTES:
1) All ALE stations shall be assigned at least one (DO: several) two-word address(es) for general use, plus an additional address(es) containing the station's assigned call sign(s). This is a mandatory user requirement, not a design requirement. However, nothing in the design shall preclude using longer addresses.
2) The recommended standard address size for intranet, internet, and general non-ISDN use is two words. Any requirement to operate with address sizes larger than six characters must be a network management decision. As examples of proper usage, a call to "EDWARD" would be "TO EDW," "DATA ARD," and a call to "MISSISSIPPI" would be "TO MIS," "DATA SIS," "REP SIP," "DATA PI@," MIL-STD-188-141B, paragraph A.5.2.4.4.2.

c. InLink Address. The inlink address feature is used by a system to denote that all members in the established link are to act upon the information sent in the frame containing the inlink address. The inlink address shall be '?@?'. When a radio enters the linked condition with one or more stations, the radio shall expand the set of recognized self addresses to include the inlink address ('?@?'). When a frame is transmitted by any member of the link using the inlink address, all members are thus addressed publicly and are to use the frame information. Thus, if a linked member sent an AMD message, all members would present that message to their user. If the member sent a frame terminated with a TWAS preamble, then all members would note that the transmitting station just 'left' the link. Short messages of 'to-?@?, to-?@?, tis-TALKINGMEMBER' would act as a keep-alive function and cause the receiving radio to extend any link termination timer, MIL-STD-188-141B, paragraph A.5.2.4.12.

d. Stuffing. The ALE basic address structure is based on single words which, in themselves, provide multiples of three characters. The quantity of available addresses within the system, and the flexibility of assigning addresses, are significantly increased by the use of address character stuffing. This technique allows address lengths that are not multiples of three to be compatibly contained in the standard (multiple of three characters) address fields by "stuffing" the empty trailing positions with the utility symbol "@." See table A-IX. "Stuff-1" and "Stuff-2" words shall only be used in the last word of an address, and therefore should appear only in the leading call (T_{lc}) of the calling cycle (T_{cc}), MIL-STD-188-141B, paragraph A.5.2.4.3.

e. AllCall Addresses. An "AllCall" is a general broadcast that does not request responses and does not designate any specific address. This mechanism is provided for emergencies ("HELP!"), broadcast data exchanges, and propagation and connectivity tracking. The global AllCall address is "@?@." The AllCall protocol is discussed in paragraph A.5.5.4.4. As a variation on the AllCall, the calling station can organize (or divide) the available but unspecified receiving stations into logical subsets, using a selective AllCall address. A selective AllCall is identical in structure, function, and protocol to the AllCall except that it specifies the last single character of the addresses of the desired subgroup of receiving stations (1/36 of all). By replacing the "?" with an alphanumeric, the selective AllCall special address pattern is "TO @A@" (or possibly "THRU @A@" and "REP @B@" if more than one subset is desired), where "A" (and "B," if applicable) in this notation represents any of the 36 alphanumerics in the Basic 38 subset. "A" and "B" may represent the same or different character from the subset, and specifically indicate which character(s) must be last in a station's address in order to stop scan and listen, MIL-STD-188-141B, paragraph A.5.2.4.7.

f. AnyCalls. An "AnyCall" is a general broadcast that requests responses without designating any specific addressee(s). It is required for emergencies, reconstitution of systems, and creation of new networks. An ALE station may use the AnyCall to generate responses from essentially unspecified stations, and it thereby can identify new stations and connectivities. The global AnyCall address is "@@?." The AnyCall protocol is discussed in paragraph A.5.5.4.5. If too many responses are received to an AnyCall, or if the caller must organize the available but unspecified responders into logical subsets, a selective AnyCall protocol is used. The selective AnyCall address is identical in structure, function, and protocol to the global AnyCall, except that it specifies the last single character of the addresses of the desired subset of receiving station (1/36 of all). By replacing the "?" with an alphanumeric, the global AnyCall becomes a selective AnyCall whose special address pattern is "TO @@A." If even narrower acceptance and response criteria are required, the double selective AnyCall should be used. The double selective AnyCall is an operator selected general broadcast which is identical to the selective AnyCall described above, except that its special address (using "@AB" format) specifies the last two characters that the desired subset of receiving stations must have to initiate a response, MIL-STD-188-141B, paragraph A.5.2.4.8.

g. Wildcards. A "wildcard" is a special character that the caller uses to address multiple-station addresses with a single-call address. The receivers shall accept the wildcard character as a substitute for any alphanumeric in their self addresses in the same position or positions. Therefore, each wildcard character shall substitute for any of 36 characters (A to Z, 0 to 9) in the Basic 38-character subset. The total lengths of the calling (wildcard) address, and the called addresses shall be the same. The special wildcard character shall be "?" (0111111). It shall substitute for any alphanumeric in the Basic 38-character subset. It shall substitute for only a single-address character position in an address, per wildcard character. See table A-XI of MIL-STD-188-141B for examples of acceptable patterns, MIL-STD-188-141B, paragraph A.5.2.4.9.

h. Self Addresses. For self test, maintenance, and other purposes, stations shall be capable of using their own self addresses in calls. When a self-addressing type function is required, ALE stations shall use the following self-addressing structures and protocols. Any ALE calling structures and protocols permissible within this standard, and containing a specifically addressed calling cycle (such as "TO ABC," but not AllCall or AnyCall), shall be acceptable, except that the station may substitute (or add) any one (or several) of its own calling addresses into the calling cycle, MIL-STD-188-141B, paragraph A.5.2.4.10.

i. Null Address. For test, maintenance, buffer times, and other purposes, the station shall use a null address that is not directed to, accepted by, or responded to by any station. When an ALE station requires a null address type function, it shall use the following null address protocol. The null address special address pattern shall be "TO @@@," (or "REP @@@"), if directly after another TO. The null address shall only use the TO (or REP), and only in the calling cycle (T_{cc}). Null addresses may be mixed with other addresses (group call), in which case they shall appear only in the leading call (T_{lc}), and not in the scanning call (T_{sc}). Nulls shall never be used in conclusion (terminator) (TIS or TWAS). If a null address appears in a group call, no station is designated to respond in the associated slot; therefore, it remains empty (and may be used as a buffer for tune-ups, or overflow from the previous slot's responder, etc.), MIL-STD-188-141B, paragraph A.5.2.4.11.

C-34.3 Test Procedures

a. Test Equipment Required

(1) PC with Soundcard

(2) Attenuators

(3) Receiver monitoring 12.000 MHz, USB

(4) Tee Connector

(6) Directional Coupler

(6) UUT plus two radios similar to UUT

b. Test Configuration. Configure the equipment as shown in figure C-34.1.

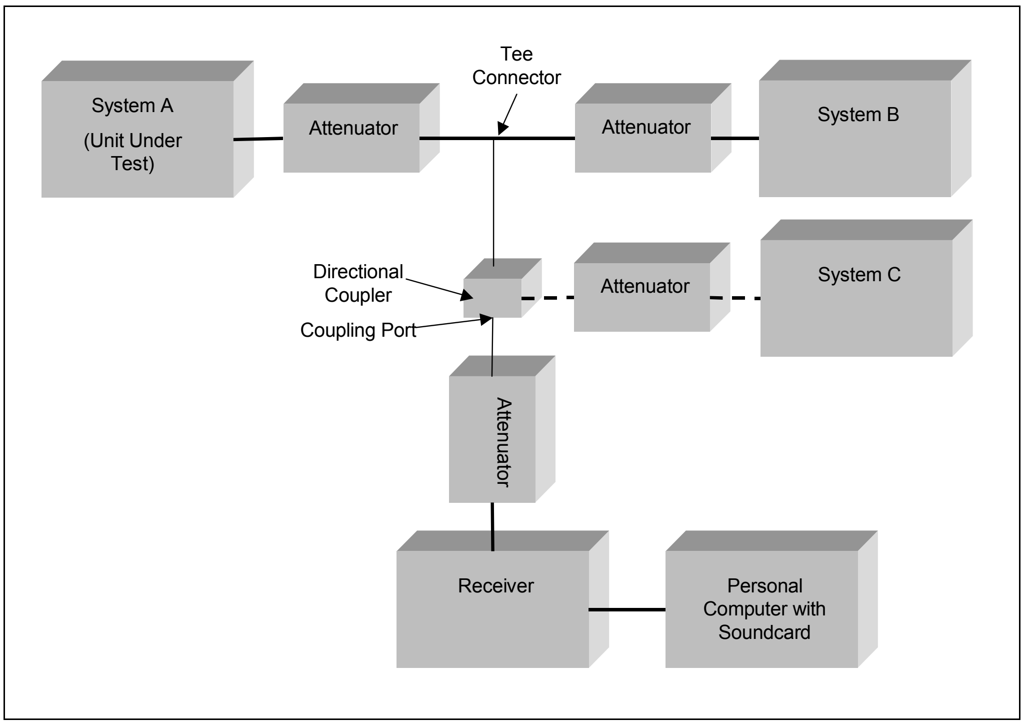

Figure C-34.1. Equipment Configuration for Addressing

c. Test Conduct. The procedures for this subtest are listed in table C-34.1.

Table C-34.1. Procedures for Addressing Subtest

Step	Action	Settings/Action	Result
The following procedure is for reference number 86.			
1	Set up equipment as shown in figure C-34.1.	Program radios in accordance with tables C-27.1 through C-27.6.	
2	Initialize the systems for operation.	"Stuffing" Radios required: UUT plus system B.	
3	Configure the PC to record audio files in WAV format.	All WAV files must be sampled at 44.1 kHz, 16 bits, mono.	
4	Place call.	System A (callsign: A) places call to system B (callsign: 2B). Radios should be in non-scan mode.	
5	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled later using ALEOOWPP software for analysis of the word content data.	
The following procedure is for reference number 89.			
6	Initialize the systems for operation in a new scenario. Use preprogrammed channel information from subtest 27.	"Extended word size" Radios required: UUT plus system B.	
7	Place call.	System A (callsign: 7EXTEND) places call to system B (callsign: 15EXTENDEDLIMIT). Radios should be in non-scan mode.	
8	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled later using ALEOOWPP software for analysis of the word content data.	
The following procedure is for reference number 92.			
9	Initialize the systems for operation in a new scenario. Use preprogrammed channel information from subtest 27.	"AllCall" Radios required: UUT plus systems B and C.	
10	Place call.	System A (program callsign 3AS into this radio) places call to AllCall address @?@. Systems B and C should be scanning channels 1 through 10. During an AllCall, the stations should link without a three-way handshake. Observe and record action of UUT during the AllCall.	
11	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled later using ALEOOWPP software for analysis of the word content data.	

Table C-34.1. Procedures for Addressing Subtest (continued)

Step	Action	Settings/Action	Result
The following procedure is for reference number 93.			
12	Initialize the systems for operation in a new scenario. Use preprogrammed channel information from subtest 27.	"AnyCall" Radios Required: UUT plus systems B and C.	
13	Place call.	System A (callsign: 3AS) places call to AnyCall address @@?. Systems B and C should be scanning channels 1 through 10.	
14	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled later using ALEOOWPP software for analysis of the word content data.	
The following procedure is for reference number 92.			
15	"Selective AllCall" Repeat steps 12 and 13 with UUT (callsign: 3AS) placing a call to Selective AllCall address @A@.		
16	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled later using ALEOOWPP software for analysis of the word content data.	
The following procedure is for reference number 93.			
17	"Selective AnyCall" Repeat steps 12 and 13 with UUT (callsign: 3AS) placing a call to Selective AnyCall address @AB.		
18	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled later using ALEOOWPP software for analysis of the word content data.	
The following procedure is for reference number 94.			
19	Proceed with operation in each of the following scenarios: "Wildcards" UUT plus Systems B and C. UUT (callsign: 3AS) places call to address ?B?. UUT (callsign: 3AS) places call to address ???. UUT (callsign: 3AS) places call to address ?B@. UUT (callsign: 3AS) places call to address ?@@. UUT (callsign: 3AS) places call to address @A?.		
20	Place all calls defined in step 19.		
21	At the audio out, use the PC to record the complete set of tones (for each call) in WAV format.	Record each file name. This file will be recalled later using ALEOOWPP software for analysis of the word content data.	
The following procedure is for reference number 96.			
22	Initialize the systems for operation in a new scenario. Use preprogrammed channel information from subtest 27.	"Null address" Radios required: UUT plus systems B and C.	
23	Place call.	System A (callsign: 3AS) places call using Null address @@@.	
24	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled later using ALEOOWPP software for analysis of the word content data.	

Table C-34.1. Procedures for Addressing Subtest (continued)

Step	Action	Settings/Action	Result
	The following procedure is for reference number 95.		
25	Initialize the systems for operation in a new scenario. Use preprogrammed channel information from subtest 27.	"Self address" Radios required: UUT plus systems B and C.	
26	Place call.	System A (callsign: 3AS) places call to Self address 3AS.	
27	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled later using ALEOOWPP software for analysis of the word content data.	
	The following procedure is for reference number 97.		
28	Initialize the systems for operation in a new scenario. Use preprogrammed channel information from subtest 27.	"In-Link address" Radios required: UUT plus systems B and C.	
29	Place call.	System A (callsign: A01) places call to Net address NA6.	
30	After link is established, program system A to send an AMD message to all stations in the established link.	At the audio out, use the PC to record the complete set of tones in WAV format. Record file name. Observe the action of systems A, B, and C. Record observations.	
31	Program system A to extend the link termination timer for all stations in the established link.	At the audio out, use the PC to record the complete set of tones in WAV format. Record file name. Observe the action of systems A, B, and C. Record observations.	
32	Send a frame from System A terminated with a TWAS preamble.	All members of the link should note that the transmitting station just 'left' the link. Observe and record action of the radios.	
33	Terminate link.		
34	After link is terminated, program system A to transmit a call to the In-Link address, ?@?.	Record action of systems B and C. Expected action: Because systems B and C are not in the linked state, they should ignore the In-Link call from system A. (Note: system A may not allow transmission of a call to the in-link address when it is not already in a link.)	
35	Use ALEOOWPP software to decode each WAV file captured in this subtest.	ALEOOWPP software and instructions are available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	
36	Review decoded "Stuffing" call recorded in step 5.	Reference number 86. Expected leading call: TO 2B@ TO 2B@ TIS A@@ Record actual results.	

Table C-34.1. Procedures for Addressing Subtest (continued)

Step	Action	Settings/Action	Result
37	Review decoded "Extended" call recorded in step 8.	Reference number 89. Expected leading call: TO 15E DATA XTE REP NDE DATA DLI REP MIT TO 15E DATA XTE REP NDE DATA DLI REP MIT TIS 7EX DATA TEN REP D@@ Record actual results.	
38	Review decoded AllCall recorded in step 11.	Reference number 92. Expected leading call: TO @?@ TO @?@ TIS 3AS Record actual results.	
39	Review decoded AnyCall recorded in step 14.	Reference number 93. Expected leading call: TO @@? TO @@? TIS 3AS Record actual results.	
40	Review decoded Selective AllCall recorded in step 16.	Reference number 92. Expected leading call: TO @A@ TO @A@ TIS 3AS Record actual results.	
41	Review decoded Wildcard calls recorded in step 21.	Reference number 94. Expected results: ?B?; ???; ?B@; ?@@; @A? Record actual results.	
42	Review decoded Null call recorded in step 24.	Reference number 96. Expected leading call: TO @@@ Record actual results.	
43	Review decoded Self call recorded in step 27.	Reference number 95. Expected leading call: TO 3AS TO 3AS TIS 3AS Record actual results.	
44	Review decoded In-Link AMD call recorded in step 30.	Reference number 97. Expected leading call: TO ?@? TO ?@? CMD [AMD] TIS A01 Record actual results.	

Table C-34.1. Procedures for Addressing Subtest (continued)

Step	Action	Settings/Action	Result
45	Review decoded In-Link "timer reset" call recorded in step 31.	Reference number 97. Expected leading call: TO ?@? TO ?@? TIS A01 Record actual results.	
The following procedure is for reference number 88.			
46	Decode file recorded in step 7 of subtest 33. Review decoded individual call.	Reference number 88. Expected leading call: TO 3BS TO 3BS TIS ABC Record actual results.	
Legend: JITC – Joint Interoperability Test Command; PC – Personal Computer; kHz – kilohertz; RF – Radio Frequency; UUT – Unit Under Test; WAV – Wave			

C-34.4 Presentation of Results. The results will be shown in tabular format (table C-34.2) indicating the requirement and measured value or indications of capability.

Table C-34.2. Addressing Subtest Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
86	A.5.2.4.3	Stuffing. The ALE basic address structure is based on single words which, in themselves, provide multiples of three characters. The quantity of available addresses within the system, and the flexibility of assigning addresses, are significantly increased by the use of address character stuffing. This technique allows address lengths that are not multiples of three to be compatibly contained in the standard (multiple of three characters) address fields by "stuffing" the empty trailing positions with the utility symbol "@." See table A-IX. "Stuff-1" and "Stuff-2" words shall only be used in the last word of an address, and therefore should appear only in the leading call (T_{lc}) of the calling cycle (T_{cc}).	TO 2B@ TO 2B@ TIS A@@			

Table C-34.2. Addressing Subtest Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
88	A.5.2.4.4.1	Basic Size. The basic address word shall be composed of a routing preamble (TO, or possibly a REP which follows a TO, in T_{lc} of group call, or a TIS or TWAS) plus three address characters, all of which shall be alphanumeric numbers of the Basic 38 subset. The three characters in the basic individual address provide a Basic 38-address capacity of 46,656, using only the 36 alphanumerics. This three-character single word is the minimum structure. In addition, all ALE stations shall associate specific timing and control information with all own addresses, such as prearranged delays for slotted net responses. As described in A.5.5, the basic individual addresses of various station(s) may be combined to implement flexible linking and networking. NOTE: All ALE stations shall be assigned at least one (DO: several) single-word address for automatic use in one-word address protocols, such as slotted (multistation type) responses. This is a mandatory user requirement, not a design requirement. However, nothing in the design shall preclude using longer addresses.	TO 3BS TO 3BS TIS ABC			

Table C-34.2. Addressing Subtest Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
89	A.5.2.4.4.2	Extended Size. Extended addresses provide address fields which are longer than one word (three characters), up to a maximum system limit of five words (15 characters). See table A-X. This 15-character capacity enables Integrated Services Digital Network (ISDN) address capability. Specifically, the ALE extended address word structure shall be composed of an initial basic address word, such as TO or TIS, as described above, plus additional words as necessary to contain the additional characters in the sequence DATA, REP, DATA, REP, for a maximum total of five words. All address characters shall be the alphanumeric members of the Basic 38 subset. NOTE 1: All ALE stations shall be assigned at least one (DO: several) two-word address(es) for general use, plus an additional address(es) containing the station's assigned call sign(s). This is a mandatory user requirement, not a design requirement. However, nothing in the design shall preclude using longer addresses. NOTE 2: The recommended standard address size for intranet, internet, and general non-ISDN use is two words. Any requirement to operate with address sizes larger than six characters must be a network management decision. As examples of proper usage, a call to "EDWARD" would be "TO EDW," "DATA ARD," and a call to "MISSISSIPPI" would be "TO MIS," "DATA SIS," "REP SIP," "DATA PI@."	TO 15E DATA XTE REP NDE DATA DLI REP MIT TO 15E DATA XTE REP NDE DATA DLI REP MIT TIS 7EX DATA TEN REP D@@			

Table C-34.2. Addressing Subtest Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
92	A.5.2.4.7	AllCall Addresses. An “AllCall” is a general broadcast that does not request responses and does not designate any specific address. This mechanism is provided for emergencies (“HELP!”), broadcast data exchanges, and propagation and connectivity tracking. The global AllCall address is “@?@.” The AllCall protocol is discussed in A.5.5.4.4. As a variation on the AllCall, the calling station can organize (or divide) the available but unspecified receiving stations into logical subsets, using a selective AllCall address. A selective AllCall is identical in structure, function, and protocol to the AllCall except that it specifies the last single character of the addresses of the desired subgroup of receiving stations (1/36 of all). By replacing the “?” with an alphanumeric, the selective AllCall special address pattern is “TO @A@” (or possibly “THRU @A@” and “REP @B@” if more than one subset is desired), where “A” (and “B,” if applicable) in this notation represents any of the 36 alphanumerics in the Basic-38 subset. “A” and “B” may represent the same or different character from the subset, and specifically indicate which character(s) must be last in a station’s address in order to stop scan and listen.	TO @?@			

Table C-34.2. Addressing Subtest Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
93	A.5.2.4.8	AnyCalls. An “AnyCall” is a general broadcast that requests responses without designating any specific addressee(s). It is required for emergencies, reconstitution of systems, and creation of new networks. An ALE station may use the AnyCall to generate responses from essentially unspecified stations, and it thereby can identify new stations and connectivities. The global AnyCall address is “@@?.” The AnyCall protocol is discussed in A.5.5.4.5. If too many responses are received to an AnyCall, or if the caller must organize the available but unspecified responders into logical subsets, a selective AnyCall protocol is used. The selective AnyCall address is identical in structure, function, and protocol to the global AnyCall, except that it specifies the last single character of the addresses of the desired subset of receiving station (1/36 of all). By replacing the “?” with an alphanumeric, the global AnyCall becomes a selective AnyCall whose special address pattern is “TO @@A.” If even narrower acceptance and response criteria are required, the double selective AnyCall should be used. The double selective AnyCall is an operator selected general broadcast which is identical to the selective AnyCall described above, except that its special address (using “@AB” format) specifies the last two characters that the desired subset of receiving stations must have to initiate a response.	TO @@?			

Table C-34.2. Addressing Subtest Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
94	A.5.2.4.9	Wildcards. A "wildcard" is a special character that the caller uses to address multiple-station addresses with a single-call address. The receivers shall accept the wildcard character as a substitute for any alphanumeric in their self addresses in the same position or positions. Therefore, each wildcard character shall substitute for any of 36 characters (A to Z, 0 to 9) in the Basic 38-character subset. The total lengths of the calling (wildcard) address, and the called addresses shall be the same. The special wildcard character shall be "?" (0111111). It shall substitute for any alphanumeric in the Basic 38-character subset. It shall substitute for only a single-address character position in an address, per wildcard character. See table A-XI for examples of acceptable patterns.	?B? ??? ?B@ ?@@ @A?			
95	A.5.2.4.10	Self Addresses. For self test, maintenance, and other purposes, stations shall be capable of using their own self addresses in calls. When a self-addressing type function is required, ALE stations shall use the following self-addressing structures and protocols. Any ALE calling structures and protocols permissible within this standard, and containing a specifically addressed calling cycle (such as "TO ABC," but not AllCall or AnyCall), shall be acceptable, except that the station may substitute (or add) any one (or several) of its own calling addresses into the calling cycle.	TO 3AS			

Table C-34.2. Addressing Subtest Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
96	A.5.2.4.11	Null Address. For test, maintenance, buffer times, and other purposes, the station shall use a null address that is not directed to, accepted by, or responded to by any station. When an ALE station requires a null address type function, it shall use the following null address protocol. The null address special address pattern shall be "TO @@@," (or "REP @@@"), if directly after another TO. The null address shall only use the TO (or REP), and only in the calling cycle (T_{cc}). Null addresses may be mixed with other addresses (group call), in which case they shall appear only in the leading call (T_{lc}), and not in the scanning call (T_{sc}). Nulls shall never be used in conclusion (terminator) (TIS or TWAS). If a null address appears in a group call, no station is designated to respond in the associated slot; therefore, it remains empty (and may be used as a buffer for tune-ups, or overflow from the previous slot's responder, etc.).	TO @@@			

Table C-34.2. Addressing Subtest Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result: Required Value	Result: Measured Value	Finding: Met	Finding: Not Met
97	A.5.2.4.12	In-Link Address. The inlink address feature is used by a system to denote that all members in the established link are to act upon the information sent in the frame containing the inlink address. The inlink address shall be '?@?'. When a radio enters the linked condition with one or more stations, the radio shall expand the set of recognized self addresses to include the inlink address ('?@?'). When a frame is transmitted by any member of the link using the inlink address, all members are thus addressed publicly and are to use the frame information. Thus, if a linked member sent an AMD message, all members would present that message to their user. If the member sent a frame terminated with a TWAS preamble, then all members would note that the transmitting station just 'left' the link. Short messages of 'to-F?@?, to-?@?, tis-TALKINGMEMBER' would act as a keep-alive function and cause the receiving radio to extend any link termination timer.	AMD Message: TO ?@? TO ?@? CMD [AMD] TIS A01			
			Reset "wait for activity timer": TO ?@? TO ?@? TIS A01. All stations reset timers.			
			System A leaves link: TO ?@? TO ?@? TWAS A01. All stations note A01 left link.			
			Stations not in linked state ignore In-Link calls.			
			Receiving stations do not respond to AMD calls, timer resets, or when stations leave the link.			

Legend: ALE – Automatic Link Establishment; DO – Design Objective; MIL-STD – Military Standard; Tcc – Calling Cycle Time

C-35 SUBTEST 35, PROTOCOLS

C-35.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, paragraphs 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 154, 155, and 156.

C-35.2 Criteria

a. Link Establishment Protocols. An ALE controller shall control an attached HF SSB radio to support both manual and automatic link operation as described in the following paragraphs, MIL-STD-188-141B, paragraph A.5.5.

b. Manual Operation. The ALE controller shall support emergency control by the operator. Each ALE controller shall provide a manual control capability to permit an operator to directly operate the basic SSB radio in emergency situations. At all other times, the radio shall be under automated control, and the operator should operate the radio through its associated controller. The ALE controller's receiving and passive collection capability to be "always listening," such as monitoring for sounding signals or alerting the operator, shall not be impaired, MIL-STD-188-141B, paragraph A.5.5.1.

c. ALE. The fundamental protocol exchange for link establishment shall be the three-way handshake (see MIL-STD-188-141B appendix I for overview of Selective Calling). A three-way handshake is sufficient to establish a link between a calling station and a responding station. With the addition of slotted responses (described in MIL-STD-188-141B paragraph A.5.5.4.2), the same call/response/acknowledgement sequence can also link a single calling station to multiple responding stations, MIL-STD-188-141B, paragraph A.5.5.2.

d. ALE Channel Selection. A scanning calling station shall send ALE calls on its scanned channels in the order dictated by its channel selection algorithm. It shall link on the first channel it tries that supports a handshake with the called station(s), MIL-STD-188-141B, paragraph A.5.5.2.3.

e. Rejected Channel. If a channel is rejected after linking by the operator or controller as unsuitable, the ALE controller shall terminate the link in accordance with paragraph A.5.5.3.5 and shall update LQA data using measurements obtained during linking, MIL-STD-188-141B, paragraph A.5.5.2.3.1.

f. Exhausted Channel List. If a calling station has exhausted all of its prearranged scan set channels and failed to establish a link, it shall immediately return to normal receive scanning (the available state). It shall also alert the operator (and networking controller if present) that the calling attempt was unsuccessful, MIL-STD-188-141B, paragraph A.5.5.2.3.3.

g. End of Frame Detection. ALE controllers shall identify the end of a received ALE signal by the following methods. The controller shall search for a valid conclusion (TIS or TWAS, possibly followed by DATA and REP for a maximum of five words, or $T_{x\ max}$). The conclusion must maintain constant redundant word phase within itself (if a sound) and with associated previous words. The controller shall examine each successive redundant word phase (T_{rw}) following the TIS (or TWAS) for the first (of up to four) non-readable or invalid word(s). Failure to detect a proper word (or detection of an improper word) or detection of the last REP, plus the last word wait delay time, (T_{lww} or T_{rw}), shall indicate the end of the received transmission. The maximal acceptable terminator sequence is TIS (or TWAS), DATA, REP, DATA, REP, MIL-STD-188-141B, paragraph A.5.5.2.4.

h. One-to-One Calling. The protocol for establishing a link between two individual stations shall consist of three ALE frames: a call, a response, and an acknowledgement . The sequence of events and the timeouts involved are discussed in the following paragraphs using a calling station SAM and a called station JOE, MIL-STD-188-141B, paragraph A.5.5.3.

i. Sending an Individual Call. After selecting a channel for calling, the calling station (SAM) shall begin the protocol by first listening on the channel to avoid "disturbing active channels," and then tuning. If the called station (JOE) is known to be listening on the chosen channel (not scanning), the calling station shall transmit a single channel call that contains only a leading call and a conclusion (see upper frame in figure A-29). Otherwise, it shall send a longer calling cycle that precedes the leading call with a scanning call of sufficient length to capture the called station's receiver as it scans (lower frame in figure A-29). The duration of this scanning call shall be 2 T_{rw} for each channel that the called station is scanning. The scanning call section shall contain only the first word of the called station address, using a TO preamble, and repeated as necessary until the end of the scanning call section. The entire called station address shall be used in the leading call section, and shall be sent twice (see figure A-29) using a TO preamble each time the first word is sent and DATA and REP as required for additional words. Any message section CMDs shall be sent immediately following the leading call, followed by a conclusion containing the complete calling station address ("TIS SAM"). The calling station shall then wait a preset reply time to start to receive the called station's response. In the single channel case, the wait for reply time shall be T_{wr}, which includes anticipated round trip propagation delay and the called station's turnaround time. In the multichannel case, the calling station shall wait through a wait for reply and tune time (T_{wrt}), which also includes time for the called station to tune up on the chosen channel. If the expected reply from the called station does not start to arrive within the preset wait for reply time (T_{wr}) or wait for reply and tune time (T_{wrt}), the linking attempt on this channel has failed. At this point, if other channels in the scan set have not been tried, the linking attempt will normally start over on a new channel. Otherwise, the ALE controller shall return to the available state, and the calling station's operator or networking controller shall be notified of the failed linking attempt, MIL-STD-188-141B, paragraph A.5.5.3.1.

j. Receiving an Individual Call. When the called station (JOE) arrives on channel, sometime during its scan period T_s, and therefore during the calling station

SAM's longer scan calling time T_{sc}, the called station shall attempt to detect ALE signaling within its dwell time. If ALE signaling is detected, and the controller achieves word sync, it shall examine the received word to determine the appropriate action. If JOE reads "TO JOE" (or an acceptable equivalent according to protocols), the ALE controller shall stop scan, enter the linking state, and continue to read ALE words while waiting a preset, limited time T_{wce} for the calling cycle to end and the message or conclusion to begin. If the received word is potentially from a sound or some other protocol, the ALE controller shall process the word in accordance with that protocol. Otherwise, the ALE controller shall resume its previous state (e.g., available if it was scanning, linked if it was linked to another station). While reading a call in the linking state, the called station shall evaluate each new received word. The controller shall immediately abort the handshake and return to its previous state upon the occurrence of any of the following: It does not receive the start of a quick-ID, message, or frame conclusion within T_{wce}, or the start of a conclusion within T_{mmax} after the start of the message section; Any invalid sequence of ALE word preambles is received, except that during receipt of a scanning call, up to three contiguous words containing uncorrectable errors shall be tolerated without causing rejection of the frame; The end of the conclusion is not detected within T_{lww}, (plus the additional multiples of T_{rw} if an extended address) after the first word of the conclusion. If a quick-ID or a message section starts within T_{wce}, the called station, (JOE) shall attempt to read one or more complete messages within a new preset, limited time $T_{mmax.}$ If a frame conclusion starts "TIS SAM," the called station shall wait and attempt to read the calling station's address (SAM) within a new preset, limited time T_{xmax}. If an acceptable conclusion sequence with TIS is read, the called station shall start a "last word wait" timeout $T_{lww} = T_{rw}$ while searching for additional address words (if any) and the end of the frame (absence of a detected word), which shall trigger its response. The called station will also expect the calling station to continue the handshake (with an acknowledgement) within the called station's reply window, $T_{wr,}$ after its response. If TWAS is read instead, the called station shall not respond but shall return to its previous state immediately after reading the entire calling station address. If all of the above criteria for responding are satisfied, the called station shall initiate an ALE response immediately after detecting the end of the call, unless otherwise directed by the operator or controller, MIL-STD-188-141B, paragraph A.5.5.3.2.

k. Response. Upon receipt of a call that is addressed to one of its own self addresses (JOE), and which contains a valid calling station address in a TIS conclusion (SAM), the called station shall listen for other traffic on the channel. If the channel is not in use, the station shall tune up, send a response (figure A-30), and start its own reply timer T_{wr}. (The longer T_{wrt} timeout is not necessary unless the calling station will send its acknowledgement on a different channel than the one carrying the call, requiring re-tuning.) If the channel is in use, the ALE controller shall ignore the call and return to its previous state unless otherwise programmed. If the calling station (SAM) successfully reads the beginning of an appropriate response ("TO SAM") starting within its timeout (either T_{wr} or T_{wrt}), it shall process the rest of the frame in accordance with the checks and timeouts described above for the call until it either aborts the handshake or receives the appropriate conclusion, which in this example is "TIS JOE." Specifically, the calling

station shall immediately abort the handshake upon the occurrence of any of the following: it does not receive an appropriate response calling cycle (“TO SAM”) starting within the timeout; an invalid sequence of ALE word preambles occurs;
it does not receive the appropriate conclusion (“TIS JOE”) starting within T_{lc} (plus $T_{m\ max}$, if message included); an end of the conclusion is not detected within T_{lww}, (plus the additional multiples of T_{rw} if an extended address). After aborting a handshake for any of the above reasons, the calling station will normally restart the calling protocol, usually on another channel. If the calling station receives the proper conclusion from the called station (“TIS JOE”) starting within T_{lc} (plus $T_{m\ max}$, if message included), it shall set a last word wait timeout as above and prepare to send an acknowledgement . If, instead, “TWAS JOE” is received, and the called station has rejected the linking attempt, the calling station ALE controller shall abort the linking attempt and inform the operator of the rejected attempt, MIL-STD-188-141B, paragraph A.5.5.3.3.

l. Acknowledgement . If all of the above criteria for an acceptable response are satisfied, and if not otherwise directed by the operator or networking controller, the calling station ALE controller shall alert its operator that a correct response has been received, send an ALE acknowledgement (see figure A-31), enter the linked state with the called station (JOE), and un-mute the speaker. A “wait for activity” timer T_{wa} shall be started (with a typical timeout of 30 seconds) that shall cause the link to be dropped if the link remains unused for extended periods (see paragraph A.5.5.3.5). If the called station (JOE) successfully reads the beginning of an appropriate acknowledgement (“TO JOE”) starting within its T_{wr} timeout, it shall process the rest of the frame in accordance with the checks and timeouts described above for the response until it either aborts the handshake or receives the appropriate conclusion, which in this example is “TIS SAM” or “TWAS SAM.” Specifically, the calling station shall immediately abort the handshake upon the occurrence of any of the following: it does not receive an appropriate response calling cycle (“TO JOE”) starting within its T_{wr} timeout; an invalid sequence of ALE word preambles occurs; it does not receive the appropriate conclusion starting within T_{lc} after the start of the frame (plus $T_{m\ max}$, if message included); the end of the conclusion is not detected within T_{lww}, (plus the additional multiples of T_{rw} if an extended address). If the handshake is aborted for any of the above reasons, the handshake has failed, and the called station ALE controller shall return to its pre-linking state. The called station shall notify the operator or controller of the failed linking attempt. Otherwise, the called station shall enter the linked state with the calling station (“SAM”), alert the operator (and network controller if present), un-mute the speaker, and set a wait-for-activity timeout T_{wa} between 9 and 14 seconds.

NOTES:
1) Although SAM’s acknowledgement to JOE appears identical to a single channel individual call from SAM to JOE, it does not cause JOE to provide another response to the acknowledgement (resulting in an endless “ping-pong” handshake) because SAM’s acknowledgement arrives within a narrow time window (T_{wr}) after JOE’s response, and an acknowledge (ACK) from SAM is expected within this window. If SAM’s acknowledgement arrives late (after T_{wr}), however, then JOE must treat it as a new

individual call (and shall therefore send a new response, if SAM concludes the frame with TIS).
2) A typical one-to-one scanning call three-way handshake takes between 9 and 14 seconds, MIL-STD-188-141B, paragraph A.5.5.3.4.

m. Link Termination. Termination of a link after a successful linking handshake shall be accomplished by sending a frame concluded with TWAS to any linked station(s) which is (are) to be terminated. For example, "TO JOE, TO JOE, TWAS SAM" (when sent by SAM) shall terminate the link between stations SAM and JOE. JOE shall immediately mute and return to the available state, unless it still retains a link with any other stations on the channel. Likewise, SAM shall also immediately mute and return to the available state, unless it retains a link with any other stations on the channel, MIL-STD-188-141B, paragraph A.5.5.3.5.

n. Manual Termination. A means shall be provided for operators to manually reset a station, which shall mute the speaker(s), return the ALE controller to the available state, and send a link terminating (TWAS) transmission, as specified above, to all linked stations, unless this latter feature is overridden by the operator. (DO: provide a manual disconnect feature that drops individual links while leaving others in place.) (MIL-STD-188-141B, paragraph A.5.5.3.5.1)

o. Automatic Termination. If no voice, data, or control traffic is sent or received by a station within a preset time limit for activity (T_{wa}), the ALE controller shall automatically mute the speaker, terminate the linked state with any linked stations, and return to the available state. The wait for the activity timer is mandatory, but shall also be capable of being disabled by the operator or network manager. This timed reset is not required to cause a termination (TWAS) transmission, as specified above. However, it is recommended that a termination be sent to reset the other linked stations(s) to immediately return them to the available state. Termination during a handshake or protocol by the use of TWAS (or a timer) should cause the receiving (or timed-out) station to end the handshake or protocol, terminate the link with that station, re-mute, and immediately return to the available state unless it still retains a link with another station, MIL-STD-188-141B, paragraph A.5.5.3.5.2.

p. Collision Detection. While receiving an ALE signal, it is possible for the continuity of the received signal to be lost (due to such factors as interference or fading) as indicated by failure to detect a good ALE word at a T_{rw} boundary. When one or both Golay words of a received ALE word contain uncorrectable errors, the ALE controller shall attempt to regain word sync, with a bias in favor of words that arrive with the same word phase as the interrupted frame. If word sync is reacquired but at a new word phase, this indicates that a collision has occurred. The interrupted frame shall be discarded, and the interrupting signal processed as a new ALE frame.

NOTE: Stations should be able to read interfering ALE signals, as they may contain useful (or critical) information, for which the station is "always listening," MIL-STD-188-141B, paragraph A.5.5.3.6.

q. AllCall Protocol. An AllCall requests all stations hearing it to stop and listen, but not respond. The AllCall special address structure(s) (see paragraph A.5.2.4.7) shall be the exclusive member(s) of the scanning call and the leading call, and shall not be used in any other address field or any other part of the handshake. The global AllCall address shall appear only in TO words. Selective AllCalls with more than one selective AllCall address, however, shall be sent using group addressing, using THRU during the scanning call and TO during the leading call. An AllCall pertains to an ALE controller when it is a global AllCall, or when a selective AllCall specifies a character that matches the last character of any self-address assigned to that station. Upon receipt of a pertinent AllCall, an ALE controller shall temporarily stop scanning and listen for a preset limited time, $T_{cc\ max}$. If a message section or frame conclusion does not arrive within $T_{cc\ max}$, the controller shall automatically resume scanning. If a quick-ID (an address beginning with a FROM word immediately after the calling cycle) arrives, the pause for the message section shall be extended for no more than five words (5 T_{rw}), and if a CMD does not arrive, the controller shall resume scanning. If a message arrives (indicated by receipt of a CMD), the controller shall pause for a preset limited time, $T_{m\ max}$ to read the message. If the frame conclusion does not arrive within $T_{m\ max}$, the controller shall automatically resume scanning. If a conclusion arrives (indicated by receipt of a TIS or TWAS), the controller shall pause (for a preset limited time, $T_{x\ max}$) to read the caller's address. If the end of the signal does not arrive within $T_{x\ max}$, the controller shall automatically resume scanning. If a pertinent AllCall frame is successfully received and is concluded with a TIS, the controller shall enter the linked state, alert the operator, un-mute its speaker and start a wait-for-activity timeout. If an AllCall is successfully received with a TWAS conclusion, the called controller shall automatically resume scanning and not respond (unless otherwise directed by the operator or controller). If a station receiving an AllCall desires to attempt to link with the calling station, the operator may initiate a handshake within the pause after a TIS conclusion. Note that in all handshakes (the initial AllCall does not constitute a handshake), the AllCall address shall not be used. To minimize possible adverse effects resulting from overuse or abuse of AllCalls, controllers shall have the capability to ignore AllCalls. Normally AllCall processing should be enabled, MIL-STD-188-141B, paragraph A.5.5.4.4.

r. AnyCall Protocol. An AnyCall is similar to an AllCall, but it instead requests responses. Use of the AnyCall special address structures is identical to that for the AllCall special address structures. Upon receipt of a pertinent AnyCall, an ALE controller shall temporarily stop scanning and examine the call identically to the procedure for AllCalls, including the $T_{cc\ max}$, $T_{m\ max}$, and $T_{x\ max}$ limits. If the AnyCall is successfully received, and is concluded with TIS, the controller shall enter the linking state and automatically generate a slotted response in accordance with paragraph A.5.5.4.1 and the following special procedure: because neither preprogrammed nor derived slot data are available, the controller shall randomly select a slot number, 1 through 16. Each slot shall be 20 T_w (2613.33...msec) wide, unless the calling station requests LQA responses, in which case the slots shall expand by 3 T_w to 23 T_w to accommodate the CMD LQA message section. The controller shall compute values for

T_{swt} and T_{wan} using this slot width and its random slot number. Slot 0 shall be used for tuning, as usual for slotted response protocols. Upon expiration of its T_{swt} timeout, the controller shall send a standard star net response consisting of TO (with the address of the caller) and TIS (with the address of the responder), with the LQA CMD included if requested. Responders shall use a self-address no longer than five words minus twice the caller address length. (For example, if the caller address is two words, the responder shall use a one-word address.) The AnyCall special address shall not be sent. In this protocol, collisions are expected and tolerated. The station sending the AnyCall shall attempt to read the best response in each slot. Upon receipt of the slotted responses, the calling station shall transmit an ACK to any subset of stations whose responses were read, using an individual or group address. The AnyCall special address shall not be used in the acknowledgement. The caller selects the conclusion of its ACK to either maintain the link for additional interoperation and traffic with the responders (TIS), or return everyone to scan (TWAS), as appropriate to the caller's original purpose. An ALE controller that responded to an AnyCall shall await and process the acknowledgement in accordance with paragraph A.5.5.4.3.6. To minimize possible adverse effects resulting from overuse or abuse of AnyCalls, controllers shall have the capability to ignore AnyCalls. Normally AnyCall processing should be enabled, MIL-STD-188-141B, paragraph A.5.5.4.5.

s. Wildcard Calling Protocol. Wildcard addresses shall be the exclusive members of a calling cycle in a call, and shall not be used in any other address sequence in the ALE frame or handshake. The span (number of cases possible) of the wildcard(s) used should be minimized to only the essential needs of the user(s). Calls to wildcard addresses that conclude with TWAS shall be processed identically to the AllCall protocol. Responses to wildcard calls that conclude with TIS shall be sent in pseudorandomly selected slots in accordance with the AnyCall protocol. As in both the AllCall and AnyCall, the controller shall be programmable to ignore wildcard calls, but wildcard call processing should normally be enabled, MIL-STD-188-141B, paragraph A.5.5.4.6.

C-35.3 Test Procedures

a. Test Equipment Required

(1) PC with Soundcard

(2) Attenuators

(3) Receiver monitoring 12.000 MHz, USB

(4) Directional Coupler

(5) Tee Connector

(6) UUT plus two radios similar to UUT

b. Test Configuration. Configure the equipment as shown in figure C-35.1.

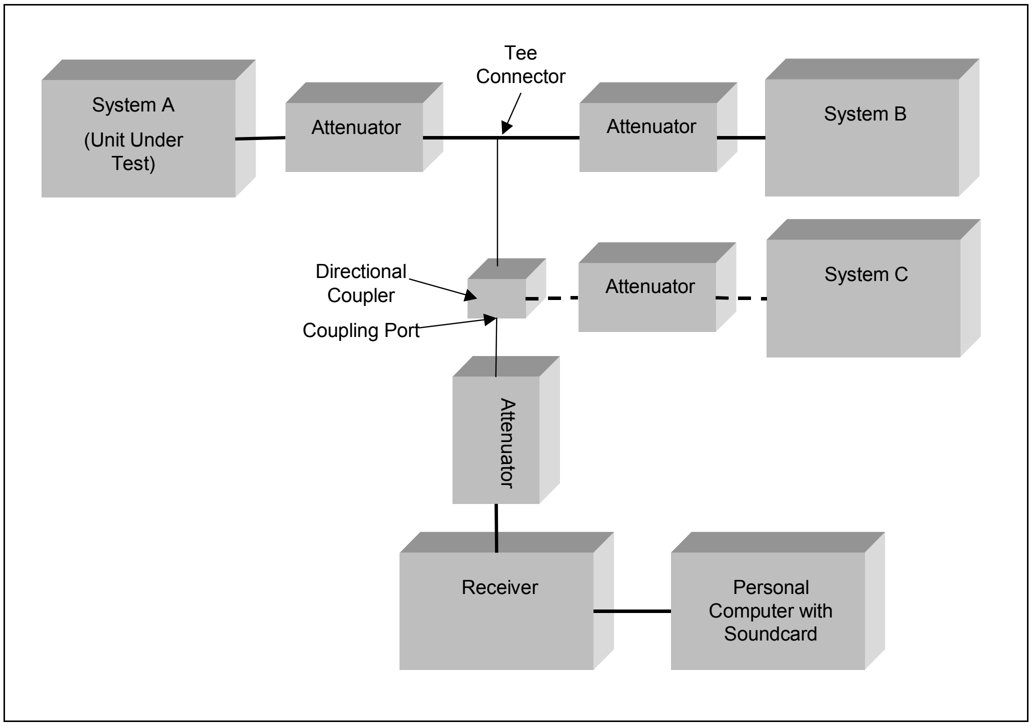

Figure C-35.1. Equipment Configuration for Protocol Subtest

c. Test Conduct. The procedures for this subtest are listed in table C-35.1.

Table C-35.1. Procedures for Protocol Subtest

Step	Action	Settings/Action	Result
The following procedure is for reference numbers 124 and 125.			
1	Set up equipment as shown in figure C-35.1.	Program radios in accordance with tables C-27.1 through C-27.6.	
2	Place systems A and B on channel 2. (Using preprogrammed channel information from subtest 27.)		
3	Without first linking radios, place a basic SSB voice call from system A to system B.	Record link quality.	
The following procedure is for reference numbers 125, 126, 127, 130, 131, 133, 136, and 137.			
4	Initialize the systems for operation.	Radios required: UUT plus system B.	
5	Place an individual call from system A (callsign: A01) to system B (callsign: B01). Systems A and B should be scanning channels 1 through 10.	Observe the action of both radios during and after the call. Record observations. Verify that the radios use a 3-way handshake to link.	
6	With the stations in the linked state, manually terminate the link.	Observe the action of both radios during and after the link termination. Record observations.	

Table C-35.1. Procedures for Protocol Subtest (continued)

Step	Action	Settings/Action	Result
The following procedure is for reference number 128.			
7	Review system A's LQA data.	Record LQA data.	
8	Place an individual call from system A (callsign: A01) to system B (callsign: B01).	After linking, reject the channel.	
9	Observe the action of both radios during and after the channel rejection. Record observations.		
10	Review System A's LQA data.	Record LQA data.	
The following procedure is for reference number 129.			
11	Initialize the systems for operation in a new scenario.	Radio required: UUT (systems B and C should not be part of the network).	
12	Place an individual call from System A (callsign: A01) to address B01. System A should be scanning channels 1 through 10.	Observe the action of the UUT during and after the call. Record observations. Expected: System A should call address B01 on all channels in the scan set. When system A has exhausted all of its prearranged scan set channels, it should immediately return to receive scanning, and alert the operator that the calling attempt was unsuccessful.	
The following procedure is for reference number 138.			
13	Initialize the systems for operation in a new scenario.	Radios required: UUT plus system B. Set system A's 'wait for activity' timer to 2 minutes.	
14	Place an individual call from system A (callsign: A01) to system B (callsign: B01).		
15	Using a stopwatch, time how long systems A and B remain linked before the link is automatically terminated.		
The following procedure is for reference numbers 132, 134, and 135.			
16	Review the call, response, and acknowledgement of the calls decoded in subtest 32. Use wave editor software to measure the length (in milliseconds) of the wait for reply times, and the duration of calls, as applicable.	Note differences between calls made with radios in scan mode versus non-scan mode. Expected: For non-scan mode, the wait for reply time should be T_{wr} (between 653.33 msec and 1306.66 msec). In scan mode, the wait for reply and tune time should be T_{wrt} (between 784 msec and 1960 msec). Duration of a call should be $2T_{rw}$ (784 msec) for each channel that the called station is scanning.	

Table C-35.1. Procedures for Protocol Subtest (continued)

Step	Action	Settings/Action	Result
The following procedure is for reference number 154.			
17	Initialize the systems for operation in a new scenario.	Radios required: UUT plus systems B and C.	
18	Place an AllCall from system A (callsign: A01). Systems B and C should be scanning channels 1 through 10.	Observe the action of the radios during and after the call. Record observations. Use a stop watch to measure T_{rw}, and T_x max as defined in reference number 154.	
19	Review the AllCalls decoded in subtest 34.		
20	Program system B to ignore AllCalls.		
21	Place an AllCall from system A (callsign: A01). Systems B and C should be scanning channels 1 through 10.	Observe the action of the radios during and after the call. Record observations. Expected: Systems A and C link, system B continues to scan.	
The following procedure is for reference number 155.			
22	Place an AnyCall from system A (callsign: A01). Do not request LQA responses. Systems B and C should be scanning channels 1 through 10.	Observe the action of the radios during and after the call. Record observations. Use a stop watch to measure T_w, T_{swt}, and T_{wan} as defined in reference number 155.	
23	Place an AnyCall from system A (callsign: A01). Program system A to request LQA responses. Systems B and C should be scanning channels 1 through 10.	Observe the action of the radios during and after the call. Record observations. Use a stop watch to measure T_w, T_{swt}, and T_{wan} as defined in reference number 155.	
24	Review the AnyCalls decoded in subtest 34.		
25	Program system B to ignore AnyCalls.		
26	Place an AnyCall from system A (callsign: A01). Systems B and C should be scanning channels 1 through 10.	Observe the action of the radios during and after the call. Record observations. Expected: Systems A and C link, system B continues to scan.	
The following procedure is for reference number 156.			
27	Place a Wildcard call from system A (callsign: A01). Conclude with TIS protocol. Systems B and C should be scanning channels 1 through 10.	Observe the action of the radios during and after the call. Record observations.	
28	Place a Wildcard call from system A (callsign: A01). Conclude with TWAS protocol. Systems B and C should be scanning channels 1 through 10.	Observe the action of the radios during and after the call. Record observations.	
29	Review the Wildcard calls decoded in subtest 34.		
30	Program system B to ignore Wildcard calls.		

Table C-35.1. Procedures for Protocol Subtest (continued)

Step	Action	Settings/Action	Result
31	Place a Wildcard call from system A (callsign: A01). Systems B and C should be scanning channels 1 through 10.	Observe the action of the radios during and after the call. Record observations.	
Legend: ALE – Automatic Link Establishment; LQA – Link Quality Analysis; SSB – Single Sideband; T - time			

C-35.4 Presentation of Results. The results will be shown in tabular format (table C-35.2) indicating the requirement and measured value or indications of capability.

Table C-35.2. Protocol Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
124	A.5.5	Link Establishment Protocols. An ALE controller shall control an attached HF SSB radio to support both manual and automatic link operation as described in the following paragraphs.	Manual and automatic operation.			
125	A.5.5.1	Manual Operation. The ALE controller shall support emergency control by the operator. Each ALE controller shall provide a manual control capability to permit an operator to directly operate the basic SSB radio in emergency situations. At all other times, the radio shall be under automated control, and the operator should operate the radio through its associated controller. The ALE controller's receiving and passive collection capability to be "always listening," such as monitoring for sounding signals or alerting the operator, shall not be impaired.	Manual operation of basic SSB radio.			
126	A.5.5.2	ALE. The fundamental protocol exchange for link establishment shall be the three-way handshake.	3-way handshake.			
127	A.5.5.2.3	ALE Channel Selection. A scanning calling station shall send ALE calls on its scanned channels in the order dictated by its channel selection algorithm. It shall link on the first channel it tries that supports a handshake with the called station(s).	Link on first channel that supports handshake.			

Table C-35.2. Protocol Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
128	A.5.5.2.3.1	Rejected Channel. If a channel is rejected after linking by the operator or controller as unsuitable, the ALE controller shall terminate the link in accordance with A.5.5.3.5 and shall update LQA data using measurements obtained during linking.	Terminate link on rejected channel.			
129	A.5.5.2.3.3	Exhausted Channel List. If a calling station has exhausted all of its prearranged scan set channels and failed to establish a link, it shall immediately return to normal receive scanning (the available state). It shall also alert the operator (and networking controller if present) that the calling attempt was unsuccessful.	Return to scan and alert operator.			
130	A.5.5.2.4	End of Frame Detection. ALE controllers shall identify the end of a received ALE signal by the following methods. The controller shall search for a valid conclusion (TIS or TWAS, possibly followed by DATA and REP for a maximum of five words, or $T_{x\ max}$).	TIS or TWAS			
131	A.5.5.3	One-to-One Calling. The protocol for establishing a link between two individual stations shall consist of three ALE frames: a call, a response, and an acknowledgement. The sequence of events, and the timeouts involved, are discussed in the following paragraphs using a calling station SAM and a called station JOE.	Call, response, acknowledgement.			

Table C-35.2. Protocol Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
132	A.5.5.3.1	Sending an Individual Call. After selecting a channel for calling, the calling station (SAM) shall begin the protocol by first listening on the channel to avoid "disturbing active channels," and then tuning. If the called station (JOE) is known to be listening on the chosen channel (not scanning), the calling station shall transmit a single channel call that contains only a leading call and a conclusion (see upper frame in figure A-29). Otherwise, it shall send a longer calling cycle that precedes the leading call with a scanning call of sufficient length to capture the called station's receiver as it scans (lower frame in figure A-29). The duration of this scanning call shall be 2 T_{rw} for each channel that the called station is scanning. The scanning call section shall contain only the first word of the called station address, using a TO preamble, and repeated as necessary until the end of the scanning call section.	Non-scan: Leading call only. Scan: Scan call plus leading call. For non-scan mode, the wait for reply time: T_{wr} = 653.33 msec to 1306.66 msec. In scan mode, the wait for reply and tune time: T_{wrt} = 784 msec to 1960 msec. Duration of a call: $2T_{rw}$ (784 msec) for each channel that the called station is scanning.			

Table C-35.2. Protocol Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
133	A.5.5.3.2	Receiving an Individual Call. When the called station (JOE) arrives on channel, sometime during its scan period T_s, and therefore during the calling station SAM's longer scan calling time T_{sc}, the called station shall attempt to detect ALE signaling within its dwell time. If ALE signaling is detected, and the controller achieves word sync, it shall examine the received word to determine the appropriate action. If JOE reads "TO JOE" (or an acceptable equivalent according to protocols), the ALE controller shall stop scan, enter the linking state, and continue to read ALE words while waiting a preset, limited time T_{wce} for the calling cycle to end and the message or conclusion to begin. If the received word is potentially from a sound or some other protocol, the ALE controller shall process the word in accordance with that protocol. Otherwise, the ALE controller shall resume its previous state (e.g., available if it was scanning, linked if it was linked to another station). While reading a call in the linking state, the called station shall evaluate each new received word. The controller shall immediately abort the handshake and return to its previous state upon the occurrence of any of the following: it does not receive the start of a quick-ID, message, or frame conclusion within T_{wce}, or the start of a conclusion within T_{mmax} after the start of the message section.	"A" sends TIS: "B" stops scanning, reads message, sends response, and waits for acknowledgement. "A" sends TWAS: "B" stops scanning, reads message, and immediately returns to scan.			

Table C-35.2. Protocol Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
134	A.5.5.3.3	Response. Upon receipt of a call that is addressed to one of its own self addresses (JOE), and which contains a valid calling station address in a TIS conclusion (SAM), the called station shall listen for other traffic on the channel. If the channel is not in use, the station shall tune up, send a response (figure A-30), and start its own reply timer T_{wr}. (The longer T_{wrt} timeout is not necessary unless the calling station will send its acknowledgement on a different channel than the one carrying the call, requiring re-tuning.) If the channel is in use, the ALE controller shall ignore the call and return to its previous state unless otherwise programmed.	TO A01 TO A01 TIS B01			
135	A.5.5.3.4	Acknowledgement. If all of the above criteria for an acceptable response are satisfied, and if not otherwise directed by the operator or networking controller, the calling station ALE controller shall alert its operator that a correct response has been received, send an ALE acknowledgement (see figure A-31), enter the linked state with the called station (JOE), and un-mute the speaker.	TO B01 TO B01 TIS A01			

Table C-35.2. Protocol Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
136	A.5.5.3.5	Link Termination. Termination of a link after a successful linking handshake shall be accomplished by sending a frame concluded with TWAS to any linked station(s) which is (are) to be terminated. For example, "TO JOE, TO JOE, TWAS SAM" (when sent by SAM) shall terminate the link between stations SAM and JOE. JOE shall immediately mute and return to the available state, unless it still retains a link with any other stations on the channel. Likewise, SAM shall also immediately mute and return to the available state, unless it retains a link with any other stations on the channel.	TWAS A01			
137	A.5.5.3.5.1	Manual Termination. A means shall be provided for operators to manually reset a station, which shall mute the speaker(s), return the ALE controller to the available state, and send a link terminating (TWAS) transmission, as specified above, to all linked stations, unless this latter feature is overridden by the operator. (DO: provide a manual disconnect feature that drops individual links while leaving others in place.)	Terminate link manually.			

Table C-35.2. Protocol Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
138	A.5.5.3.5.2	Automatic Termination. If no voice, data, or control traffic is sent or received by a station within a preset time limit for activity (T_{wa}), the ALE controller shall automatically mute the speaker, terminate the linked state with any linked stations, and return to the available state. The wait for the activity timer is mandatory, but shall also be capable of being disabled by the operator or network manager. This timed reset is not required to cause a termination (TWAS) transmission, as specified above. However, it is recommended that a termination be sent to reset the other linked station(s) to immediately return them to the available state. Termination during a handshake or protocol by the use of TWAS (or a timer) should cause the receiving (or timed-out) station to end the handshake or protocol, terminate the link with that station, re-mute, and immediately return to the available state unless it still retains a link with another station.	Automatically terminate link if no activity for 2 minutes.			

Table C-35.2. Protocol Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
154	A.5.5.4.4	AllCall Protocol. An AllCall requests all stations hearing it to stop and listen, but not respond. The AllCall special address structure(s) (see A.5.2.4.7) shall be the exclusive member(s) of the scanning call and the leading call, and shall not be used in any other address field or any other part of the handshake. The global AllCall address shall appear only in TO words. Selective AllCalls with more than one selective AllCall address, however, shall be sent using group addressing, using THRU during the scanning call and TO during the leading call. An AllCall pertains to an ALE controller when it is a global AllCall, or when a selective AllCall specifies a character that matches the last character of any self address assigned to that station. Upon receipt of a pertinent AllCall, an ALE controller shall temporarily stop scanning and listen for a preset limited time, $T_{cc\ max}$. If a quick-ID (an address beginning with a FROM word immediately after the calling cycle) arrives, the pause for the message section shall be extended for no more than five words (5 T_{rw}), and if a CMD does not arrive, the controller shall resume scanning. If a message arrives (indicated by receipt of a CMD), the controller shall pause for a preset limited time, $T_{m\ max}$ to read the message. If the frame conclusion does not arrive within $T_{m\ max}$, the controller shall automatically resume scanning. If a conclusion arrives (indicated by receipt of a TIS or TWAS), the controller shall pause (for a preset limited time, $T_{x\ max}$) to read the caller's address. If the end of the signal does not arrive within $T_{x\ max}$, the controller shall automatically resume scanning.	Link with AllCall TWAS: Return to scan Disable link with AllCall: No Link T_{rw}, and T_x max as defined in reference number 154.			

Table C-35.2. Protocol Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
155	A.5.5.4.5	AnyCall Protocol. An AnyCall is similar to an AllCall, but it instead requests responses. Use of the AnyCall special address structures is identical to that for the AllCall special address structures. Upon receipt of a pertinent AnyCall, an ALE controller shall temporarily stop scanning and examine the call identically to the procedure for AllCalls, including the $T_{cc\ max}$, $T_{m\ max}$, and $T_{x\ max}$ limits. If the AnyCall is successfully received, and is concluded with TIS, the controller shall enter the linking state and automatically generate a slotted response in accordance with A.5.5.4.1 and the following special procedure: because neither preprogrammed nor derived slot data are available, the controller shall randomly select a slot number, 1 through 16. Each slot shall be 20 T_w (2613.33...msec) wide, unless the calling station requests LQA responses, in which case the slots shall expand by 3 T_w to 23 T_w to accommodate the CMD LQA message section. The controller shall compute values for T_{swt} and T_{wan} using this slot width and its random slot number. Slot 0 shall be used for tuning, as usual for slotted response protocols. Upon expiration of its T_{swt} timeout, the controller shall send a standard star net response consisting of TO (with the address of the caller) and TIS (with the address of the responder), with the LQA CMD included if requested. Responders shall use a self address no longer than five words minus twice the caller address length. (For example, if the caller address is two words, the responder shall use a one-word address.) The AnyCall special address shall not be sent.	Respond in any slot between 1 and 16. Link if the UUT address is included in the acknowledgement. Disable linking with AnyCall. T_w, T_{swt}, and T_{wan} as defined in reference number 155.			

Table C-35.2. Protocol Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
156	A.5.5.4.6	Wildcard Calling Protocol. Wildcard addresses shall be the exclusive members of a calling cycle in a call, and shall not be used in any other address sequence in the ALE frame or handshake. The span (number of cases possible) of the wildcard(s) used should be minimized to only the essential needs of the user(s). Calls to wildcard addresses that conclude with TWAS shall be processed identically to the AllCall protocol. Responses to wildcard calls that conclude with TIS shall be sent in pseudorandomly-selected slots in accordance with the AnyCall protocol. As in both the AllCall and AnyCall, the controller shall be programmable to ignore wildcard calls, but wildcard call processing should normally be enabled.	UUT responds in any slot between 1 and 16. Disable linking with Wildcard call: No Link TWAS: No response TIS: Response			

Legend: ALE – Automatic Link Establishment; AMD – Automatic Message Display; DO – Design Objective; HF – High Frequency; LQA – Link Quality Analysis; MIL-STD – Military Standard; PTT – Push to talk; SSB – Single Sideband; UUT – Unit Under Test

C-36 SUBTEST 36, SOUNDING

C-36.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, paragraphs 105, 106, and 107.

C-36.2 Criteria

a. Introduction. The sounding signal is a unilateral, one-way transmission performed at periodic intervals on unoccupied channels. To implement, a timer is added to the controller to periodically initiate sounding signals (if the channel is clear). Sounding is not an interactive, bilateral technique, such as polling. However, the identification of connectivity from a station by hearing its sounding signal does indicate a high probability (but not guarantee) of bilateral connectivity and it may be done passively at the receiver. Sounding uses the standard ALE signaling; any station can receive sounding signals. As a minimum, the signal (address) information shall be displayed to the operator and, for stations equipped with connectivity and LQA memories, the information shall be stored and used later for linking. If a station has had recent transmissions on any channels that are to be sounded on, it may not be necessary to sound on those channels again until the sounding interval, as restarted from those last transmissions, has elapsed. In addition, if a net (or group) of stations is polled, their responses shall serve as sounding signals for the other net (or group) receiving stations. All stations shall be capable of performing periodic sounding on clear prearranged channels. The sounding capability may be selectively activated by, and the period between sounds shall be adjustable by the operator or controller, according to system requirements. When available, and not otherwise committed or directed by the operator or controller, all ALE stations shall automatically and temporarily display the addresses of all stations heard, with an operator selectable alert, MIL-STD-188-141B, paragraph A.5.3.1.

b. Single Channel. The fundamental capability to automatically sound on a channel shall be in accordance with the sounding protocol as shown in figure A-22. As an option, stations may employ this protocol for single channel sounding, connectivity tracking, and the broadcast of their availability for calls and traffic. The basic protocol consists of only one part: the sound. The sound contains its own address ("TIS A"). If "A" is encouraging calls and receives one, "A" shall follow the sound with the optional handshake protocol described in paragraph A.5.3.4. If "A" plans to ignore calls, it shall use the TWAS, which advises "B" and the others not to attempt calls, and then "A" shall immediately return to normal "available." In some systems it is necessary for a multichannel station "A" to periodically sound to a single channel network, usually to inform them that he is active and available on that channel, although scanning. Upon receipt of "A's" sound, "B" (see figure A-23) and the other stations shall display "A's" address as a received sound and, if they have an LQA and connectivity memory, they shall store the connectivity information, MIL-STD-188-141B, paragraph A.5.3.2.

c. Multiple Channels. Sounding must be compatible with the scanning timing. All stations shall be capable of performing the scanning sounding protocols described herein, even if operating on a fixed frequency. See figures A-22, A-23, and A-24. These protocols establish and positively confirm unilateral connectivity between stations on any available mutually scanned channel, and they assist in the establishment of links between stations waiting for contact. Stations shall employ these protocols for multichannel sounding, connectivity tracking, and the broadcast of their availability for calls and traffic. All timing considerations and computations for individual scanning calling shall apply to scanning sounding, including sounding cycle times and (optional) handshake times. NOTE: The scanning sound is identical to the single channel sound except for the extension of the redundant sound time (T_{rs}) by adding words to the scan sounding time (T_{ss}) to form a scanning redundant sound time (T_{srs}); that is $T_{srs} = T_{ss} + T_{rs}$. The scan sounding time (T_{ss}) is identical in purpose to the scan calling time (T_{sc}) for an equivalent scanning situation, but it only uses the whole address of the transmitter. The channel-scanning sequences and selection criteria for individual scanning calling shall also apply to scanning sounding. The channels to be sounded are termed a “sound set,” and usually are identical to the “scan set” used for scanning. See figure A-23. In this illustration, station “A” is sounding and station “B” is scanning normally. If a station “A” plans to ignore calls (from “B”), which may follow “A’s” sound, the following call rejection scanning sounding protocol shall be used. In a manner identical to the previously described individual scanning call, “A” lands on the first channel in the scan set (1), waits (T_{wt}) to see if the channel is clear (3), tunes (T_t) its coupler, comes to full power, and initiates the frame of the scanning redundant sound times (T_{srs}). This scanning sound is computed to exceed “B’s” (and any others) scan period (T_s) by at least a redundant sound time (T_{rs}), which will ensure an available detection period exceeding T_{drw} = 784 msec. In this five-channel example, with “B” scanning at 5 chps, “A” sounds for at least 12 T_{rw} (4704 msec). “A” also uses “TWAS A,” redundantly to indicate that calls are not invited. Upon completion of the scanning sounding frame transmission, “A” immediately leaves the channel and goes to the next channel in the sound set. This procedure repeats until all channels have been sounded, or skipped if occupied. When the calling ALE station has exhausted all the prearranged sound set channels, it shall automatically return to the normal “available” receive scan mode. As shown in figure A-23, the timing of both “A” and “B” have been prearranged to ensure that “B” has at least one opportunity, on each channel, to arrive and “capture” “A’s” sound. Specifically, “B” arrives, detects sounds, waits for good words, reads at least three (redundant) “TWAS A” (in 3 to 4 T_w), stores the connectivity information (if capable), and departs immediately to resume scan. There are several specific protocol differences when station “A” plans to welcome calls after the sound. See figure A-24. In this illustration, “A” is sounding and “B” is scanning normally. If station “A” plans to welcome calls (from “B”), which may follow his sound, the following call acceptance scanning sounding protocol shall be used. In this protocol, “A” sounds for the same time period as before. However, since “A” is receptive to calls, he shall use his normal scanning dwell time (T_d) or his preset wait before transmit time (T_{wt}), whichever is longer, to listen for both channel activity and calls before sounding. If the channel is clear, “A” shall initiate the scanning sound identically to before, but with “TIS A.” At the end of the sounding frame, “A” shall wait for calls identically to the wait for reply and tune time (T_{wrt}) in the individual scanning calling protocol, in this case shown to be 6 T_w (for fast-tuning stations). During this wait, “A” shall (as always) be listening for calls that may coincidentally arrive even though unassociated with “A’s” sound, plus any other sound heard, which “A” shall store as connectivity information if polling-capable. If no calls are received, “A” shall leave the channel, MIL-STD-188-141B, paragraph A.5.3.3.

C-36.3 Test Procedures

a. Test Equipment Required

(1) PC with Soundcard

(2) Attenuators

(3) Receiver monitoring 12.000 MHz, USB

(4) Directional Coupler

(5) Tee Connector

(6) UUT plus two radios similar to UUT

b. Test Configuration. Configure the equipment as shown in figure C-36.1.

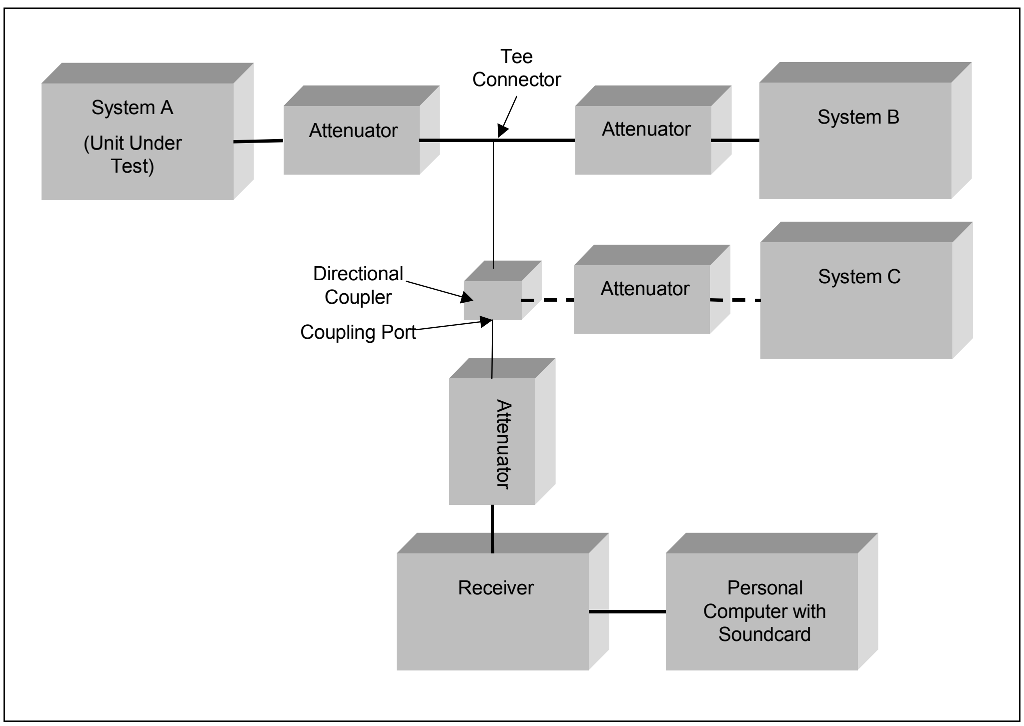

Figure C-36.1. Equipment Configuration for Sounding Subtest

c. Test Conduct. The procedures for this subtest are listed in table C-36.1.

Table C-36.1. Procedures for Sounding Subtest

Step	Action	Settings/Action	Result
The following procedure is for reference numbers 106 and 107.			
1	Set up equipment as shown in figure C-36.1.	Program radios in accordance with tables C-27.1 through C-27.6.	
2	Initialize the system for operation. Use preprogrammed channel information from subtest 27.	"Sounding" Radios required: UUT plus system B.	
3	Configure the PC to record audio files in WAV format.	All WAV files must be sampled at 44.1 kHz, 16 bits, mono.	
4	Place call.	System A (callsign: A01) places manual Sound call on a five channel scan list using "TWAS" protocol. System B should be scanning five channels per second.	
5	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled later using ALEOOWPP software for analysis of the word content data.	
6	Use wave editor software to review the WAV file captured in the previous step.	Use this software to measure the length (in seconds) of system A's Sound.	
The following procedure is for reference number 105.			
7	Observe System B as it receives sounding signals from system A.	Record any information displayed to the operator by system B.	
The following procedure is for reference numbers 106 and 107.			
8	Place call.	System A (callsign: A01) places manual Sound call on a five channel scan list using "TIS" protocol.	
9	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled using ALEOOWPP software for analysis of the word content data.	
10	Use wave editor software to review the WAV file captured in the previous step.	Use this software to measure the length of time (in seconds) that system A waits for a call before leaving the channel.	
The following procedure is for reference number 105.			
11	Observe system B as it receives sounding signals from system A.	Record any information displayed to the operator by system B.	
12	After System A Sounds on all five channels, review System B's LQA memories.	Record results.	
The following procedure is for reference numbers 106 and 107.			
13	Use ALEOOWPP software to decode file captured in steps 5 and 9.	ALEOOWPP software and instructions are available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	
14	Review decoded Sounding calls.	Record results.	
The following procedure is for reference numbers 105 and 107.			
15	Configure system A to Sound each channel on the scan list at five-minute intervals.	Using a stopwatch, measure the time interval between Sounds. Record results.	
16	Configure system A to Sound each channel on the scan list at 10-minute intervals.	Using a stopwatch, measure the time interval between Sounds. Record results.	

Table C-36.1. Procedures for Sounding Subtest (continued)

Step	Action	Settings/Action	Result
17	Configure system A to Sound while operating on a fixed frequency.	Record any information displayed to the operator by system B.	
Legend: JITC – Joint Interoperability Test Command; kHz – kilohertz; LQA – Link Quality Analysis; PC – Personal Computer; RF – Radio Frequency; UUT – Unit Under Test; WAV – Wave			

C-36.4 Presentation of Results. The results will be shown in tabular format (table C-36.2) indicating the requirement and measured value or indications of capability.

Table C-36.2. Sounding Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
105	A.5.3.1	Introduction. As a minimum, the signal (address) information shall be displayed to the operator and, for stations equipped with connectivity and LQA memories, the information shall be stored and used later for linking. In addition, if a net (or group) of stations is polled, their responses shall serve as sounding signals for the other net (or group) receiving stations. All stations shall be capable of performing periodic sounding on clear prearranged channels. The sounding capability may be selectively activated by, and the period between sounds shall be adjustable by the operator or controller, according to system requirements. When available, and not otherwise committed or directed by the operator or controller, all ALE stations shall automatically and temporarily display the addresses of all stations heard, with an operator selectable alert.	Address information displayed to operator: A01 LQA information stored. Sounding: 5-minute intervals, 10-minute intervals			

Table C-36.2. Sounding Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
106	A.5.3.2	Single Channel. The fundamental capability to automatically sound on a channel shall be in accordance with the sounding protocol as shown in figure A-22. If "A" is encouraging calls and receives one, "A" shall follow the sound with the optional handshake protocol described in A.5.3.4. If "A" plans to ignore calls, it shall use the TWAS, which advises "B" and the others not to attempt calls, and then "A" shall immediately return to normal "available." Upon receipt of "A's" sound, "B" (see figure A-23) and the other stations shall display "A's" address as a received sound and, if they have an LQA and connectivity memory, they shall store the connectivity information.	TIS TWAS			

Table C-36.2. Sounding Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
107	A.5.3.3	Multiple Channels. When the calling ALE station has exhausted all the prearranged sound set channels, it shall automatically return to the normal "available" receive scan mode. As shown in figure A-23, the timing of both "A" and "B" have been prearranged to ensure that "B" has at least one opportunity, on each channel, to arrive and "capture" "A's" sound. Specifically, "B" arrives, detects sounds, waits for good words, reads at least three (redundant) "TWAS A" (in 3 to 4 T_w), stores the connectivity information (if capable), and departs immediately to resume scan. There are several specific protocol differences when station "A" plans to welcome calls after the sound. See figure A-24. In this illustration, "A" is sounding and "B" is scanning normally. If station "A" plans to welcome calls (from "B"), which may follow his sound, the following call acceptance scanning sounding protocol shall be used. In this protocol, "A" sounds for the same time period as before. However, since "A" is receptive to calls, he shall use his normal scanning dwell time (T_d) or his preset wait before transmit time (T_{wt}), whichever is longer, to listen for both channel activity and calls before sounding. If the channel is clear, "A" shall initiate the scanning sound identically to before, but with "TIS A." At the end of the sounding frame, "A" shall wait for calls identically to the wait for reply and tune time (T_{wrt}) in the individual scanning calling protocol, in this case shown to be 6 T_w (for fast-tuning stations). During this wait, "A" shall (as always) be listening for calls that may coincidentally arrive even though unassociated with "A's" sound, plus any other sound heard, which "A" shall store as connectivity information if polling-capable. If no calls are received, "A" shall leave the channel.	Sound on channels 1 through 10. TWAS (redundantly) TIS (at the end of Sounding frame, System A should wait for calls for 6 T_w. If no calls are received, System A should leave the channel.) With System B scanning 5 channels, at 5 channels per second, System A Sounds for at least 4704 msec.			

Legend: ALE – Automatic Link Establishment; LQA – Link Quality Analysis; MIL-STD – Military Standard

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C-37 SUBTEST 37, MULTIPLE STATION OPERATION

C-37.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 58, 140, 141, 142, 143, 144, 145, 147, 148, 149, 150, 151, 152, and 153.

C-37.2 Criteria

a. Stations called by their net call address shall respond with their associated self (net member) address with the specified delay (T_{swt}(SN)). For example, the call is "GUY," thus the response is "BEN." Stations called individually by one of their self addresses (even if a net member address) shall respond immediately and with that address, as specified in the individual scanning calling protocol. Stations called by one of their self addresses (even if a net member address) within a group call shall respond in the derived slot, and with that address, as specified in the star group scanning protocol. If a station is called by one of its net addresses and has no associated net member address, it shall pause and listen but shall not respond (unless subsequently called separately with an available self or net member address), but shall enter the linked state, MIL-STD-188-141B, paragraph A.4.3.2.

b. Slotted Responses. The simple three-way handshake used for individual links cannot be used for one-to-many calling because the responses from the called stations would collide with each other. Instead, a time-division multiple access (TDMA) scheme is used. Each responding station shall send its response in an assigned or computed time slot as described later for the particular one-to-many protocol. At the end of a one-to-many call frame, the following events shall take place: the calling station shall set a wait-for-response-and-tune timeout (WRTT) that shall trigger its acknowledgement after the last response slot time has expired. The time allowed is denoted T_{wrn}. The value of T_{wrn} is described later for each one-to-many protocol. The called stations shall set their own WRTTs that bound their waiting times for an acknowledgement. To allow time for acquiring word sync during the leading call of the acknowledgement, the waiting time shall be set to $T_{wan} = T_{wrn} + 2\ T_{rw}$. Each called station shall also set a slot wait timeout T_{swt} that shall trigger its response. The called stations shall tune as required during the slot immediately following the end of the call frame, called slot 0. As each station's slot wait timer expires, it shall send its response and continue to await the expiration of its WRTT. Should that timer expire before the start of an acknowledgement from the calling station, the called station shall abort the linking attempt, and return to its pre-linking state, MIL-STD-188-141B, paragraph A.5.5.4.1.

c. Slotted Response Frames. Slotted response frames shall be formatted identically to responses in the one-to-one calling protocol (see figure A-32), including a leading call, an optional message section, and a frame conclusion. A responding station shall conclude its response with TIS to accept the call, or TWAS to reject it. When the calling and responding addresses are one word (as shown), slots are each 14 T_w, or about 1.8 seconds, MIL-STD-188-141B, paragraph A.5.5.4.1.1.

d. Slot Widths. Unless otherwise specified, all slots shall be 14 T_w in duration, which allows response frames with single-word addresses to propagate to and from the other side of the globe and use commonly available HF transceivers and tuners. When any slot is extended, all following slots shall be delayed commensurately. When the calling station address is longer than one word, every slot shall be extended by two T_{rw} (six T_w) per additional address word. When a called station address is longer than one word, its slot shall be extended by one T_{rw} (three T_w) per additional address word. Slots shall be extended by one T_{rw} (three T_w) for each ALE word to be sent in the message section of responses (including LQA CMD), MIL-STD-188-141B, paragraph A.5.5.4.1.2.

e. Star Net Call. A star net call is identical to a one-to-one call, except that the called station address is a net address, as shown in figure A-34. The calling station address shall be an individual station address (not a net or other collective address), MIL-STD-188-141B, paragraph A.5.5.4.2.1.

f. Star Net Response. When an ALE controller receives a call that is addressed to a net address that appears in its self address memory (see A.4.3.2), it shall process the call using the same checks and timeouts as an individual call (see A.5.5.3.2). If the call is acceptable, it shall respond in accordance with paragraph A.5.5.4.1 using its assigned net member address and slot number for the net address that was called, MIL-STD-188-141B, paragraph A.5.5.4.2.2.

g. Star Net Acknowledgement . A star net acknowledgement is identical to a one-to-one acknowledgement, except that the called station address is a net address. An ALE controller that has responded to a net call shall process the acknowledgement from the calling station in accordance with paragraph A.5.5.3.4, except that the wait-for-response timeout value shall be the T_{wan} timeout from paragraph A.5.5.4.1.3. A TWAS acknowledgement from the calling station shall return the called ALE controller to its pre-linking state. If a TIS acknowledgement is received from the calling station, the called ALE controller shall enter the linked state with the calling station (SAM in this example), alert the operator (and network controller if present), un-mute the speaker, and set a wait-for-activity timeout T_{wa}, MIL-STD-188-141B, paragraph A.5.5.4.2.3.

h. Star Group Scanning Call. A group address is produced by combining individual addresses of the stations that are to form the group. During a scanning call, only the first word(s) of addresses shall be sent, just as for individual or net calls. The set of unique first address words for the group members shall be sent repeatedly in rotation until the end of T_{sc}. These address words shall alternate between THRU and REP preambles (see figure A-35 for a sample group consisting of BOB, EDGAR, and SAM). When group member addresses share a common first word, that word shall be sent only once during T_{sc}. A limit of five unique first words may be sent in rotation during T_{sc}, MIL-STD-188-141B, paragraph A.5.5.4.3.1.

i. Star Group Leading Call. During T_{lc}, the complete addresses of the prospective group members shall be sent, using TO preambles as usual. Up to 12 address words total are allowed for the full addresses of group members, so T_{lc} in a group call may last up to 24 T_{rw}. Note in figure A-34 that when a TO word would follow another TO word, a REP preamble must be used, but when a TO follows any other word, it shall remain a TO, MIL-STD-188-141B, paragraph A.5.5.4.3.2.

j. Star Group Call Conclusion. The optional message section and the conclusion of a star group call shall be in accordance with paragraph A.5.2.5, MIL-STD-188-141B, paragraph A.5.5.4.3.3.

k. Receiving a Star Group Call. Slots shall be derived for group call responses by noting the order in which individual addresses appear in the call.

(1) When an ALE controller pauses on a channel carrying a group scanning call, it will read either a THRU or a REP preamble. If the address word in this first received word matches the first word of one of its individual addresses, the ALE controller shall stay to read the leading call. Otherwise, it shall continue to read first address words until it finds a match with the first word of a self address, or a repetition of a word it has already seen, or five unique words. (In the latter two cases, the station is not being called and the ALE controller shall return to the available or linked state as appropriate.)

(2) When T_{lc} starts, an ALE controller potentially addressed in the scanning call shall watch for its complete address. If found, a slot counter shall be set to 1 and incremented for each address that follows it. If that address is found again (as it should be, because the address list is repeated in T_{lc}), the counter shall be then reset to 1, and incremented for each following address as before. The number of words in each following address shall also be noted for use in computing T_{swt}.

(3) The message section (if any) and the frame conclusion shall be processed in accordance with paragraph A.5.5.3.2.

In the event that an addressed ALE controller arrives on channel too late to identify the size of the called group, it will be unable to compute the correct T_{wan}. In this situation, it shall use a default value for T_{wan}, which is equal to the longest possible group call of twelve one-word addresses. It will, however, have computed its correct slot number because to have received its own address it must also have received the addresses that followed that self-address in the leading call, MIL-STD-188-141B, paragraph A.5.5.4.3.4.

l. Star Group Slotted Responses. Slotted responses shall be sent and checked in accordance with paragraph A.5.5.4.1, using the derived slot numbers and the self-address contained in the leading call, MIL-STD-188-141B, paragraph A.5.5.4.3.5.

m. Star Group Acknowledgement. The acknowledgement in a group call handshake shall be addressed to any subset of the members originally called, and is usually limited to those whose responses were heard by the calling station. The leading call of the acknowledgement shall include the full addresses of the stations addressed, sent twice, using the same syntax as in the call (paragraph A.5.5.4.3.2). An ALE controller that responded to a group call shall await acknowledgement and process an incoming acknowledgement in accordance with paragraph A.5.5.3.4, with the following exceptions: the wait-for-response timeout value shall be the T_{wan} timeout from paragraph A.5.5.4.1.3, not $T_{wr.}$ Self-address detection shall search through the entire leading call group address. An ALE controller that responded but was not named in the acknowledgement shall return to its pre-linking state. An ALE controller that is addressed in the acknowledgement shall proceed as follows: a TWAS acknowledgement from the calling station shall return the called ALE controller to its pre-linking state. If a TIS acknowledgement is received from the calling station, the called ALE controller shall enter the linked state with the calling station (SAM in this example), alert the operator (and network controller if present), un-mute the speaker, and set a wait-for-activity timeout T_{wa}, MIL-STD-188-141B, paragraph A.5.5.4.3.6.

n. Star Group Call Example. In the example group call in figure A-35, SAMUEL will respond in slot 1, with $T_{swt} = 14\ T_w$ (the one-word address JOE causes slot 0 to be 14 T_w). EDGAR will respond in slot 2, with $T_{swt} = 14 + 17\ T_w = 31\ T_w$ (slot 1 is 17 T_w because of SAMUEL's two-word address). BOB will respond in slot 3, with $T_{swt} = 48\ T_w$. JOE will send an acknowledgement after 62 T_w, MIL-STD-188-141B, paragraph A.5.5.4.3.7.

o. Multiple Self Addresses in Group Call. If a station is addressed multiple times in a group call, even by different addresses, it shall properly respond to at least one address.

NOTE: The fact that the called station has multiple addresses may not be known to the caller. In some cases, it would be confusing or inappropriate to respond to one but not another address. Redundant calling address conflicts can be resolved after successful linking, if there is a problem, MIL-STD-188-141B, paragraph A.5.5.4.3.8.

C-37.3 Test Procedures

a. Test Equipment Required

(1) PC with Soundcard

(2) Attenuators

(3) Receiver monitoring 12.000 MHz, USB

(4) Directional Coupler

(5) Tee Connector

(6) UUT plus two radios similar to UUT

b. Test Configuration. Configure the equipment as shown in figure C-37.1.

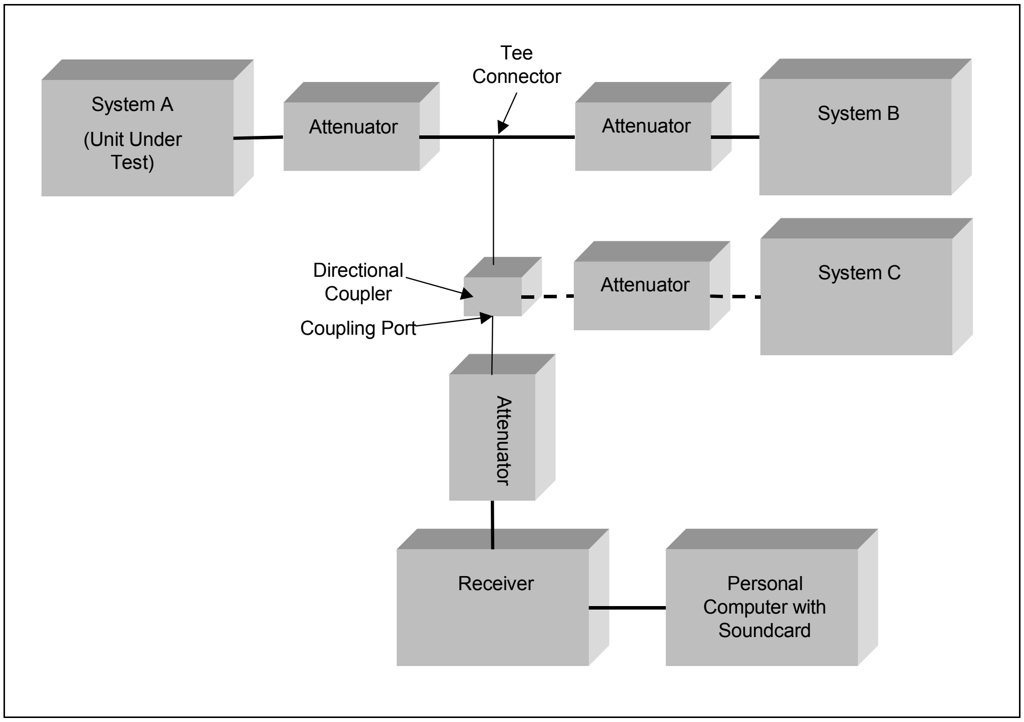

Figure C-37.1. Equipment Configuration for Multiple Station Operation Subtest

c. Test Conduct. The procedures for this subtest are listed in table C-37.1.

Table C-37.1. Procedures for Multiple Station Operation Subtest

Step	Action	Settings/Action	Result
The following procedure is for reference numbers 58, and 140 through 145			
1	Set up equipment as shown in figure C-37.1.	Program radios in accordance with tables C-27.1 through C-27.6.	
2	Initialize the systems for operation. Use preprogrammed channel information from subtest 27.	"Net call" Radios required: UUT plus systems B and C.	
3	Configure the PC to record audio files in WAV format.	All WAV files must be sampled at 44.1 kHz, 16 bits, mono.	
4	Place Net call.	System A (callsign: A01) places a net call to address NA1. Radios should be scanning channels 1 through 10. Net address NA1 should contain the following 1-word addresses: A01, B01, C01, D01, and E01. Record call.	

Table C-37.1. Procedures for Multiple Station Operation Subtest (continued)

Step	Action	Settings/Action	Result
5	Use wave editor software to view the WAV file captured in the previous step.	Use software to measure the Slot Widths of the call placed in the previous step. Record results. Expected: 14 T_w = 1829.24 msec	
6	Use ALEOOWPP software to decode the Net call. ALEOOWPP software and instructions are available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm		
7	Record the slotted responses.	Expected responses: Slot 2: TO A01 TO A01 TIS B01 Slot 3: TO A01 TO A01 TIS C01	
8	Record acknowledgement.	Expected acknowledgement: TO NA1 TO NA1 TIS A01	
9	After the link is established, observe system B and record the callsign(s) of the station(s) that appear to be linked with system B.	Expected link: A01	
10	Terminate the link manually from system A.		
11	After the link is terminated, observe system B and record the callsign(s) of the station(s) that appear to be linked with system B.	Expected link: NONE	
12	Place Net call from system A using a 2-word calling station address. Reprogram radios as required.	System A (callsign: A01EXT) places a net call to address NA1. Radios should be scanning channels 1 through 10. Net address NA1 should contain the following 1-word addresses: A01EXT, B01, C01, D01, and E01. Record call.	
13	Use wave editor software to view the WAV file captured in the previous step.	Use software to measure the Slot Widths of the call placed in the previous step. Record results. Expected: 23 T_w for A01EXT slot, all other slots 20 T_w	
14	Place Net call to a 2-word called station address. Reprogram radios as required.	System A (callsign: A01) places a net call to address NA6EXT. Radios should be scanning channels 1 through 10. Net address NA6EXT should contain the following 1-word addresses: A01, B01, C01, D01, and E01. Record call.	

Table C-37.1. Procedures for Multiple Station Operation Subtest (continued)

Step	Action	Settings/Action	Result
15	Use wave editor software to view the WAV file captured in the previous step.	Use software to measure the Slot Widths of the call placed in the previous step. Record results. Expected: 14 T_w = 1829.24 msec	
The following procedure is for reference numbers 146 through 153.			
16	Initialize the systems for operation. Use preprogrammed channel information from subtest 27.	"Group call" Radios Required: UUT plus systems B and C.	
17	Configure the PC to record audio files in WAV format.	All WAV files must be sampled at 44.1 kHz, 16 bits, mono.	
18	Place Group call. Reprogram radios as required.	System A (callsign: JOE) places a group call to the following addresses: BOB, SAMUEL, and SAMY. Record call.	
19	Use ALEOOWPP software to decode the Group call.		
20	Record the scanning call.	Expected scanning call: THRU BOB REP SAM THRU BOB REP SAM THRU BOB (repeated)	
21	Record the leading call.	Expected leading call: TO BOB REP SAM DATA UEL TO SAM DATA Y@@ TO BOB REP SAM DATA UEL TO SAM DATA Y@@ TIS JOE	
22	Record the slotted responses.	Expected responses: TO JOE TO JOE TIS SAM DATA UEL TO JOE TO JOE TIS SAM DATA Y@@	
23	Record acknowledgement.	Expected acknowledgement: TO SAM DATA UEL TO SAM DATA Y@@ TO SAM DATA UEL TO SAM DATA Y@@ TIS JOE	
24	Place Group call to six 1-word addresses. Reprogram radios as required.	System A (callsign: A01) places a group call to the following addresses: B01, C01, D01, E01, F01, and G01. Record call. (Note: the UUT may reject the command to program the illegal group. This should be also be considered as passing this requirement.)	
25	Use ALEOOWPP software to decode the Group call captured in the previous step.	Record the decoded scanning call. (Note: A limit of five unique first words may be sent in rotation during a scanning call.)	

Table C-37.1. Procedures for Multiple Station Operation Subtest (continued)

Step	Action	Settings/Action	Result
26	Place a Group call addressing B01 multiple times. Reprogram radios as required.	System A (callsign: A01) places a group call to the following addresses: B01, B01, and C01. Record call. (Note: UUT may not allow duplicate addresses to be programmed into a group.)	
27	Use ALEOOWPP software to decode the Group call captured in the previous step.	Record the decoded response. (Note: If a station is addressed multiple times in a group call, it should properly respond to at least one address.)	
28	After the link is established, observe system B and record the callsign(s) of the station(s) that appear to be linked with system B.		
29	Terminate the link manually from system A.		
30	After the link is terminated, observe system B and record the callsign(s) of the station(s) that appear to be linked with system B.	Expected link: NONE	
Legend: ALE – Automatic Link Establishment; JITC – Joint Interoperability Test Command; PC – Personal Computer; T – time; UUT – Unit Under Test; WAV – Wave			

C-37.4 Presentation of Results. The results will be shown in tabular format (table C-37.2) indicating the requirement and measured value or indications of capability.

Table C-37.2. Multiple Station Operation Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
58	A.4.3.2	Stations called by their net call address shall respond with their associated self (net member) address with the specified delay (T_{swt}(SN)). For example, the call is "GUY," thus the response is "BEN." Stations called individually by one of their self addresses (even if a net member address) shall respond immediately and with that address, as specified in the individual scanning calling protocol. Stations called by one of their self addresses (even if a net member address) within a group call shall respond in the derived slot, and with that address, as specified in the star group scanning protocol. If a station is called by one of its net addresses and has no associated net member address, it shall pause and listen but shall not respond (unless subsequently called separately with an available self or net member address), but shall enter the linked state.	Slot 2: TO A01 TO A01 TIS B01 Slot 3: TO A01 TO A01 TIS C01			

Table C-37.2. Multiple Station Operation Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
140	A.5.5.4.1	Slotted Responses. At the end of a one-to-many call frame, the following events shall take place: The calling station shall set a wait-for-response-and-tune timeout (WRTT) that shall trigger its acknowledgement after the last response slot time has expired. The time allowed is denoted T_{wrn}. The value of T_{wrn} is described later for each one-to-many protocol. The called stations shall set their own WRTTs that bound their waiting times for an acknowledgement. To allow time for acquiring word sync during the leading call of the acknowledgement, the waiting time shall be set to $T_{wan} = T_{wrn} + 2\ T_{rw}$. Each called station shall also set a slot wait timeout T_{swt} that shall trigger its response. The called stations shall tune as required during the slot immediately following the end of the call frame, called slot 0. As each station's slot wait timer expires, it shall send its response and continue to await the expiration of its WRTT. Should that timer expire before the start of an acknowledgement from the calling station, the called station shall abort the linking attempt, and return to its pre-linking state.	Link: A01, B01, C01			
141	A.5.5.4.1.1	Slotted Response Frames. Slotted response frames shall be formatted identically to responses in the one-to-one calling protocol (see figure A-32), including a leading call, an optional message section, and a frame conclusion. A responding station shall conclude its response with TIS to accept the call, or TWAS to reject it. When the calling and responding addresses are one-word (as shown), slots are each 14 T_w, or about 1.8 seconds.	TIS TWAS 1.8 seconds			

Table C-37.2. Multiple Station Operation Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
142	A.5.5.4.1.2	Slot Widths. Unless otherwise specified, all slots shall be 14 T_w in duration, which allows response frames with single-word addresses to propagate to and from the other side of the globe and use commonly available HF transceivers and tuners. When any slot is extended, all following slots shall be delayed commensurately. When the calling station address is longer than one word, every slot shall be extended by two T_{rw} (six T_w) per additional address word. When a called station address is longer than one word, its slot shall be extended by one T_{rw} (three T_w) per additional address word. Slots shall be extended by one T_{rw} (three T_w) for each ALE word to be sent in the message section of responses (including LQA CMD).	Expected: 23 T_w for A01EXT slot, all other slots 20 T_w			
143	A.5.5.4.2.1	Star Net Call. A star net call is identical to a one-to-one call, except that the called station address is a net address, as shown in figure A-34. The calling station address shall be an individual station address (not a net or other collective address).	Calling address is individual address 'TO NA1'			
144	A.5.5.4.2.2	Star Net Response. When an ALE controller receives a call that is addressed to a net address that appears in its self address memory (see A.4.3.2), it shall process the call using the same checks and timeouts as an individual call (see A.5.5.3.2). If the call is acceptable, it shall respond in accordance with A.5.5.4.1 using its assigned net member address and slot number for the net address that was called.	Slot 1: TO A01 TO A01 TIS B01 Slot 2: TO A01 TO A01 TIS C01			

Table C-37.2. Multiple Station Operation Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
145	A.5.5.4.2.3	Star Net Acknowledgement. A star net acknowledgement is identical to a one-to-one acknowledgement, except that the called station address is a net address. An ALE controller that has responded to a net call shall process the acknowledgement from the calling station in accordance with A.5.5.3.4, except that the wait-for-response timeout value shall be the T_{wan} timeout from A.5.5.4.1.3. A TWAS acknowledgement from the calling station shall return the called ALE controller to its pre-linking state. If a TIS acknowledgement is received from the calling station, the called ALE controller shall enter the linked state with the calling station (SAM in this example), alert the operator (and network controller if present), un-mute the speaker, and set a wait-for-activity timeout T_{wa}.	TO NA1 TO NA1 TIS A01			
146	A.5.5.4.3.1	Star Group Scanning Call. A group address is produced by combining individual addresses of the stations that are to form the group. During a scanning call, only the first word(s) of addresses shall be sent, just as for individual or net calls. The set of unique first address words for the group members shall be sent repeatedly in rotation until the end of T_{sc}. These address words shall alternate between THRU and REP preambles (see figure A-35 for a sample group consisting of BOB, EDGAR, and SAM). When group member addresses share a common first word, that word shall be sent only once during T_{sc}. A limit of five unique first words may be sent in rotation during T_{sc}.	THRU BOB REP SAM THRU BOB REP SAM THRU BOB (repeated) A limit of five unique first words sent in rotation during T_{sc}.			

Table C-37.2. Multiple Station Operation Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
147	A.5.5.4.3.2	Star Group Leading Call. During T_{lc}, the complete addresses of the prospective group members shall be sent, using TO preambles as usual. Up to 12 address words total are allowed for the full addresses of group members, so T_{lc} in a group call may last up to 24 T_{rw}. Note in figure A-34 that when a TO word would follow another TO word, a REP preamble must be used, but when a TO follows any other word it shall remain a TO.	TO BOB REP SAM DATA UEL TO SAM DATA Y@@ TO BOB REP SAM DATA UEL TO SAM DATA Y@@ TIS JOE			
148	A.5.5.4.3.3	Star Group Call Conclusion. The optional message section and the conclusion of a star group call shall be in accordance with A.5.2.5.	See paragraph A.5.2.5.			

Table C-37.2. Multiple Station Operation Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
149	A.5.5.4.3.4	Receiving a Star Group Call. Slots shall be derived for group call responses by noting the order in which individual addresses appear in the call. a. When an ALE controller pauses on a channel carrying a group scanning call, it will read either a THRU or a REP preamble. If the address word in this first received word matches the first word of one of its individual addresses, the ALE controller shall stay to read the leading call. Otherwise, it shall continue to read first address words until it finds: a match with the first word of a self address, or a repetition of a word it has already seen, or five unique words. b. When T_{lc} starts, an ALE controller potentially addressed in the scanning call shall watch for its complete address. If found, a slot counter shall be set to 1 and incremented for each address that follows it. If that address is found again (as it should be, because the address list is repeated in T_{lc}), the counter shall be then reset to 1, and incremented for each following address as before. The number of words in each following address shall also be noted for use in computing T_{swt}. c. The message section (if any) and the frame conclusion shall processed in accordance with A.5.5.3.2. In the event that an addressed ALE controller arrives on channel too late to identify the size of the called group, it will be unable to compute the correct T_{wan}.	Link: A01, B01, C01			
150	A.5.5.4.3.5	Star Group Slotted Responses. Slotted responses shall be sent and checked in accordance with A.5.5.4.1, using the derived slot numbers and the self address contained in the leading call.	TO JOE TO JOE TIS SAM DATA UEL TO JOE TO JOE TIS SAM DATA Y@@			

Table C-37.2. Multiple Station Operation Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
151	A.5.5.4.3.6	Star Group Acknowledgement. The acknowledgement in a group call handshake shall be addressed to any subset of the members originally called, and is usually limited to those whose responses were heard by the calling station. The leading call of the acknowledgement shall include the full addresses of the stations addressed, sent twice, using the same syntax as in the call (A.5.5.4.3.2). An ALE controller that responded to a group call shall await acknowledgement and process an incoming acknowledgement in accordance with A.5.5.3.4, with the following exceptions: the wait-for-response timeout value shall be the T_{wan} timeout from A.5.5.4.1.3, not T_{wr}. Self address detection shall search through the entire leading call group address. An ALE controller that responded but was not named in the acknowledgement shall return to its pre-linking state. An ALE controller that is addressed in the acknowledgement shall proceed as follows: A TWAS acknowledgement from the calling station shall return the called ALE controller to its pre-linking state. If a TIS acknowledgement is received from the calling station, the called ALE controller shall enter the linked state with the calling station (SAM in this example), alert the operator (and network controller if present), un-mute the speaker, and set a wait-for-activity timeout T_{wa}.	TO SAM DATA UEL TO SAM DATA Y@@ TO SAM DATA UEL TO SAM DATA Y@@ TIS JOE			

Table C-37.2. Multiple Station Operation Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
152	A.5.5.4.3.7	Star Group Call Example. In the example group call in figure A-35, SAMUEL will respond in slot 1, with T_{swt} = 14 T_w (the one-word address JOE causes slot 0 to be 14 T_w). EDGAR will respond in slot 2, with T_{swt} = 14 + 17 T_w = 31 T_w (slot 1 is 17 T_w because of SAMUEL's two-word address). BOB will respond in slot 3, with T_{swt} = 48 T_w. JOE will send an acknowledgement after 62 T_w.	THRU BOB REP SAM THRU BOB REP SAM THRU BOB (repeated) TO BOB REP SAM DATA UEL TO SAM DATA Y@@ TO BOB REP SAM DATA UEL TO SAM DATA Y@@ TIS JOE TO JOE TO JOE TIS SAM DATA UEL TO JOE TO JOE TIS SAM DATA Y@@ TO SAM DATA UEL TO SAM DATA Y@@ TO SAM DATA UEL TO SAM DATA Y@@ TIS JOE			
153	A.5.5.4.3.8	Multiple Self Addresses in Group Call. If a station is addressed multiple times in a group call, even by different addresses, it shall properly respond to at least one address. NOTE: The fact that the called station has multiple addresses may not be known to the caller. In some cases, it would be confusing or inappropriate to respond to one but not another address. Redundant calling address conflicts can be resolved after successful linking, if there is a problem.	Response from B01.			

Legend: ALE – Automatic Link Establishment; CMD – Command; HF – High Frequency; LQA – Link Quality Analysis; MIL-STD – Military Standard; WRTT – Wait-for-Response-and-Tune-Timeout

C-38 SUBTEST 38, AUTOMATIC MESSAGE DISPLAY

C-38.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 182, 183, 184, 185, and 186.

C-38.2 Criteria

a. Overview. Three message protocols are available for carrying user data using the ALE waveform and signal structure. The characteristics of these three protocols are summarized in table A-XXXI. All ALE controllers complying with this appendix shall implement the Automatic Message Display (AMD) protocol, MIL-STD-188-141B, paragraph A.5.7.1.

b. AMD Mode. The operators and controllers shall be able to send and receive simple ASCII text messages using only the existing station equipment, MIL-STD-188-141B, paragraph A.5.7.2.

c. Expanded 64-ASCII Subset. The expanded 64 ASCII subset shall include all capital alphabetics (A-Z), all digits (0-9), the utility symbols "@" and "?," plus 26 other commonly used symbols. See figure A-46. The expanded 64 subset shall be used for all basic orderwire message functions, plus special functions as may be standardized. For orderwire message use, the subset members shall be enclosed within a sequence of DATA (and REP) words and shall be preceded by an associated CMD (such as Data Text Messaging (DTM)). The CMD designates the usage of the information that follows, and shall also be preceded by a valid and appropriate calling cycle using the Basic 38 ASCII subset addressing. Digital discrimination of the expanded 64 ASCII subset may be accomplished by examination of the two MSBs (b_7 and b_6), as all of the members within the "01" and "10" MSBs are acceptable. No parity bits are transmitted because the integrity of the information is protected by the basic ALE Forward Error Correction (FEC) and redundancy and may be ensured by optional use of the CMD CRC as described in paragraph A.5.6.1. The station shall have the capability to both send and receive AMD messages from and to both the operator and the controller. The station shall also have the capability to display any received AMD messages directly to the operator and controller upon arrival, and to alert them. The operator and controller shall have the capability to disable the display and the alarm when their functions would be operationally inappropriate, MIL-STD-188-141B, paragraph A.5.7.2.1.

d. AMD Protocol. When an ASCII short orderwire AMD type function is required, the following CMD AMD protocol shall be used, unless another protocol in this standard is substituted. An AMD message shall be constructed in the standard word format, as described herein, and the AMD message shall be inserted in the message section of the frame. The receiving station shall be capable of receiving an AMD message contained in any ALE frame, including calls, responses, and acknowledgments. Within the AMD structure, the first word shall be a CMD AMD word, which shall contain the first three characters of the message. It shall be followed by a sequence of alternating DATA and REP words that shall contain the remainder of the message. The CMD, DATA, and REP words shall all contain only characters from the expanded ASCII 64 subset, which shall identify them as an AMD transmission. Each separate AMD message shall be kept intact and shall only be sent in a single frame, and in the exact sequence of the message itself. If one or two additional characters are required to fill the triplet in the last word sent, the position(s) shall be "stuffed" with the "space" character (0100000) automatically by the controller, without operator action. The end of the AMD message shall be indicated by the start of the frame conclusion, or by the receipt of another CMD. Multiple AMD messages may be sent within a frame, but they each shall start with their own CMD AMD with the first three characters, MIL-STD-188-141B, paragraph A.5.7.2.2.

e. Maximum AMD Message Size. Receipt of the CMD AMD word shall warn the receiving station that an AMD message is arriving and shall instruct it to alert the operator and controller and display the message, unless they disable these outputs. The station shall have the capability to distinguish among, and separately display, multiple separate AMD messages that were in one or several transmissions. The AMD word format shall consist of a CMD (110) in bits P3 through P1 (W1 through W3), followed by the three standard character fields C1, C2, and C3. In each character field, each character shall have its most significant bits (MSBs) bit 7 and bit 6 (C1-7 and C1-6, C2-7 and C2-6, and C3-7 and C3-6) set to the values of "01" or "10" (that is, all three characters are members of the expanded ASCII 64 subset). The rest of the AMD message shall be constructed identically, except for the alternating use of the DATA and REP preambles. Any quantity of AMD words may be sent within the message section of the frame within the $T_{m\ max}$ limitation of 30 words (90 characters). $T_{m\ max}$ shall be expanded from 30 words, to a maximum of 59 words, with the inclusion of CMD words within the message section. The maximum AMD message shall remain 30 words, exclusive of additional CMD words included within the message section of the frame. The maximum number of CMD words within the message section shall be 30. The message characters within the AMD structure shall be displayed verbatim as received. If a detectable information loss or error occurs, the station shall warn of this by the substitution of a unique and distinct error indication, such as all display elements activated (like a "block"). The display shall have a capacity of at least 20 characters (DO: at least 40). The AMD message storage capacity, for recall of the most recently received message(s), shall be at least 90 characters plus sending station address. (DO: at least 400). By operator or controller direction, the display shall be capable of reviewing all messages in the AMD memory and shall also be capable of identifying the originating station's address. If words are received that have the proper AMD format but are within a portion of the message section under the control of another message protocol (such as DTM), the other protocol shall take precedence and the words shall be ignored by the station's AMD function.

NOTE: If higher data integrity or reliability is required, the CMD DTM and Data Block Messaging (DBM) protocols should be used, MIL-STD-188-141B, paragraph A.5.7.2.3.

C-38.3 Test Procedures

a. Test Equipment Required

(1) Receiver monitoring 12.000 MHz, USB

(2) PC with Soundcard

(3) Attenuators

(4) Tee Connector

(5) UUT plus one additional outstation

b. Test Configuration. Configure the equipment as shown in figure C-38.1.

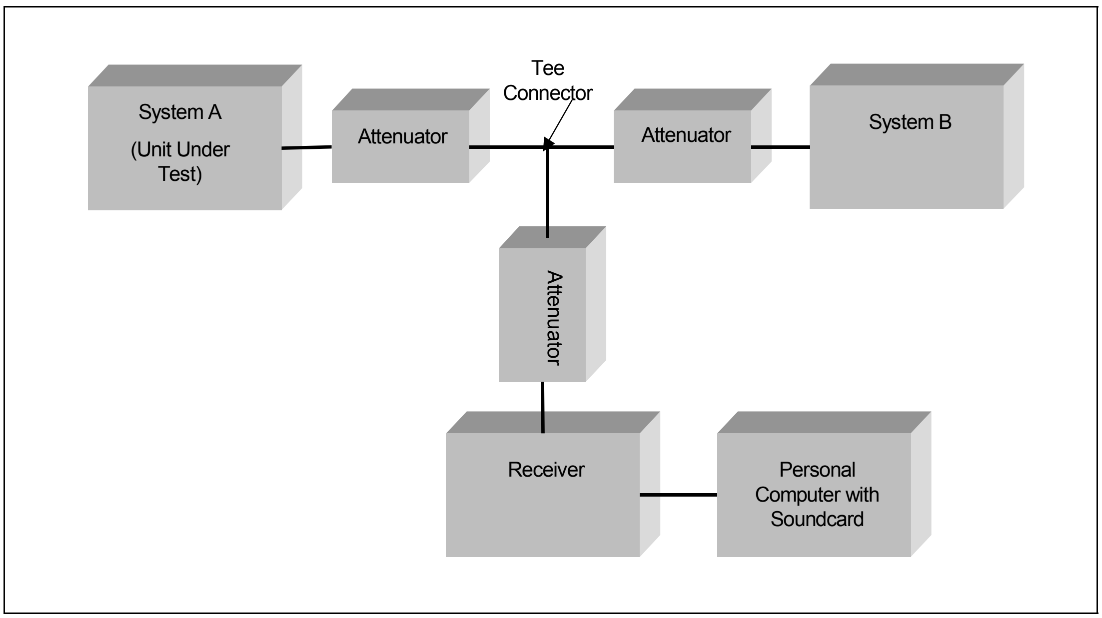

Figure C-38.1. Equipment Configuration for Automatic Message Display Subtest

c. Test Conduct. The procedures for this subtest are listed in table C-38.1.

Table C-38.1. Procedures for Automatic Message Display Subtest

Step	Action	Settings/Action	Result
The following procedure is for reference numbers 182, 183, 185, and 186.			
1	Set up equipment as shown in figure C-38.1. Use spectrum analyzer to verify that both radios in the network provide an equal RF level into the receiver.	Program radios in accordance with tables C-27.1 through C-27.6.	
2	Initialize the system. Use preprogrammed channel information from subtest 27.	Radios required: UUT plus system B.	
3	Attempt to program the following AMD message into the UUT: the quick red fox jumped over the lazy brown dog. (Note: Lowercase characters are not included in the Expanded 64 ASCII subset.)	Record message accepted by UUT.	
4	Program the given AMD messages into UUT.	1) "THE QUICK RED FOX JUMPED OVER THE LAZY BROWN DOG!" 2) 123456789012345678901234567890 123456789012345678901234567890 123456789012345678901234567890 3) #$%&')(*+,-./:;⇔?@[\]^ 4) THIS IS AN AMD MESSAGE FROM SYSTEM A. 5) EXPANDED 64 ASCII SUBSET 6) SOLVE FOR X: (50 + 25) * X = 150 7) 4^2 = 16 8) SEND AND RECEIVE SIMPLE ASCII TEXT MESSAGES USING EXISTING STATION EQUIPMENT. 9) ALE TEST MESSAGE #9	
5	Configure the PC to record audio files in WAV format.	All WAV files must be sampled at 44.1 kHz, 16 bits, mono.	
6	Place nine AMD calls. Each call should send a unique AMD message.	System A (callsign: A01) calls system B (callsign: B01).	
7	At the audio out, use the PC to record the complete set of tones for each call in WAV format.	Record file name.	
The following procedure is for reference numbers 183, 184, and 186.			
8	Observe system B during and after message transmission.	Record observations. (It is expected that system B will display the AMD message, and alert the operator of message reception.)	

Table C-38.1. Procedures for Automatic Message Display Subtest (continued)

Step	Action	Settings/Action	Result
9	After all messages are sent, observe system B and record the AMD messages that system B received from system A. Compare the messages sent by system A to the messages received by system B.	Record the maximum number of characters that can be displayed by the UUT. Record the maximum number of characters that can be stored by the UUT, for review by the operator or controller. Record results of message comparisons between systems A and B.	
10	Configure system B so that it will not display received AMD messages, or alert the operator when a message is received.		
11	Place an AMD call.	System A (callsign: A01) calls system B (callsign: B01) and sends AMD message #1.	
The following procedure is for reference number 184.			
12	Observe system B during and after message transmission.	Record observations. (It is expected that system B will not display the AMD message, or alert the operator of message reception.)	
The following procedure is for reference number 185.			
13	Use ALEOOWPP software to decode each call. ALEOOWPP software and instructions are available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	Expected results: AMD word format should consist of CMD, followed by three standard seven character fields, which is followed by alternating use of DATA and REP preambles until the complete AMD message is received. Record actual results.	
14	Is the AMD message located in the calling frame, conclusion frame, or optional response frame?		
15	Does the UUT use the optional "quick ID" (i.e., FROM A01)?		
Legend: AMD – Automatic Message Display; ASCII – American Standard Code for Information Interchange; CMD – Command; JITC – Joint Interoperability Test Command; kHz – kilohertz; PC – Personal Computer; REP – Repeat; RF – Radio Frequency; UUT – Unit Under Test; WAV – Wave			

C-38.4 Presentation of Results. The results will be shown in tabular format (table C-38.2) indicating the requirement and measured value or indications of capability.

Table C-38.2. Automatic Message Display Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result: Required Value	Result: Measured Value	Finding: Met	Finding: Not Met
182	A.5.7.1	Overview. Three message protocols are available for carrying user data using the ALE waveform and signal structure. The characteristics of these three protocols are summarized in the table A-XXXI. All ALE controllers complying with this appendix shall implement the AMD protocol.	UUT sends AMD messages 1 through 9.			
183	A.5.7.2	AMD Mode (Mandatory). The operators and controllers shall be able to send and receive simple ASCII text messages using only the existing station equipment.	UUT sends AMD messages 1 through 9.			
184	A.5.7.2.1	Expanded 64-ASCII Subset. The expanded 64 ASCII subset shall include all capital alphabetics (A-Z), all digits (0-9), the utility symbols "@" and "?," plus 26 other commonly used symbols. See figure A-46. The station shall have the capability to both send and receive AMD messages from and to both the operator and the controller. The station shall also have the capability to display any received AMD messages directly to the operator and controller upon arrival, and to alert them. The operator and controller shall have the capability to disable the display and the alarm when their functions would be operationally inappropriate.	Alert operator and controller. Display and alarm disabled: No display or alarm B01 displays messages from A01 upon arrival.			

Table C-38.2. Automatic Message Display Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
185	A.5.7.2.2	AMD Protocol. When an ASCII short orderwire AMD type function is required, the following CMD AMD protocol shall be used, unless another protocol in this standard is substituted. An AMD message shall be constructed in the standard word format, as described herein, and the AMD message shall be inserted in the message section of the frame. The receiving station shall be capable of receiving an AMD message contained in any ALE frame, including calls, responses, and acknowledgments. Within the AMD structure, the first word shall be a CMD AMD word, which shall contain the first three characters of the message. It shall be followed by a sequence of alternating DATA and REP words that shall contain the remainder of the message. The CMD, DATA, and REP words shall all contain only characters from the expanded ASCII 64 subset, which shall identify them as an AMD transmission. Each separate AMD message shall be kept intact and shall only be sent in a single frame, and in the exact sequence of the message itself. If one or two additional characters are required to fill the triplet in the last word sent, the position(s) shall be "stuffed" with the "space" character (0100000) automatically by the controller, without operator action. The end of the AMD message shall be indicated by the start of the frame conclusion, or by the receipt of another CMD. If words are received that have the proper AMD format but are within a portion of the message section under the control of another message protocol (such as DTM), the other protocol shall take precedence and the words shall be ignored by the station's AMD function.	AMD word: CMD, followed by three standard seven-character fields, followed by alternating use of DATA and REP preambles. Only accepts extended 64 ASCII characters.			

Table C-38.2. Automatic Message Display Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
186	A.5.7.2.3	Maximum AMD Message Size. Receipt of the CMD AMD word shall warn the receiving station that an AMD message is arriving and shall instruct it to alert the operator and controller and display the message, unless they disable these outputs. The station shall have the capability to distinguish among, and separately display, multiple separate AMD messages that were in one or several transmissions. The message characters within the AMD structure shall be displayed verbatim as received. If a detectable information loss or error occurs, the station shall warn of this by the substitution of a unique and distinct error indication, such as all display elements activated (like a "block"). The display shall have a capacity of at least 20 characters (DO: at least 40). The AMD message storage capacity, for recall of the most recently received message(s), shall be at least 90 characters plus sending station address. (DO: at least 400). By operator or controller direction, the display shall be capable of reviewing all messages in the AMD memory and shall also be capable of identifying the originating station's address. If words are received that have the proper AMD format but are within a portion of the message section under the control of another message protocol (such as DTM), the other protocol shall take precedence and the words shall be ignored by the station's AMD function.	Storage capacity: at least 90 characters. Display capacity: at least 20 characters. Message characters displayed verbatim. The operator can recall all AMD messages in memory.			

Legend: ALE – Automatic Link Exchange; AMD – Automatic Message Display; ASCII – American Standard Code for Information Interchange; CMD – Command; DO – Design Objective; DTM – Data Text Messaging; MIL-STD – Military Standard; REP – Repeat

C-39 SUBTEST 39, DATA TEXT MESSAGE (DTM)

C-39.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 187.

C-39.2 Criteria. DTM mode. The DTM ALE (orderwire) message protocol function enables stations to communicate (full ASCII or unformatted binary bits) messages to and from any selected station(s) for direct output to and input from associated data terminals or other data terminal equipment (DTE) devices through their standard data circuit-terminating equipment (DCE) ports. The DTM data transfer function is a standard speed mode (like AMD) with improved robustness, especially against weak signals and short noise bursts. When used over MF/HF by the ALE system, DTM orderwire messages may be unilateral or bilateral, and broadcast or acknowledged. As the DTM data blocks are of moderate sizes, this special orderwire message function enables utilization of the inherent redundancy and FEC techniques to detect weak HF signals and tolerate short noise bursts.

The DTM data blocks shall be fully buffered at each station and should appear transparent to the using DTEs or data terminals. As a DO, and under the direction of the operator or controller, the stations should have the capability of using the DTM data traffic mode (ASCII or binary bits) to control switching of the DTM data traffic to the appropriate DCE port or associated DTE equipment, such as to printers and terminals (if ASCII mode), or computers and cryptographic devices (if binary bits mode). As an operator or controller selected option, the received DTM message may also be presented on the operator display similar to the method for AMD in paragraph A.5.7.2.

There are four CMD DTM modes: BASIC, EXTENDED, NULL, and Automatic Repeat Request (ARQ). The DTM BASIC block ranges over a moderate size and contains a variable quantity of data, from zero to full as required, which is exactly measured to ensure integrity of the data during transfer. The DTM EXTENDED blocks are variable over a larger range of sizes, in integral multiples of the ALE basic word, and are filled with integral multiples of message data. The DTM NULL and ARQ modes are used for both link management, and error and flow control. The characteristics of the CMD DTM orderwire message functions are listed in table A-XXXII and are summarized below.

When an ASCII, or binary bit, digital data message function is required, the following CMD DTM orderwire structures and protocols shall be used as specified herein, unless another standardized protocol is substituted. The DTM structure shall be inserted within the message section of the standard ALE frame. A CMD DTM word shall be constructed in the standard 24 bit format, using the CMD preamble (see table A-XXXIII). The message data to be transferred shall also be inserted in words, using the DATA and REP preambles. The words shall then be Golay FEC encoded and interleaved, and then shall be transmitted immediately following the CMD DTM word. A CMD CRC shall immediately follow the data block words, and it shall carry the error control CRC FCS.

When the DTM structure transmission time exceeds the maximum limit for the message section ($T_{m\ max}$), the DTM protocol shall take precedence and shall extend the T_m limit to accommodate the DTM. The DTM mode preserves the required consistency of redundant word phase during the transmission. The message expansion due to the DTM is always a multiple of one T_{rw}, as the basic ALE word structure is used. The transmission time of the DTM data block (DTM words x 392 msec) does not include the T_{rw} for the preceding CMD DTM word or the following CMD CRC. Figure A-47 shows an example of a DTM message structure.

The DTM protocol shall be as described herein. The CMD DTM BASIC and EXTENDED formats (herein referred to as DTM data blocks) shall be used to transfer messages and information among stations. The CMD DTM ARQ format shall be used to acknowledge other CMD DTM formats and for error and flow control, except for non-ARQ and one-way broadcasts. The CMD DTM NULL format shall be used to (a) interrupt ("break") the DTM and message flow, (b) to interrogate station to confirm DTM capability before initiation of the DTM message transfer protocols, and (c) to terminate the DTM protocols while remaining linked. When used in ALE handshakes and subsequent exchanges, the protocol frame terminations for all involved stations shall be TIS until all the DTM messages are successfully transferred, and all are acknowledged if ARQ error control is required. The only exceptions shall be when the protocol is a one-way broadcast or the station is forced to abandon the exchange by the operator or controller, in which cases the termination should be TWAS.

Once a CMD DTM word of any type has been received by a called (addressed) or linked station, the station shall remain on channel for the entire specified DTM data block time (if any), unless forced to abandon the protocol by the operator or controller. The start of the DTM data block itself shall be exactly indicated by the end of the CMD DTM BASIC or EXTENDED word itself. The station shall attempt to read the entire DTM data block information in the DATA and REP words, and the following CMD CRC, plus the expected frame continuation, which shall contain a conclusion (possibly preceded by additional functions in the message section, as indicated by additional CMD words).

With or without ARQ, identification of each DTM data block and its associated orderwire message (if segmented into sequential DTM data blocks) shall be achieved by use of the sequence and message control bits, KD1 and KD2 (as shown in table A-XXXIII) which shall alternate with each DTM transmission and message, respectively. The type of data contained within the data block (ASCII or binary bits) shall be indicated by KD3 as a data identification bit. Activation of the ARQ error control protocol shall use the ARQ control bit KD4. If no ARQ is required, such as in one-way broadcasts, multiple DTM data blocks may be sent in the same frame, but they shall be in proper sequential order if they are transferring a segmented message.

When ARQ error or flow control is required, the CMD DTM ARQ shall identify the acknowledged DTM data block by the use of the sequence and message control bits KD1 and KD2, which shall be set to the same values as the immediately preceding and referenced DTM data block transmission. Control bit KD3 shall be used as the DTM flow control to pause or continue (or resume) the flow of the DTM data blocks. The ACK and request-for-repeat non-acknowledgement (NAK) functions shall use the ARQ control bit KD4. If no ARQ has been required by the sending station, but the receiving station needs to control the flow of the DTM data blocks, it shall use the DTM ARQ to request a pause in, and resumption of, the flow.

When data transfer ARQ error and flow control is required, the DTM data blocks shall be sent individually, in sequence, and each DTM data block shall be acknowledged before the next DTM data block is sent. Therefore, with ARQ there shall be only one DTM data block transmission in each ALE frame. If the transmitted DTM data block causes a NAK in the returned DTM ARQ, as described below, or if ACK or DTM ARQ is detected in the returned frame, or if no ALE frame is detected at all, the sending station shall resend an exact duplicate of the unacknowledged DTM data block. It shall send and continue to resend duplicates (which should be up to at least seven) one at a time and with appropriate pauses for responses, until the involved DTM data block is specifically acknowledged by a correct DTM ARQ. Only then shall the next DTM data block in the sequence be sent. If the sending station is frequently or totally unable to detect ALE frame or DTM ARQ responses, it should abort the DTM transfer protocol, terminate the link, and relink and reinitiate the DTM protocol on a better channel, under operator or controller direction.

Before initiation of the DTM data transfer protocols, the sending stations should confirm the existence of the DTM capability in the intended receiving stations, if not already known. When a DTM interrogation function is required, the following protocol shall be used. Within any standard protocol frame (using TIS), the sending station shall transmit a CMD DTM NULL, with ARQ required, to the intended station(s). These receiving stations shall respond with the appropriate standard frame and protocol, with the following variations: they shall include a CMD DTM ARQ if they are DTM capable, and they shall omit it if they are not DTM capable. The sending station shall examine the ALE and DTM ARQ responses for existence, correctness, and the status of the DTM KD control bits, as described herein. The transmitted CMD DTM NULL shall have its control bits set as follows: KD1 and KD2 set opposite of any subsequent and sequential CMD DTM BASIC or EXTENDED data blocks, which will be transmitted next; KD3 set to indicate the intended type of traffic, and KD4 set to require ARQ. The returned CMD DTM ARQ shall have its control bits set as follows: KD1 and KD2 set to match the interrogating DTM NULL; KD3 set to indicate if the station is ready for DTM data exchanges, or if a pause is requested; and KD4 set to ACK if the station is ready to accept DTM data transmissions with the specified traffic type, and NAK if it cannot or will not participate, or it failed to read the DTM NULL.

The sending (interrogating) station shall handle any and all stations that return a NAK, or do not return a DTM ARQ at all, or do not respond at all, in any combination of the following three ways, and for any combination of these stations. The specific actions and stations shall be selected by the operator or controller. The sending station shall: (a) terminate the link with them, using an appropriate and specific call and the TWAS terminator; or (b) direct them to remain and stay linked during the transmissions, using the CMD STAY protocol in each frame immediately before each CMD DTM word and data block sent; or (c) redirect them to do anything else that is controllable using the CMD functions described within this standard.

Each received DTM data block shall be examined using the CRC data integrity test included within the mandatory associated CMD CRC that immediately follows the DTM data block structure. If the data block passes the CRC test, the data shall be passed through to the appropriate DCE port (or normal output as directed by the operator or controller). If the data block is part of a larger message segmented before DTM transfer, it shall be recombined before output. If any DTM data blocks are received and do not pass the CRC data integrity test, any detectable but uncorrectable errors or areas likely to contain errors and should be tagged for further analysis, error control, or inspection by the operator or controller.

If ARQ is required, the received but unacceptable data block shall be temporarily stored, and a DTM ARQ NAK shall be returned to sender, who shall retransmit an exact duplicate DTM data block. Upon receipt of the duplicate, the receiving station shall again test the CRC. If the CRC is successful, the data block shall be passed through as described before, the previously unacceptable data block should be deleted, and a DTM ARQ ACK shall be returned. If the CRC fails again, both the duplicate and the previously stored data blocks shall be used to correct, as possible, errors and to create an “improved” data block. See figure A-48 for an example of data block reconstruction. The “improved” data block shall then be CRC tested. If the CRC is successful, the “improved” data block is passed through, the previously unacceptable data blocks should be deleted, and a DTM ARQ ACK shall be returned. If the CRC test fails, the “improved” data block shall be stored and a DTM ARQ NAK shall be returned. This process shall be repeated until: (a) a received duplicate, or an “improved” data block passes the CRC test (the data block is passed through, and a DTM ARQ ACK is returned); (b) the maximum number of duplicates (such as seven or more) have been sent without success (with actions by the sender as described above); or (c) the operators or controllers terminate or redirect the DTM protocol.

During reception of ALE frames and DTM data blocks, it is expected that fades, interferences, and collisions will occur. The receiving station shall have the capability to maintain synchronization with the frame and the DTM data block transmission, once initiated. It shall also have the capability to read and process any colliding and significantly stronger (that is, readable) ALE signals without confusing them with the DTM signal (basic ALE reception in parallel, and always listening). Therefore, useful information that may be derived from readable collisions of ALE signals should not be arbitrarily rejected or wasted. The DTM structures, especially the DTM EXTENDED, can tolerate weak signals, short fades, and short noise bursts. For these cases and for collisions, the DTM protocol can detect DTM words that have been damaged and “tag” them for error correction or repeats. The DTM constructions are described herein. Within the DTM data block structure, the CMD DTM word shall be placed ahead of the DTM data block itself. The DTM word shall alert the receiving station that a DTM data block is arriving, how long it is, what type of traffic it contains, what its message and block sequence is, and if ARQ is required. It shall also indicate the exact start of the data block (the end of the CMD DTM word), and shall initiate the reception, tracking, decoding, reading, and checking of the message data contained within the data block, which itself is within the DATA and REP words. The message data itself shall be either one of two types, binary bits or ASCII.

The ASCII characters (typically used for text) shall be the standard 7-bit length, and the start, stop, and parity bits shall be removed at the sending (and restored at the receiving) station. The binary bits (typically used for other character formats, computer files, and cryptographic devices) may have any (or no) pattern or format, and they shall be transferred transparently (that is, exactly as they were input to the sending station) with the same length and without modification.

The size of the DTM BASIC or EXTENDED data block shall be the smallest multiple of DATA and REP words that will accommodate the quantity of the ASCII or binary bits message data to be transferred in the DTM data block. If the message data to be transferred does not exactly fit the unencoded data field of the DTM block size selected, the available empty positions shall be "stuffed" with ASCII "DEL" (1111111) characters or all "1" bits. The combined message and "stuff" data in the uncoded DTM data field shall then be checked by the CRC for error control in the DTM protocol. The resulting 16 bit CRC word shall always be inserted into the CMD CRC word that immediately follows the DTM data block words themselves. All the bits in the data field shall then be inserted into standard DATA and REP words on a 21-bit or three-character basis and Golay FEC encoded, interleaved, and tripled for redundancy. Immediately after the CMD DTM word, the DTM DATA and REP words shall follow standard word format, and the CMD CRC shall be at the end.

The DTM BASIC data block has a relatively compact range of sizes from 0 to 31 words and shall be used to transfer any quantity of message data between zero and the maximum limits for the DTM BASIC structure, which is up to 651 bits or 93 ASCII characters. It is capable of counting the exact quantity of message data it contains, on a bit-by bit basis. It should be used as a single DTM for any message data within this range. It shall also be used to transfer any message data in this size range that is an "overflow" from the larger size (and increments) DTM EXTENDED data blocks, which shall immediately precede the DTM BASIC in the DTM sequence of sending.

The DTM EXTENDED data blocks are also variable in size in increments of single ALE words up to 351. They should be used as a single, large DTM to maximize the advantages of DTM throughput. The size of the data block should be selected to provide the largest data field size that can be totally filled by the message data to be transferred. Any "overflow" shall be in a message data segment sent within an immediately following and appropriately sized DTM EXTENDED or BASIC data block. Under operator or controller direction, multiple DTM EXTENDED data blocks, with smaller than the maximum appropriate ID sizes, should be selected if they will optimize DTM data transfer throughput and reliability. However, these multiple data blocks will require that the message data be divided into multiple segments at the sending station, that they be sent only in the exact order of the segments in the message, and that the receiving stations recombine the segments into a complete received message. When binary bits are being transferred, the message data segment sent within an immediately following and appropriately sized DTM EXTENDED or BASIC data block. Under operator or controller direction, multiple DTM EXTENDED data blocks, with smaller than the maximum appropriate ID sizes, should be selected if they will optimize DTM data transfer throughput and reliability. However, these multiple data blocks will require that the message data be divided into multiple segments at the sending station, that they be sent only in the exact order of the segments in the message, and that the receiving stations recombine the segments into a complete received message. When binary bits are being transferred, the EXTENDED data field shall be filled exactly to the last bit. When ASCII characters are being transferred, there are no stuff bits as the 7-bit characters fit the ALE word 21-bit data field exactly.

If stations are exchanging DTM data blocks and DTM ARQs, they may combine both functions in the same frames, and they shall discriminate based on the direction of transmission and the sending and destination addressing. If ARQ is required in a given direction, only one DTM data block shall be allowed within any frame in that direction, and only one DTM ARQ shall be allowed in each frame in the return direction. If no ARQ is required in a given direction, multiple DTM data blocks may be included in frames in that direction, and multiple DTM ARQ's may be included in the return direction.

As always throughout the DTM protocol, any sequence of DTM data blocks to be transferred shall have the KD1 sequence control bits alternating with the preceding and following DTM data blocks (except duplicates for ARQ, which shall be exactly the same as the originally transmitted DTM data block).

Also, all multiple DTM data blocks transferring multiple segments of a larger data message shall all have their KD2 message control bits set to the same value, and opposite of the preceding and following messages. If a sequence of multiple but unrelated DTM data blocks are sent (such as several independent and short messages within several DTM BASIC data blocks), they may be sent in any sequence. However, the KD1 or KD2 sequence and message control bits shall alternate with those in the adjacent DTM data blocks.

The CMD DTM words shall be constructed as shown in table A-XXXIII. The preamble shall be CMD (110) in bits P3 through P1 (W1 through W3). The first character shall be "d" (1100100) in bits C1-7 through C1-1) (W4 through W10), which shall identify the DTM "data" function.

For DTM BASIC, EXTENDED, and NULL, when the "ARQ" control bit KD4 (W11) is set to "0," no correct data receipt acknowledgement is required; and when set to "1," it is required. For DTM ARQ, "ARQ" control bit KD4 is set to "0" to indicate acknowledgement or correct data block receipt (ACK); and when set to "1," it indicates a failure to receive the data and is therefore a request-for-repeat (NAK). For DTM ARQ responding to a DTM NULL interrogation, KD4 “0” indicates non-participation in the DTM protocol or traffic type, and KD4 “1” indicates affirmative participation in both the DTM protocol and traffic type.

For DTM BASIC, EXTENDED, and NULL, when the “data type” control bit KD3 (W12) is set to “0,” the message data contained within the DTM data block shall be binary bits with no required format or pattern; and when KD3 is set to “1” the message data is 7-bit ASCII characters. For DTM ARQ, “flow” control bit KD3 is set to indicate that the DTM transfer flow should continue, or resume; and when KD3 is set to “1” it indicates that the sending station should pause (until another and identical DTM ARQ is returned, except that KD3 shall be “0”).

For DTM BASIC, EXTENDED, and NULL, when the “message” control bit KD2 (W13) is set to the same value as the KD2 in any sequentially adjacent DTM data block, the message data contained within those adjacent blocks (after individual error control) shall be recombined with the message data within the present DTM data block segment-by-segment to reconstitute the original whole message, and when KD2 is set opposite to any sequentially adjacent DTM data blocks, those data blocks contain separate message data and shall not be combined. For DTM ARQ, “message” control bit KD2 shall be set to match the referenced DTM data block KD2 value to provide message confirmation.

For DTM BASIC, EXTENDED, and NULL, the “sequence” control bit KD1 (W14) shall be set opposite to the KD1 value in the sequentially adjacent DTM BASIC, EXTENDED, or NULLs to be sent (the KD1 values therefore alternate, regardless of their message dependencies). When KD1 is set to the same value as any sequentially adjacent DTM sent, it indicates that it is a duplicate (which shall be exactly the same). For DTM ARQ, “sequence” control bit KD1 shall be set to match the referenced DTM data block or NULL KD1 value to provide sequence confirmation.

When used for the DTM protocols, the ten DTM data code (DC) bits DC10 through DC1 (W15 through W24) shall indicate the DTM mode (BASIC, EXTENDED, ARQ, or NULL). They shall also indicate the size of the message data and the length of the data block. The DTM NULL DC value shall be “0” (0000000000), and it shall designate the single CMD DTM NULL word.

The DTM EXTENDED DC values shall range from “1” (0000000001) to “351” (0101011111), and they designate the CMD DTM EXTENDED word and the data block multiple of DATA and REP words that define the variable data block sizes. The EXTENDED sizes shall range from 1 to 351 words, with a range of 21 to 7371 binary bits, in increments of 21; or three to 1053 ASCII characters, in increments of three. The DTM BASIC DC values shall range from “353” (0101100001) to “1023” (1111111111), and they shall designate the CMD DTM BASIC word and the exact size of the message data in compact and variable size data blocks, with up to 651 binary bits or 93 ASCII characters. The DTM ARQ DC value shall be “352” (0101100000), and it shall designate the single CMD DTM ARQ word. The DC values “384” (0110000000) and all higher multiples of “32m” (m x 100000) shall be reserved until standardized. See table A-XXXII for DC values and DTM block sizes and other characteristics, MIL-STD-188-141B, paragraph A.5.7.3.

C-39.3 Test Procedures

a. Test Equipment Required

(1) Receiver monitoring 12.000 MHz, USB

(2) PC with Soundcard

(3) Attenuators

(4) Tee Connector

(5) UUT plus one additional outstation

b. Test Configuration. Configure the equipment as shown in figure C-39.1.

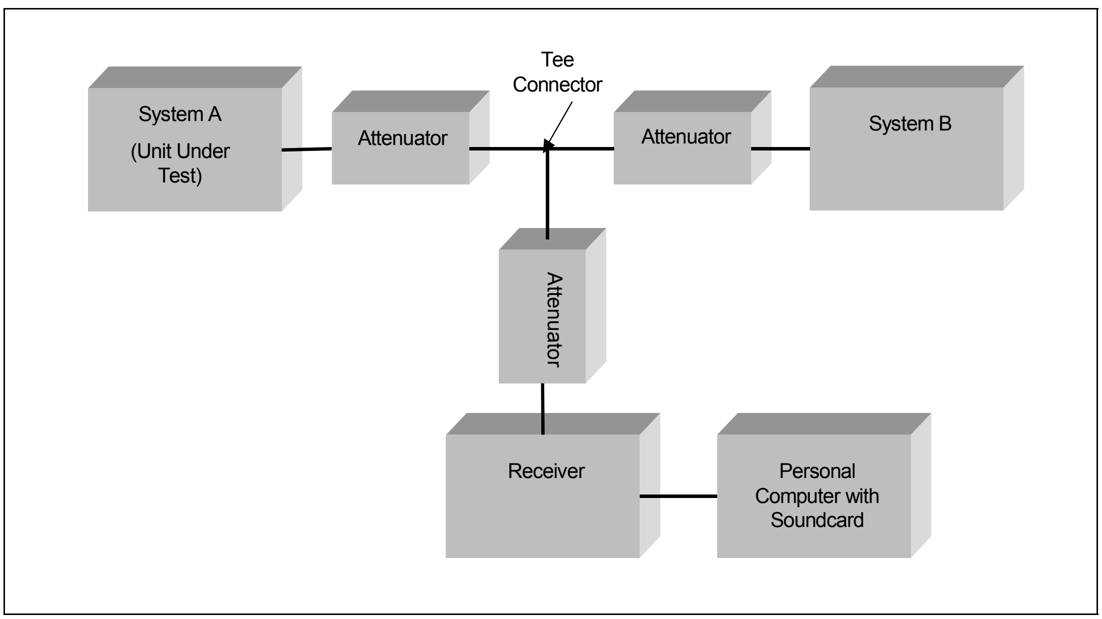

Figure C-39.1. Equipment Configuration for Data Text Message Subtest

c. Test Conduct. The procedures for this subtest are listed in table C-39.1.

Table C-39.1. Procedures for Data Text Message Subtest

Step	Action	Settings/Action	Result
The following procedure is for reference number 187.			
1	Set up equipment as shown in figure C-39.1.	Program radios in accordance with tables C-27.1 through C-27.6.	
2	Initialize the system for operation. Use preprogrammed channel information from subtest 27.	"DTM" Radios required: UUT (System A) plus system B.	
3	Configure the PC to record audio files in WAV format.	All WAV files must be sampled at 44.1 kHz, 16 bits, mono.	
4	Place call.	System A (callsign: A01) places individual call to system B (callsign: B01). Configure radios for operation in DTM mode.	
5	After linking, send a NULL from system A to confirm that system B has DTM capability.	Use the PC to record ALE tones in WAV format.	
6	Record file name. This file will be recalled using ALEOOWPP software for analysis of the word content data.		
7	Send the following 7-bit ASCII message from system A to system B. "THE QUICK BROWN FOX!" System A should request ACK from system B.	Use the PC to record ALE tones in WAV format.	
8	Record file name. This file will be recalled using ALEOOWPP software for analysis of the word content data.		
9	Record the message received by system B.		
10	Send a 1050 character 7-bit ASCII message from system A to system B.	Use the PC to record ALE tones in WAV format.	
11	Record file name. This file will be recalled using ALEOOWPP software for analysis of the word content data.		
12	Terminate link between systems A and B.		
13	Send the following one-way broadcast from System A. "THE QUICK BROWN FOX!"	Use the PC to record ALE tones in WAV format.	
14	Record file name. This file will be recalled using ALEOOWPP software for analysis of the word content data.		
15	Use ALEOOWPP software to decode all WAV files captured in this subtest.	ALEOOWPP software and instructions are available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	

Table C-39.1. Procedures for Data Text Message Subtest (continued)

Step	Action	Settings/Action	Result
16	Review file recorded in step 6.	Expected decode: System A sends “CMD DTM NULL” KD1 and KD2 set opposite of any subsequent and sequential CMD DTM data blocks, which will be transmitted next; KD3 set to indicate the intended type of traffic (0 for binary, 1 for ASCII), and KD4 set to “1” to require ARQ. System B sends “CMD DTM ARQ” KD1 and KD2 set to match the interrogating DTM NULL; KD3 set to “1” if the station is ready for DTM data exchanges; and KD4 set to “1” if the station is ready to accept DTM data transmissions. Expected Null Data Code bits: 0000000000 Record actual results.	
17	Review file recorded in step 8.	Expected decoded message: TO B01 CMD DTM DATA THE REP (sp)QU DATA ICK REP (sp)BR DATA OWN REP (sp)FO DATA X!@ CMD CRC TIS A01 Expected Control bits: KD4: 1 KD3: 1 KD2: 0 or 1 KD1: 0 or 1 Expected Data Code bits for this message: 0101100111 Record actual results.	

Table C-39.1. Procedures for Data Text Message Subtest (continued)

Step	Action	Settings/Action	Result
18	Review file recorded in step 11.	Review both CMD DTM from system A, and DTM ARQ from system B. Expected Control bits for DTM transmission: KD2 should be set the same as the sequentially adjacent DTMs if the transmitted data field is to be reintegrated as part of a larger DTM, and alternately different if independent from the prior adjacent DTM data field. KD1 should be set alternately to “0” and “1” in any sequence of DTMs, as a sequence control. Expected Control bits for DTM ARQ transmission: KD4 set to 1 (for 7-bit ASCII characters) KD3 set to 0 or 1 (flow control bit) KD2 set the same as the referenced DTM transmission. KD1 set the same as the referenced DTM transmission. Expected Data Code bits for 1050 character message: 0101011110 If message data to be transferred does not fill the data field of the DTM block, the remaining data field should be stuffed with all ones.	
19	Review file recorded in step 14.	Expected decoded message: TO B01 CMD DTM DATA THE REP (sp)QU DATA ICK REP (sp)BR DATA OWN REP (sp)FO DATA X!@ CMD CRC TWAS A01 Record actual results.	
20	Subtest 41 will validate NAK and CRC requirements.		

Legend: ACK – Acknowledgement; ALE – Automatic Link Establishment; ARQ – Automatic Repeat Request; ASCII – American Standard Code for Information Interchange; CRC – Cyclic Redundancy Check; DTM – Data Text Message; JITC – Joint Interoperability Test Command; kHz – kilohertz; NAK – non-acknowledgement; PC – Personal Computer; RF – Radio Frequency; UUT – Unit Under Test; WAV – Wave

C-39.4 Presentation of Results. The results will be shown in tabular format (table C-39.2) indicating the requirement and measured value or indications of capability.

Table C-39.2. Data Text Message Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
187	A.5.7.3	The DTM ALE (orderwire) message protocol function enables stations to communicate (full ASCII or unformatted binary bits) messages to and from any selected station(s) for direct output to and input from associated data terminals or other date terminal equipment (DTE) devices through their standard data circuit-terminating equipment (DCE) ports. The DTM data transfer function is a standard speed mode (like AMD) with improved robustness, especially against weak signals and short noise bursts. When used over medium frequency (MF)/HF by the ALE system, DTM orderwire messages may be unilateral or bilateral, and broadcast or acknowledged. As the DTM data blocks are of moderate sizes, this special orderwire message function enables utilization of the inherent redundancy and FEC techniques to detect weak HF signals and tolerate short noise bursts. The DTM data blocks shall be fully buffered at each station and should appear transparent to the using DTEs or data terminals. As a DO, and under the direction of the operator or controller, the stations should have the capability of using the DTM data traffic mode (ASCII or binary bits) to control switching of the DTM data traffic to the appropriate DCE port or associated DTE equipment, such as to printers and terminals (if ASCII mode), or computers and cryptographic devices (if binary bits mode). As an operator or controller selected option, the received DTM message may also be presented on the operator display similar to the method for AMD in A.5.7.2.	TO B01 CMD DTM DATA THE REP (sp)QU DATA ICK REP (sp)BR DATA OWN REP (sp)FO DATA X!@ CMD CRC TIS A01 Expected Control bits: KD4: 1 KD3: 1 KD2: 0 or 1 KD1: 0 or 1 Expected Data Code bits: 0101100111 Expected Null Data Code bits: 0000000000 Extended DTM structured as shown in table A-XXXIII.			

Table C-39.2. Data Text Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
187	A.5.7.3 (continued)	There are four CMD DTM modes: BASIC, EXTENDED, NULL, and ARQ. The DTM BASIC block ranges over a moderate size and contains a variable quantity of data, from zero to full as required, which is exactly measured to ensure integrity of the data during transfer. The DTM EXTENDED blocks are variable over a larger range of sizes, in integral multiples of the ALE basic word, and are filled with integral multiples of message data. The DTM NULL and ARQ modes are used for both link management, and error and flow control. The characteristics of the CMD DTM orderwire message functions are listed in table A-XXXII and are summarized below: When an ASCII, or binary bit, digital data message function is required, the following CMD DTM orderwire structures and protocols shall be used as specified herein, unless another standardized protocol is substituted. The DTM structure shall be inserted within the message section of the standard ALE frame. A CMD DTM word shall be constructed in the standard 24-bit format, using the CMD preamble (see table A-XXXIII). The message data to be transferred shall also be inserted in words, using the DATA and REP preambles. The words shall then be Golay FEC encoded and interleaved, and then shall be transmitted immediately following the CMD DTM word. A CMD CRC shall immediately follow the data block words, and it shall carry the error control CRC FCS.				

Table C-39.2. Data Text Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
187	A.5.7.3 (continued)	When the DTM structure transmission time exceeds the maximum limit for the message section ($T_{m\ max}$), the DTM protocol shall take precedence and shall extend the T_m limit to accommodate the DTM. The DTM mode preserves the required consistency of redundant word phase during the transmission. The message expansion due to the DTM is always a multiple of one T_{rw}, as the basic ALE word structure is used. The transmission time of the DTM data block (DTM words x 392 msec) does not include the T_{rw} for the preceding CMD DTM word or the following CMD CRC. Figure A-47 shows an example of a DTM message structure. The DTM protocol shall be as described herein. The CMD DTM BASIC and EXTENDED formats (herein referred to as DTM data blocks) shall be used to transfer messages and information among stations. The CMD DTM ARQ format shall be used to acknowledge other CMD DTM formats and for error and flow control, except for non-ARQ and one-way broadcasts. The CMD DTM NULL format shall be used to (a) interrupt ("break") the DTM and message flow, (b) to interrogate station to confirm DTM capability before initiation of the DTM message transfer protocols, and (c) to terminate the DTM protocols while remaining linked. When used in ALE handshakes and subsequent exchanges, the protocol frame terminations for all involved stations shall be TIS until all the DTM messages are successfully transferred, and all are acknowledged if ARQ error control is required. The only exceptions shall be when the protocol is a one-way broadcast or the station is forced to abandon the exchange by the operator or controller, in which cases the termination should be TWAS.				

Table C-39.2. Data Text Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
187	A.5.7.3 (continued)	Once a CMD DTM word of any type has been received by a called (addressed) or linked station, the station shall remain on channel for the entire specified DTM data block time (if any), unless forced to abandon the protocol by the operator or controller. The start of the DTM data block itself shall be exactly indicated by the end of the CMD DTM BASIC or EXTENDED word itself. The station shall attempt to read the entire DTM data block information in the DATA and REP words, and the following CMD CRC, plus the expected frame continuation, which shall contain a conclusion (possibly preceded by additional functions in the message section, as indicated by additional CMD words). With or without ARQ, identification of each DTM data block and its associated orderwire message (if segmented into sequential DTM data blocks) shall be achieved by use of the sequence and message control bits, KD1 and KD2, (as shown in table A-XXXIII), which shall alternate with each DTM transmission and message, respectively. The type of data contained within the data block (ASCII or binary bits) shall be indicated by KD3 as a data identification bit. Activation of the ARQ error control protocol shall use the ARQ control bit KD4. If no ARQ is required, such as in one-way broadcasts, multiple DTM data blocks may be sent in the same frame, but they shall be in proper sequential order if they are transferring a segmented message.				

Table C-39.2. Data Text Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
187	A.5.7.3 (continued)	When ARQ error or flow control is required, the CMD DTM ARQ shall identify the acknowledged DTM data block by the use of the sequence and message control bits KD1 and KD2, which shall be set to the same values as the immediately preceding and referenced DTM data block transmission. Control bit KD3 shall be used as the DTM flow control to pause or continue (or resume) the flow of the DTM data blocks. The ACK and request-for-repeat (NAK) functions shall use the ARQ control bit KD4. If no ARQ has been required by the sending station, but the receiving station needs to control the flow of the DTM data blocks, it shall use the DTM ARQ to request a pause in, and resumption of, the flow. When data transfer ARQ error and flow control is required, the DTM data blocks shall be sent individually, in sequence, and each DTM data block shall be acknowledged before the next DTM data block is sent. Therefore, with ARQ there shall be only one DTM data block transmission in each ALE frame. If the transmitted DTM data block causes a NAK in the returned DTM ARQ, as described below, or if ACK or DTM ARQ is detected in the returned frame, or if no ALE frame is detected at all, the sending station shall resend an exact duplicate of the unacknowledged DTM data block. It shall send and continue to resend duplicates (which should be up to at least seven) one at a time and with appropriate pauses for responses, until the involved DTM data block is specifically acknowledged by a correct DTM ARQ. Only then shall the next DTM data block in the sequence be sent.				

Table C-39.2. Data Text Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
187	A.5.7.3 (continued)	If the sending station is frequently or totally unable to detect ALE frame or DTM ARQ responses, it should abort the DTM transfer protocol, terminate the link, and relink and reinitiate the DTM protocol on a better channel, under operator or controller direction. Before initiation of the DTM data transfer protocols, the sending stations should confirm the existence of the DTM capability in the intended receiving stations, if not already known. When a DTM interrogation function is required, the following protocol shall be used. Within any standard protocol frame (using TIS), the sending station shall transmit a CMD DTM NULL, with ARQ required, to the intended station(s). These receiving stations shall respond with the appropriate standard frame and protocol, with the following variations. They shall include a CMD DTM ARQ if they are DTM capable, and they shall omit it if they are not DTM capable. The sending station shall examine the ALE and DTM ARQ responses for existence, correctness, and the status of the DTM KD control bits, as described herein. The transmitted CMD DTM NULL shall have its control bits set as follows: KD1 and KD2 set opposite of any subsequent and sequential CMD DTM BASIC or EXTENDED data blocks, which will be transmitted next; KD3 set to indicate the intended type of traffic, and KD4 set to require ARQ. The returned CMD DTM ARQ shall have its control bits set as follows: KD1 and KD2 set to match the interrogating DTM NULL; KD3 set to indicate if the station is ready for DTM data exchanges, or if a pause is requested; and KD4 set to ACK if the station is ready to accept DTM data transmissions with the specified traffic type, and NAK if it cannot or will not participate, or it failed to read the DTM NULL.				

Table C-39.2. Data Text Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
187	A.5.7.3 (continued)	The sending (interrogating) station shall handle any and all stations that return a NAK, or do not return a DTM ARQ at all, or do not respond at all, in any combination of the following three ways, and for any combination of these stations. The specific actions and stations shall be selected by the operator or controller. The sending station shall: (a) terminate the link with them, using an appropriate and specific call and the TWAS terminator; or (b) direct them to remain and stay linked during the transmissions, using the CMD STAY protocol in each frame immediately before each CMD DTM word and data block sent; or (c) redirect them to do anything else that is controllable using the CMD functions described within this standard.				
187	A.5.7.3 (continued)	Each received DTM data block shall be examined using the CRC data integrity test included within the mandatory associated CMD CRC that immediately follows the DTM data block structure. If the data block passes the CRC test, the data shall be passed through to the appropriate DCE port (or normal output as directed by the operator or controller). If the data block is part of a larger message segmented before DTM transfer, it shall be recombined before output. If any DTM data blocks are received and do not pass the CRC data integrity test, any detectable but uncorrectable errors or areas likely to contain errors and should be tagged for further analysis, error control, or inspection by the operator or controller.				

Table C-39.2. Data Text Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
187	A.5.7.3 (continued)	If ARQ is required, the received but unacceptable data block shall be temporarily stored, and a DTM ARQ NAK shall be returned to sender, who shall retransmit an exact duplicate DTM data block. Upon receipt of the duplicate, the receiving station shall again test the CRC. If the CRC is successful, the data block shall be passed through as described before, the previously unacceptable data block should be deleted, and a DTM ARQ ACK shall be returned. If the CRC fails again, both the duplicate and the previously stored data blocks shall be used to correct, as possible, errors and to create an "improved" data block. See figure A-48 for an example of data block reconstruction. The "improved" data block shall then be CRC tested. If the CRC is successful, the "improved" data block is passed through, the previously unacceptable data blocks should be deleted, and a DTM ARQ ACK shall be returned. If the CRC test fails, the "improved" data block shall be stored and a DTM ARQ NAK shall be returned. This process shall be repeated until: (a) a received duplicate, or an "improved" data block passes the CRC test (the data block is passed through, and a DTM ARQ ACK is returned); (b) the maximum number of duplicates (such as seven or more) have been sent without success (with actions by the sender as described above); or (c) the operators or controllers terminate or redirect the DTM protocol.				

Table C-39.2. Data Text Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
187	A.5.7.3 (continued)	During reception of ALE frames and DTM data blocks, it is expected that fades, interferences, and collisions will occur. The receiving station shall have the capability to maintain synchronization with the frame and the DTM data block transmission, once initiated. It shall also have the capability to read and process any colliding and significantly stronger (that is, readable) ALE signals without confusing them with the DTM signal (basic ALE reception in parallel, and always listening). Therefore, useful information that may be derived from readable collisions of ALE signals should not be arbitrarily rejected or wasted. The DTM structures, especially the DTM EXTENDED, can tolerate weak signals, short fades, and short noise bursts. For these cases and for collisions, the DTM protocol can detect DTM words that have been damaged and "tag" them for error correction or repeats. The DTM constructions are described herein. Within the DTM data block structure, the CMD DTM word shall be placed ahead of the DTM data block itself. The DTM word shall alert the receiving station that a DTM data block is arriving, how long it is, what type of traffic it contains, what its message and block sequence is, and if ARQ is required. It shall also indicate the exact start of the data block (the end of the CMD DTM word), and shall initiate the reception, tracking, decoding, reading, and checking of the message data contained within the data block, which itself is within the DATA and REP words. The message data itself shall be either one of two types, binary bits or ASCII.				

Table C-39.2. Data Text Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
187	A.5.7.3 (continued)	The ASCII characters (typically used for text) shall be the standard 7-bit length, and the start, stop, and parity bits shall be removed at the sending (and restored at the receiving) station. The binary bits (typically used for other character formats, computer files, and cryptographic devices) may have any (or no) pattern or format, and they shall be transferred transparently (that is, exactly as they were input to the sending station) with the same length and without modification.				

Table C-39.2. Data Text Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
187	A.5.7.3 (continued)	The size of the DTM BASIC or EXTENDED data block shall be the smallest multiple of DATA and REP words that will accommodate the quantity of the ASCII or binary bits message data to be transferred in the DTM data block. If the message data to be transferred does not exactly fit the unencoded data field of the DTM block size selected, the available empty positions shall be "stuffed" with ASCII "DEL" (1111111) characters or all "1" bits. The combined message and "stuff" data in the uncoded DTM data field shall then be checked by the CRC for error control in the DTM protocol. The resulting 16-bit CRC word shall always be inserted into the CMD CRC word that immediately follows the DTM data block words themselves. All the bits in the data field shall then be inserted into standard DATA and REP words on a 21-bit or three-character basis and Golay FEC encoded, interleaved, and tripled for redundancy. Immediately after the CMD DTM word, the DTM DATA and REP words shall follow standard word format, and the CMD CRC shall be at the end. The DTM BASIC data block has a relatively compact range of sizes from 0 to 31 words and shall be used to transfer any quantity of message data between zero and the maximum limits for the DTM BASIC structure, which is up to 651 bits or 93 ASCII characters. It is capable of counting the exact quantity of message data it contains, on a bit-by-bit basis. It should be used as a single DTM for any message data within this range. It shall also be used to transfer any message data in this size range that is an "overflow" from the larger size (and increments) DTM EXTENDED data blocks, which shall immediately precede the DTM BASIC in the DTM sequence of sending.				

Table C-39.2. Data Text Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
187	A.5.7.3 (continued)	The DTM EXTENDED data blocks are also variable in size in increments of single ALE words up to 351. They should be used as a single, large DTM to maximize the advantages of DTM throughput. The size of the data block should be selected to provide the largest data field size that can be totally filled by the message data to be transferred. Any "overflow" shall be in a message data segment sent within an immediately following and appropriately sized DTM EXTENDED or BASIC data block. Under operator or controller direction, multiple DTM EXTENDED data blocks, with smaller than the maximum appropriate ID sizes, should be selected if they will optimize DTM data transfer throughput and reliability. However, these multiple data blocks will require that the message data be divided into multiple segments at the sending station, that they be sent only in the exact order of the segments in the message, and that the receiving stations recombine the segments into a complete received message. When binary bits are being transferred, the message data segment sent within an immediately following and appropriately sized DTM EXTENDED or BASIC data block. Under operator or controller direction, multiple DTM EXTENDED data blocks, with smaller than the maximum appropriate ID sizes, should be selected if they will optimize DTM data transfer throughput and reliability. However, these multiple data blocks will require that the message data be divided into multiple segments at the sending station, that they be sent only in the exact order of the segments in the message, and that the receiving stations recombine the segments into a complete received message. When binary bits are being transferred, the EXTENDED data field shall be filled exactly to the last bit.				

Table C-39.2. Data Text Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
187	A.5.7.3 (continued)	When ASCII characters are being transferred, there are no stuff bits as the 7-bit characters fit the ALE word 21-bit data field exactly. If stations are exchanging DTM data blocks and DTM ARQs, they may combine both functions in the same frames, and they shall discriminate based on the direction of transmission and the sending and destination addressing. If ARQ is required in a given direction, only one DTM data block shall be allowed within any frame in that direction, and only one DTM ARQ shall be allowed in each frame in the return direction. If no ARQ is required in a given direction, multiple DTM data blocks may be included in frames in that direction, and multiple DTM ARQ's may be included in the return direction. As always throughout the DTM protocol, any sequence of DTM data blocks to be transferred shall have the KD1 sequence control bits alternating with the preceding and following DTM data blocks (except duplicates for ARQ, which shall be exactly the same as the originally transmitted DTM data block).				

Table C-39.2. Data Text Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
187	A.5.7.3 (continued)	Also, all multiple DTM data blocks transferring multiple segments of a larger data message shall all have their KD2 message control bits set to the same value, and opposite of the preceding and following messages. If a sequence of multiple but unrelated DTM data blocks are sent (such as several independent and short messages within several DTM BASIC data blocks), they may be sent in any sequence. However, the KD1 or KD2 sequence and message control bits shall alternate with those in the adjacent DTM data blocks. The CMD DTM words shall be constructed as shown in table A-XXXIII. The preamble shall be CMD (110) in bits P3 through P1 (W1 through W3). The first character shall be "d" (1100100) in bits C1-7 through C1-1 (W4 through W10), which shall identify the DTM "data" function. For DTM BASIC, EXTENDED, and NULL, when the "ARQ" control bit KD4 (W11) is set to "0," no correct data receipt acknowledgement is required; and when set to "1," it is required. For DTM ARQ, "ARQ" control bit KD4 is set to "0" to indicate acknowledgement or correct data block receipt (ACK); and when set to "1," it indicates a failure to receive the data and is therefore a request-for-repeat (NAK). For DTM ARQ responding to a DTM NULL interrogation, KD4 "0" indicates non-participation in the DTM protocol or traffic type, and KD4 "1" indicates affirmative participation in both the DTM protocol and traffic type.				

Table C-39.2. Data Text Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
187	A.5.7.3 (continued)	For DTM BASIC, EXTENDED, and NULL, when the "data type" control bit KD3 (W12) is set to "0," the message data contained within the DTM data block shall be binary bits with no required format or pattern; and when KD3 is set to "1" the message data is 7-bit ASCII characters. For DTM ARQ, "flow" control bit KD3 is set to indicate that the DTM transfer flow should continue, or resume; and when KD3 is set to "1" it indicates that the sending station should pause (until another and identical DTM ARQ is returned, except that KD3 shall be "0").				

Table C-39.2. Data Text Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
187	A.5.7.3 (continued)	For DTM BASIC, EXTENDED, and NULL, when the "message" control bit KD2 (W13) is set to the same value as the KD2 in any sequentially adjacent DTM data block, the message data contained within those adjacent blocks (after individual error control) shall be recombined with the message data within the present DTM data block segment-by-segment to reconstitute the original whole message, and when KD2 is set opposite to any sequentially adjacent DTM data blocks, those data blocks contain separate message data and shall not be combined. For DTM ARQ, "message" control bit KD2 shall be set to match the referenced DTM data block KD2 value to provide message confirmation. For DTM BASIC, EXTENDED, and NULL, the "sequence" control bit KD1 (W14) shall be set opposite to the KD1 value in the sequentially adjacent DTM BASIC, EXTENDED, or NULLs to be sent (the KD1 values therefore alternate, regardless of their message dependencies). When KD1 is set to the same value as any sequentially adjacent DTM sent, it indicates that it is a duplicate (which shall be exactly the same). For DTM ARQ, "sequence" control bit KD1 shall be set to match the referenced DTM data block or NULL KD1 value to provide sequence confirmation. When used for the DTM protocols, the ten DTM data code (DC) bits DC10 through DC1 (W15 through W24) shall indicate the DTM mode (BASIC, EXTENDED, ARQ, or NULL). They shall also indicate the size of the message data and the length of the data block. The DTM NULL DC value shall be "0" (0000000000), and it shall designate the single CMD DTM NULL word.				

Table C-39.2. Data Text Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
187	A.5.7.3 (continued)	The DTM EXTENDED DC values shall range from "1" (0000000001) to "351" (0101011111), and they designate the CMD DTM EXTENDED word and the data block multiple of DATA and REP words that define the variable data block sizes. The EXTENDED sizes shall range from 1 to 351 words, with a range of 21 to 7371 binary bits, in increments of 21; or three to 1053 ASCII characters, in increments of three. The DTM BASIC DC values shall range from "353" (0101100001) to "1023" (1111111111), and they shall designate the CMD DTM BASIC word and the exact size of the message data in compact and variable size data blocks, with up to 651 binary bits or 93 ASCII characters. The DTM ARQ DC value shall be "352" (0101100000), and it shall designate the single CMD DTM ARQ word. The DC values "384" (0110000000) and all higher multiples of "32m" (m x 100000) shall be reserved until standardized. See table A-XXXII for DC values and DTM block sizes and other characteristics.				

Legend: ALE – Automatic Link Establishment; AMD – Automatic Message Display; ASCII – American Standard Code for Information Interchange; CMD – Command; CRC – Cyclic Redundancy Check; DCE – Data Communication Equipment; DTE – Data Terminal Equipment; DTM – Data Text Message; FEC – Forward Error Correction; HF – High Frequency; MF – Medium Frequency; MIL-STD – Military Standard

C-40 SUBTEST 40, DATA BLOCK MESSAGE (DBM)

C-40.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 104 and 188.

C-40.2 Criteria

a. Receiver word syncronization. The receive demodulator accepts baseband audio from the receiver; acquires, tracks, and demodulates ALE signals; and provides the recovered digital data to the decoders. See figure A-11. In data block message (DBM) mode, the receive demodulator shall also be capable of reading single data bits for deep deinterleaving and decoding, MIL-STD-188-141B, paragraph A.5.2.6.2.

b. DBM mode. The DBM ALE (orderwire) message protocol function enables ALE stations to communicate either full ASCII, or unformatted binary bit messages to and from any selected ALE station(s) for direct output to and input from associated data terminal or other DTE devices through their standard DCE ports. This DBM data transfer function is a high-speed mode (relative to DTM and AMD) with improved robustness, especially against long fades and noise bursts. When used over MF/HF by the ALE system, DBM orderwire messages may be unilateral or bilateral, and broadcast or acknowledged. As the DBM data blocks can be very large, this special orderwire message function enables exploitation of deep interleaving and FEC techniques to penetrate HF-channel long fades and large noise bursts.

The DBM data blocks shall be fully buffered at each station and should appear transparent to the using DTEs or data terminals. As a Design Objective and under the direction of the operator or controller, the stations should have the capability of using the DBM data traffic mode (ASCII or binary bits) to control switching of the DBM data traffic to the appropriate DCE port or associated DTE equipment, such as to printers and terminals (if ASCII mode) or computers and cryptographic devices (if binary bits mode). As an operator or controller-selected option, the received DBM message may also be presented on the operator display, similar to the method for AMD in table A.5.7.2.

There are four CMD DBM modes: BASIC, EXTENDED, NULL, and ARQ. The DBM BASIC block is a fixed size and contains a variable quantity of data, from zero to full as required, which is exactly measured to ensure integrity of the data during transfer. The DBM EXTENDED blocks are variable in size in integral multiples of the BASIC block, and are filled with integral multiples of message data. The DBM NULL and ARQ modes are used for both link management, and error and flow control. The characteristics of the CMD DBM orderwire message functions are listed in table A-XXXIV, and they are summarized below.

When an ASCII, or binary bit, digital data message function is required, the following CMD DBM orderwire structures and protocols shall be used as specified herein, unless another standardized protocol is substituted. The DBM structure shall be inserted within the message section of the standard frame. A CMD DBM word shall be constructed in the standard format. The data to be transferred shall be Golay FEC encoded, interleaved (for error spreading during decoding), and transmitted immediately following the CMD DBM word.

When the DBM structure transmission time exceeds the maximum for the message section ($T_{m\ max}$), the DBM protocol shall take precedence and shall extend the T_m limit to accommodate the DBM. The DBM mode preserves the required consistency of redundant word phase during the transmission. The message expansion due to the DBM is always a multiple of 8 T_{rw}, as the interleaver depth is always a multiple of 49. The transmission time of the DBM data block (T_{dbm}) itself is equal to (interleaver depth x 64ms), not including the T_{rw} for the preceding CMD DBM word. Figure A-49 shows an example of an exchange using the DBM orderwire to transfer and acknowledge messages. Figure A-50 shows an example of a DBM data interleaver, and figure A-51 shows the transmitted DBM bit-stream sequence.

The DBM protocol shall be as described herein. The CMD DBM BASIC and EXTENDED formats (herein referred to as DBM data blocks) shall be used to transfer messages in information among ALE stations. The CMD DBM ARQ format shall be used to acknowledge other CMD DBM formats and for error and flow control, except for non-ARQ and one-way broadcasts. The CMD DBM NULL format shall be used: (a) to interrupt ("break") the DBM and message flow; (b) to interrogate stations to confirm DBM capability beforeinitiation of the DBM message transfer protocols; and (c) to terminate the DBM protocols while remaining linked. When used in handshakes and subsequent exchanges, the protocol frame terminations for all involved stations shall be TIS until all the DBM messages are successfully transferred, and all are acknowledged if ARQ error control is required. The only exceptions shall be when the protocol is a one-way broadcast or the station is forced to abandon the exchange by the operator or controller, in which cases the termination should be TWAS.

Once a CMD DBM word of any type has been received by a called (addressed) or linked station, the station shall remain on channel for the entire specified DBM data block time (if any), unless forced to abandon the protocol by the operator or controller. The start of the DBM data block itself shall be exactly indicated by the end of the CMD DBM BASIC or EXTENDED word itself. The station shall attempt to read the entire DBM data block information, plus the expected frame continuation, which shall contain a conclusion (possibly preceded by additional functions in the message section, as indicated by additional CMD words).

With or without ARQ, identification of each DBM data block and its associated orderwire message (if segmented into sequential DBM data blocks) shall be achieved by use of the sequence and message control bits, KB1 and KB2, (see table A-XXXV) which shall alternate with each DBM transmission and message, respectively. The type of data contained within the data block (ASCII or binary bits) shall be indicated by KB3 as a data identification bit. Activation of the ARQ error-control protocol shall use the ARQ control bit KB4. If no ARQ is required, such as in one-way broadcasts, multiple DBM data blocks may be sent in the same frame, but they shall be in proper sequence if they are transferring a segmented message.

When ARQ error or flow control is required, the CMD DBM ARQ shall identify the acknowledged DBM data block by the use of the sequence and message control bits KB1 and KB2, which shall be set to the same values as the immediately preceding and referenced DBM data block transmission. Controlbit KB3 shall be used as the DBM flow control to pause or continue (or resume) the flow of the DBM data blocks. The ACK and NAK functions shall use the ARQ control bit KB4. If no ARQ has been required by the sending station, but the receiving station needs to control the flow of the DBM data blocks, it shall use the DBM ARQ to request a pause in, and resumption of, the flow.

When data transfer ARQ error and flow control is required, the DBM data blocks shall be sent individually and in sequence. Each DBM data block shall be individually acknowledged before the next DBM data block is sent. Therefore, with ARQ there shall be only one DBM data block transmission in each frame. If the transmitted DBM data block causes a NAK in the returned DBM ARQ, as described below, or if no ACK or DBM ARQ is detected in the returned frame, or if no frame is detected at all, the sending station shall resend an exact duplicate of the unacknowledged DBM data block. It shall continue to resend duplicates (which should be at least seven), one at a time and with appropriate pauses for responses, until the involved DBM data block is specifically acknowledged by a correct DBM ARQ. Only then shall the next DBM data block in the sequence be sent. If the sending station is frequently or totally unable to detect frame or DBM ARQ responses, it should abort the DBM transfer protocol, terminate the link, relink, and reinitiate the DBM protocol on a better channel (under operator or controller direction).

Before initiation of the DBM data transfer protocols, the sending stations should confirm the existence of the DBM capability in the intended receiving stations, if not already known. When a DBM interrogation function is required, the following protocol shall be used. Within any standard protocol frame (using TIS), the sending station shall transmit a CMD DBM NULL, with ARQ required, to the intended station(s). These receiving stations shall respond with the appropriate standard frame and protocol, with the following variations. They shall include a CMD DBM ARQ if they are DBM capable, and they shall omit it if they are not DBM capable. The sending station shall examine the ALE and DBM ARQ responses for existence, correctness, and the status of the DBM KB control bits, as described herein. The transmitted CMD DBM NULL shall have its control bits set as follows: KB1 and KB2 set opposite of any subsequent and sequential CMD DBM BASIC or EXTENDED data blocks which will be transmitted next; KB3 set to indicate the intended type of traffic; and KB4 set to require ARQ. The returned CMD DBM ARQ shall have its control bits set as follows: KB1 and KB2 set to match the interrogating DBM NULL; KB3 set to indicate if the station is ready for DBM data exchanges, or if a pause is requested; and KB4 set to ACK if the station is ready to accept DBM data transmissions with the specified traffic type, and NAK if it cannot or will not participate, or if it failed to read the DBM NULL.

The sending (interrogating) station shall handle any stations which return a NAK, do not return a DBM ARQ, do not respond, and in any combination of the following; for any combination of these stations. The specific actions and stations shall be selected by the operator or controller. The sending station shall: (a) terminate the link with these stations, using an appropriate and specific call and the TWAS terminator; (b) direct the stations to remain and stay linked during the transmissions, using the CMD STAY protocol in each frame immediately before each CMD DBM word and data block sent; or (c) redirect them to do anything else which is controllable using the CMD functions described within this standard.

Each received DBM data block shall be examined using the CRC data integrity test which is embedded within the DBM structure and protocol. If the data block passes the CRC test, the data shall be passed through to the appropriate DCE port (or normal output as directed by the operator or controller). If the data block is part of a larger message which was segmented before DBM transfer, it shall be recombined before output. If any DBM data blocks are received and do not pass the CRC data integrity test, any detectable but uncorrectable errors; or areas likely to contain errors, should be tagged for further analysis, error control, or inspection by the operator or controller. If ARQ is required, the received but unacceptable data block shall be temporarily stored, and a DBM ARQ NAK shall be returned to the sender, who shall retransmit an exact duplicate DBM data block. Upon receipt of the duplicate, the receiving station shall again test the CRC. If the CRC is successful, the data block shall be passed through as described before, the previously unacceptable data block should be deleted, and a DBM ARQ ACK shall be returned. If the CRC fails again, both the duplicate and the previously stored data blocks shall be used to correct, as possible, errors and to create an “improved” data block. See figure A-48 for an example of data block reconstruction. The “improved” data block shall then be CRC tested. If the CRC is successful, the “improved” data block is passed through, the previously unacceptable data blocks should be deleted, and a DBM ARQ ACK shall be returned. If the CRC test fails, the “improved” data block shall also be stored and a DBM ARQ NAK shall be returned. This process shall be repeated until: (a) a received duplicate, or an “improved” data block passes the CRC test (and the data block is passed through, and a DBM ARQ ACK is returned); (b) the maximum number of duplicates (such as seven or more) have been sent without success (with actions by the sender as described above); or (c) the operators or controllers terminate or redirect the DBM protocol.

During reception of frames and DBM data blocks, it is expected that fades, interferences, and collisions will occur. The receiving station shall have the capability to maintain synchronization with the frame and the DBM data block transmission, once initiated. It shall also have the capability to read and process any colliding and significantly stronger (that is, readable) ALE signals without confusing them with the DBM signal (basic ALE reception in parallel, and always listening). The DBM structures, especially the DBM EXTENDED, can tolerate significant fades, noise bursts, and collisions. Therefore, useful information which may be derived from readable collisions of ALE signals should not be arbitrarily rejected or wasted.

The DBM constructions shall be as described herein. Within the DBM data block structure, a CMD DBM word shall be placed ahead of the encoded and interleaved data block itself. The DBM word shall alert the receiving station that a DBM data block is arriving, how long it is, what type of traffic it contains, what its interleaver depth is, what its message and block sequence is, and if ARQ is required. It shall also indicate the exact start of the data block itself (the end of the CMD DBM word itself) and shall initiate the reception, tracking, deinterleaving, decoding, and checking of the data contained within the block. The message data itself shall be either one of two types, binary bits or ASCII. The ASCII characters (typically used for text) shall be the standard 7-bit length, and the start, stop, and parity bits shall be removed at the sending (and restored at the receiving) station. The binary bits (typically used for other character formats, computer files, and cryptographic devices) may have any (or no) pattern or format, and they shall be transferred transparently, that is, exactly as they were input to the sending station, with the same length and without modification. The value of the interleaver depth shall be the smallest (multiple of 49) which will accommodate the quantity of ASCII or binary bits message data to be transferred in the DBM data block. If the message data to be transferred does not exactly fit the uncoded data field of the DBM block size selected (except for the last 16 bits, which are reserved for the CRC), the available empty positions shall be "stuffed" with ASCII "DEL" characters or all "1" bits. The combined message and "stuff" data in the uncoded DBM data field shall then be checked by the CRC for error control in the DBM protocol. The resulting 16-bit CRC word shall always occupy the last 16 bits in the data field. All the bits in the field shall then be Golay FEC encoded, on a 12-bit basis, to produce rows of 24-bit code words, arranged from top to bottom in the interleaver matrix (or equivalent), as shown in figure A-50. The bits in the matrix are then read out by columns (of length equal to the interleaver depth) for transmission. Immediately after the CMD DBM word, the encoded and interleaved data blocks bits shall follow in bit format, three bits per symbol (tone).

The DBM BASIC data block has a fixed size (interleaver depth 49) and shall be used to transfer any quantity of message data between zero and the maximum limits for the DBM BASIC structure, which is up to 572 bits or 81 ASCII characters. It is capable of counting the exact quantity of message data which it contains, on a bit-by bit basis. It should be used as a single DBM for any message data within this range. It shall also be used to transfer any message data in this size range which is an "overflow" from the larger size (and increments) DBM EXTENDED data blocks (which shall immediately precede the DBM BASIC in the DBM sequence of sending).

The DBM EXTENDED data blocks are variable in size, in increments of 49 times the interleaver depth. They should be used as a single, large DBM to maximize the advantages of DBM deep interleaving, FEC techniques, and higher speed (than DTM or AMD) transfer of data. The interleaver depth of the EXTENDED data block should be selected to provide the largest data field size which can be totally filled by the message data to be transferred. Any "overflow" shall be in a message data segment sent within an immediately following DBM EXTENDED or BASIC data block. Under operator or controller direction, multiple DBM EXTENDED data blocks, with smaller than the maximum appropriate interleaver depth sizes, should be selected if they will optimize

DBM data transfer throughput and reliability. However, these multiple data blocks will require that the message data be divided into multiple segments at the sending station and sent only in the exact order of the segments in the message. The receiving stations must recombine the segments into a complete received message. When binary bits are being transferred, the EXTENDED data field shall be filled exactly to the last bit. When ASCII characters are being transferred, the EXTENDED data field may have 0 to 6 "stuff" bits inserted. Individual ASCII characters shall not be split between DBM data blocks and the receiving station shall read the decoded data field on a 7-bit basis, and it shall discard any remaining "stuff" bits (modulo-7 remainder). If stations are exchanging DBM data blocks and DBM ARQs, they may combine both functions in the same frames. They shall discriminate based on the direction of transmission and the sending and destination addressing. If ARQ is required in a given direction, only one DBM data block shall be allowed within any frame in that direction, and only one DBM ARQ shall be allowed in each frame in the return direction. If no ARQ is required in a given direction, multiple DBM data blocks may be included in frames in that direction, and multiple DBM ARQs may be included in the return direction. As always throughout the DBM protocol, any sequence of DBM data blocks to be transferred shall have their KB1 sequence control bits alternating with the preceding and following DBM data blocks (except duplicates for ARQ, which shall be exactly the same as their originally transmitted DBM data block). Also, all multiple DBM data blocks transferring multiple segments of a large data message shall all have their KB2 message control bits set to the same value, and opposite of the preceding and following messages. If a sequence of multiple but unrelated DBM data blocks are sent (such as several independent and short messages within several DBM BASIC data blocks), they may be sent in any sequence. However, when sent, the associated KB1 and KB2 sequence and message control bits shall alternate with those in the adjacent DBM data blocks.

The CMD DBM words shall be constructed as shown in table A-XXXV. The preamble shall be CMD (110) in bits P3 through P1 (W1 through W3). The first character shall be "b" (1100010) in bits C1-7 through C1-1 (W4 through W10), which shall identify the DBM "block" function.

For DBM BASIC, EXTENDED, and NULL, when the ARQ control bit KB4 (W11) is set to "0," no correct data receipt acknowledgement is required; and when set to "1," it is required. For DBM ARQ, ARQ control bit KB4 is set to "0" to indicate acknowledgement or correct data block receipt (ACK); and when set to "1," it indicates a failure to receive the data and is therefore a request-for-repeat (NAK). For DBM ARQ responding to a DBM NULL interrogation, KB4 "0" indicates non-participation in the DBM protocol or traffic type, and KB4 "1" indicates affirmative participation in both the DBM protocol and traffic type.

For DBM BASIC, EXTENDED, and NULL, when the data type control bit KB3 (W12) is set to "0," the message data contained within the DBM data block shall be binary bits with no required format or pattern; and when KB3 is set to "1" the message data is 7-bit ASCII characters. For DBM ARQ, flow control bit KB3 is set to "0" to indicate that the DBM transfer flow should continue or resume; and when KB3 is set to "1" it indicates that the sending station should pause (until another and identical DBM ARQ is returned, except that KB3 shall be “0”). For DBM BASIC, EXTENDED, and NULL, when the “message” control bit KB2 (W13) is set to the same value as the KB2 in any sequentially adjacent DBM data block, the message data contained within those adjacent blocks (after individual error control) shall be recombined with the message data within the present DBM data block to reconstitute (segment-by-segment) the original whole message; and when KB2 is set opposite to any sequentially adjacent DBM data blocks, those data blocks contain separate message data and shall not be combined. For DBM ARQ, “message” control bit KB2 shall be set to match the referenced DBM data block KB2 value to provide message confirmation.

For DBM BASIC, EXTENDED, and NULL, the sequence control bit KB1 (W14) shall be set opposite to the KB1 value in the sequentially adjacent DBM BASIC, EXTENDED, or NULLs be sent (the KB1 values therefore alternate, regardless of their message dependencies). When KB1 is set the same as any sequentially adjacent DBM sent, it indicates a duplicate. For DBM ARQ, sequence control bit KB1 shall be set to match the referenced DBM data block or NULL KB1 value to provide sequence confirmation. When used for the DBM protocols, the ten DBM data code (BC) bits BC10 through BC1 (W15 through W24) shall indicate the DBM mode (BASIC, EXTENDED, ARQ, or NULL). They shall also indicate the size of the message data and the length of the data block. The DBM NULL BC value shall be “0” (0000000000), and it shall designate the single CMD DBM NULL word. The DBM EXTENDED BC values shall range from “1” (0000000001) to “445” (0110111101), and they shall designate the CMD DBM EXTENDED word and the data block multiple (of 49 INTERLEAVER DEPTH) which defines the variable data block sizes, in increments of 588 binary bits or 84 ASCII characters. The DBM BASIC BC values shall range from “448” (0111000000) to “1020” (1111111100), and they shall designate the CMD DBM BASIC word and the exact size of the message data in a fixed size (INTERLEAVER DEPTH = 49) data block, with up to 572 binary bits or 81 ASCII characters. The DBM ARQ BC value shall be “1021” (1111111101), and it shall designate the single CMD DBM ARQ word.

NOTES:
1) The values “446” (0110111110) and “447” (0110111111) are reserved.
2) The values “1022” (1111111110) and “1023” (1111111111) are reserved until standardized (see table A-XXXIV), MIL-STD-188-141B, paragraph A.5.7.4.

C-40.3 Test Procedures

a. Test Equipment Required

(1) Receiver monitoring 12.000 MHz, USB

(2) PC with Soundcard

(3) Attenuators

(4) UUT plus one additional outstation

(5) Tee Connector

b. Test Configuration. Configure the equipment as shown in figure C-40.1.

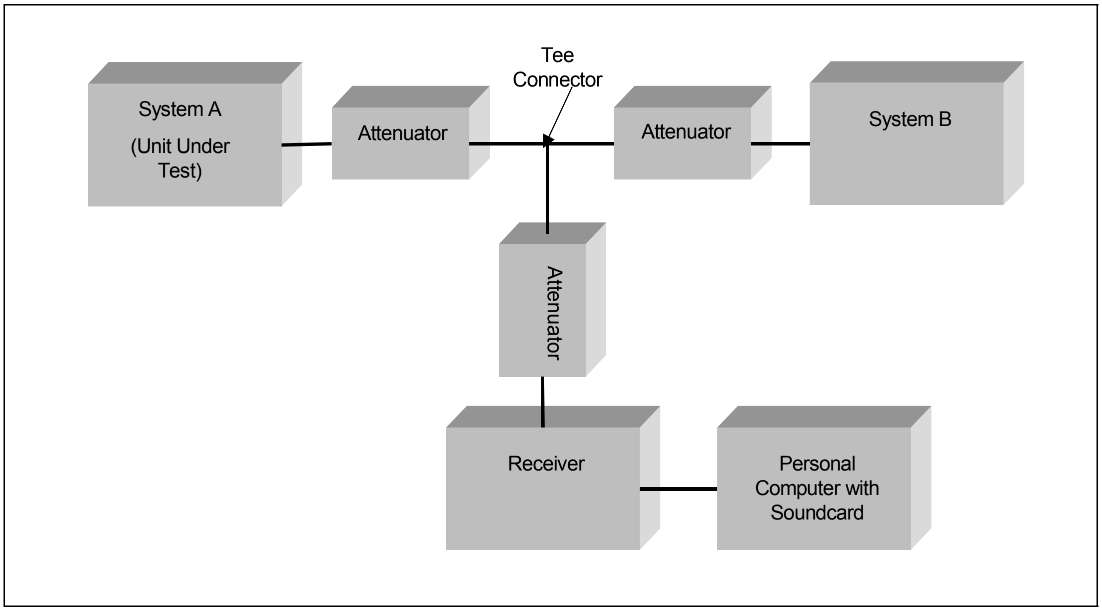

Figure C-40.1. Equipment Configuration for Data Block Message Subtest

c. Test Conduct. The procedures for this subtest are listed in table C-40.1.

Table C-40.1. Procedures for Data Block Message Subtest

Step	Action	Settings/Action	Result
The following procedure is for reference numbers 104 and 188.			
1	Set up equipment as shown in figure C-40.1.	Program radios in accordance with tables C-27.1 through C-27.6.	
2	Initialize the system for operation. Use preprogrammed channel information from subtest 27.	"DBM" Radios required: UUT plus system B.	
3	Configure the PC to record audio files in WAV format.	All WAV files must be sampled at 44.1 kHz, 16 bits, mono.	
4	Place call.	System A (callsign: A01) places individual call to system B (callsign: B01). Configure radios for operation in DBM mode.	
5	After linking, send a NULL from system A to confirm that system B has DBM capability.	Use the PC to record ALE tones in WAV format.	
6	Record file name. This file will be recalled using ALEOOWPP software for analysis of the word content data.		

Table C-40.1. Procedures for Data Block Message Subtest (continued)

Step	Action	Settings/Action	Result
7	Send the following 7-bit ASCII message from System A to System B. “THE QUICK BROWN FOX!” System A should request ACK from system B.	Use the PC to record ALE tones in WAV format.	
8	Record file name. This file will be recalled using ALEOOWPP software for analysis of the word content data.		
9	Record the message received by system B.		
10	Send a 165 character 7-bit ASCII message from system A to system B.	Use the PC to record ALE tones in WAV format.	
11	Record file name. This file will be recalled using ALEOOWPP software for analysis of the word content data.		
12	Terminate link between systems A and B.		
13	Send the following one-way broadcast from system A. “THE QUICK BROWN FOX!”		
14	Record the message received by system B.		
15	Use ALEOOWPP software to decode all WAV files captured in this subtest.	ALEOOWPP software and instructions are available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	
16	Review file recorded in step 6.	Expected decode: System A sends “CMD DBM NULL” KB1 and KB2 set opposite of any subsequent and sequential CMD DBM data blocks, which will be transmitted next; KB3 set to indicate the intended type of traffic, and KB4 set to require ARQ. System B sends “CMD DBM ARQ” KB1 and KB2 set to match the interrogating DBM NULL; KB3 set to indicate if the station is ready for DBM data exchanges; and KB4 set to ACK if the station is ready to accept DBM data transmissions. Expected Null Data Code bits: 0000000000 Record actual results.	

Table C-40.1. Procedures for Data Block Message Subtest (continued)

Step	Action	Settings/Action	Result
17	Review file recorded in step 8.	Expected decoded message: TO B01 CMD DBM (Data is deeply interleaved; ALEOOWPP will not decode) Expected Control bits: KB4: 1 KB3: 1 KB2: 0 or 1 KB1: 0 or 1 Expected Data Code bits: 1001010011 Record actual results.	
18	Review file recorded in step 11.	Review both CMD DBM from System A, and DBM ARQ from System B. Expected Control bits for DBM transmission: KB2 should be set the same as the sequentially adjacent DBMs if the transmitted data field is to be reintegrated as part of a larger DBM, and alternately different if independent from the prior adjacent DBM data field. KB1 should be set alternately to “0” and “1” in any sequence of DBMs, as a sequence control. Expected Control bits for DBM ARQ transmission: KB4 set to 0 (ACK) KB3 set to 0 or 1 (flow control bit) KB2 set the same as the referenced DBM transmission. KB1 set the same as the referenced DBM transmission. Expected Data Code bits for 165 character message: 0000000010	
Legend: ACK – Acknowledgement; ARQ – automatic repeat request; ASCII – American Standard Code for Information Interchange; CMD – command; CRC – Cyclic Redundancy Check; DBM – Data Block Message; JITC – Joint Interoperability Test Command; kHz – kilohertz; PC – Personal Computer; RF – Radio Frequency; UUT – Unit Under Test; WAV – Wave			

C-40.4 Presentation of Results. The results will be shown in tabular format (table C-40.2) indicating the requirement and measured value or indications of capability.

Table C-40.2. Data Block Message Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
104	A.5.2.6.2	Receiver word sync. The receive demodulator accepts baseband audio from the receiver; acquires, tracks, and demodulates ALE signals; and provides the recovered digital data to the decoders. See figure A-11. In data block message (DBM) mode, the receive demodulator shall also be capable of reading single data bits for deep deinterleaving and decoding.	Message received by System B: "THE QUICK BROWN FOX!"			

Table C-40.2. Data Block Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
188	A.5.7.4	DBM mode. The DBM ALE (orderwire) message protocol function enables ALE stations to communicate either full ASCII, or unformatted binary bit messages to and from any selected ALE station(s) for direct output to and input from associated data terminal or other DTE devices through their standard DCE ports. This DBM data transfer function is a high-speed mode (relative to DTM and AMD) with improved robustness, especially against long fades and noise bursts. When used over MF/HF by the ALE system, DBM orderwire messages may be unilateral or bilateral, and broadcast or acknowledged. As the DBM data blocks can be very large, this special orderwire message function enables exploitation of deep interleaving and FEC techniques to penetrate HF-channel long fades and large noise bursts. The DBM data blocks shall be fully buffered at each station and should appear transparent to the using DTEs or data terminals. As a design objective and under the direction of the operator or controller, the stations should have the capability of using the DBM data traffic mode (ASCII or binary bits) to control switching of the DBM data traffic to the appropriate DCE port or associated DTE equipment, such as to printers and terminals (if ASCII mode) or computers and cryptographic devices (if binary bits mode). As an operator or controller-selected option, the received DBM message may also be presented on the operator display, similar to the method for AMD in table A.5.7.2.	Expected individual call with DBM: TO B01 CMD DBM (data is deeply interleaved; ALEOOWPP will not decode). Expected response with ARQ: TO A01 CMD DBM ARQ TIS B01. Expected Null Data Code bits: 0000000000 Expected Control bits: KB4: 1 KB3: 1 KB2: 0 or 1 KB1: 0 or 1 Expected Data Code bits: 1001010011 DBM structured as shown in table A-XXXV.			

Table C-40.2. Data Block Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
188	A.5.7.4 (continued)	There are four CMD DBM modes: BASIC, EXTENDED, NULL, and ARQ. The DBM BASIC block is a fixed size and contains a variable quantity of data, from zero to full as required, which is exactly measured to ensure integrity of the data during transfer. The DBM EXTENDED blocks are variable in size in integral multiples of the BASIC block, and are filled with integral multiples of message data. The DBM NULL and ARQ modes are used for both link management, and error and flow control. The characteristics of the CMD DBM orderwire message functions are listed in table A-XXXIV, and they are summarized below: When an ASCII, or binary bit, digital data message function is required, the following CMD DBM orderwire structures and protocols shall be used as specified herein, unless another standardized protocol is substituted. The DBM structure shall be inserted within the message section of the standard frame. A CMD DBM word shall be constructed in the standard format. The data to be transferred shall be Golay FEC encoded, interleaved (for error spreading during decoding), and transmitted immediately following the CMD DBM word.	Note: Procedures are being investigated for shalls that are not currently validated.			

Table C-40.2. Data Block Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
188	A.5.7.4 (continued)	When the DBM structure transmission time exceeds the maximum for the message section ($T_{m\ max}$), the DBM protocol shall take precedence and shall extend the T_m limit to accommodate the DBM. The DBM mode preserves the required consistency of redundant word phase during the transmission. The message expansion due to the DBM is always a multiple of 8 T_{rw}, as the interleaver depth is always a multiple of 49. The transmission time of the DBM data block (T_{dbm}) itself is equal to (interleaver depth x 64ms), not including the T_{rw} for the preceding CMD DBM word. Figure A-49 shows an example of an exchange using the DBM orderwire to transfer and acknowledge messages. Figure A-50 shows an example of a DBM data interleaver, and figure A-51 shows the transmitted DBM bit-stream sequence. The DBM protocol shall be as described herein. The CMD DBM BASIC and EXTENDED formats (herein referred to as DBM data blocks) shall be used to transfer messages in information among ALE stations. The CMD DBM ARQ format shall be used to acknowledge other CMD DBM formats and for error and flow control, except for non-ARQ and one-way broadcasts. The CMD DBM NULL format shall be used to: (a) interrupt ("break") the DBM and message flow; (b) to interrogate stations to confirm DBM capability before initiation of the DBM message transfer protocols; and (c) to terminate the DBM protocols while remaining linked. When used in handshakes and subsequent exchanges, the protocol frame terminations for all involved stations shall be TIS until all the DBM messages are successfully transferred, and all are acknowledged if ARQ error control is required.				

Table C-40.2. Data Block Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
188	A.5.7.4 (continued)	The only exceptions shall be when the protocol is a one-way broadcast or the station is forced to abandon the exchange by the operator or controller, in which cases the termination should be TWAS. Once a CMD DBM word of any type has been received by a called (addressed) or linked station, the station shall remain on channel for the entire specified DBM data block time (if any), unless forced to abandon the protocol by the operator or controller. The start of the DBM data block itself shall be exactly indicated by the end of the CMD DBM BASIC or EXTENDED word itself. The station shall attempt to read the entire DBM data block information, plus the expected frame continuation, which shall contain a conclusion (possibly preceded by additional functions in the message section, as indicated by additional CMD words). With or without ARQ, identification of each DBM data block and its associated orderwire message (if segmented into sequential DBM data blocks) shall be achieved by use of the sequence and message control bits, KB1 and KB2, (see table A-XXXV) which shall alternate with each DBM transmission and message, respectively. The type of data contained within the data block (ASCII or binary bits) shall be indicated by KB3 as a data identification bit. Activation of the ARQ error-control protocol shall use the ARQ control bit KB4. If no ARQ is required, such as in one-way broadcasts, multiple DBM data blocks may be sent in the same frame, but they shall be in proper sequence if they are transferring a segmented message.				

Table C-40.2. Data Block Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
188	A.5.7.4 (continued)	When ARQ error or flow control is required, the CMD DBM ARQ shall identify the acknowledged DBM data block by the use of the sequence and message control bits KB1 and KB2, which shall be set to the same values as the immediately preceding and referenced DBM data block transmission. Control bit KB3 shall be used as the DBM flow control to pause or continue (or resume) the flow of the DBM data blocks. The ACK and NAK functions shall use the ARQ control bit KB4. If no ARQ has been required by the sending station, but the receiving station needs to control the flow of the DBM data blocks, it shall use the DBM ARQ to request a pause in, and resumption of, the flow. When data transfer ARQ error and flow control is required, the DBM data blocks shall be sent individually and in sequence. Each DBM data block shall be individually acknowledged before the next DBM data block is sent. Therefore, with ARQ there shall be only one DBM data block transmission in each frame. If the transmitted DBM data block causes a NAK in the returned DBM ARQ, as described below, or if no ACK or DBM ARQ is detected in the returned frame, or if no frame is detected at all, the sending station shall resend an exact duplicate of the unacknowledged DBM data block. It shall continue to resend duplicates (which should be at least seven), one at a time and with appropriate pauses for responses, until the involved DBM data block is specifically acknowledged by a correct DBM ARQ. Only then shall the next DBM data block in the sequence be sent. If the sending station is frequently or totally unable to detect frame or DBM ARQ responses, it should abort the DBM transfer protocol, terminate the link and relink and reinitiate the DBM protocol on a better channel (under operator or controller direction).				

Table C-40.2. Data Block Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
188	A.5.7.4 (continued)	Before initiation of the DBM data transfer protocols, the sending stations should confirm the existence of the DBM capability in the intended receiving stations, if not already known. When a DBM interrogation function is required, the following protocol shall be used. Within any standard protocol frame (using TIS), the sending station shall transmit a CMD DBM NULL, with ARQ required, to the intended station(s). These receiving stations shall respond with the appropriate standard frame and protocol, with the following variations. They shall include a CMD DBM ARQ if they are DBM capable, and they shall omit it if they are not DBM capable. The sending station shall examine the ALE and DBM ARQ responses for existence, correctness, and the status of the DBM KB control bits, as described herein. The transmitted CMD DBM NULL shall have its control bits set as follows: KB1 and KB2 set opposite of any subsequent and sequential CMD DBM BASIC or EXTENDED data blocks which will be transmitted next; KB3 set to indicate the intended type of traffic; and KB4 set to require ARQ. The returned CMD DBM ARQ shall have its control bits set as follows: KB1 and KB2 set to match the interrogating DBM NULL; KB3 set to indicate if the station is ready for DBM data exchanges, or if a pause is requested; and KB4 set to ACK if the station is ready to accept DBM data transmissions with the specified traffic type, and NAK if it cannot or will not participate, or if it failed to read the DBM NULL.				

Table C-40.2. Data Block Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
188	A.5.7.4 (continued)	The sending (interrogating) station shall handle any stations which return a NAK, or do not return a DBM ARQ, or do not respond, in any combination of the following, and for any combination of these stations. The specific actions and stations shall be selected by the operator or controller. The sending station shall: (a) terminate the link with these stations, using an appropriate and specific call and the TWAS terminator; (b) direct the stations to remain and stay linked during the transmissions, using the CMD STAY protocol in each frame immediately before each CMD DBM word and data block sent; or (c) redirect them to do anything else which is controllable using the CMD functions described within this standard. Each received DBM data block shall be examined using the CRC data integrity test which is embedded within the DBM structure and protocol. If the data block passes the CRC test, the data shall be passed through to the appropriate DCE port (or normal output as directed by the operator or controller). If the data block is part of a larger message which was segmented before DBM transfer, it shall be recombined before output. If any DBM data blocks are received and do not pass the CRC data integrity test, any detectable but uncorrectable errors; or areas likely to contain errors, should be tagged for further analysis, error control, or inspection by the operator or controller.				

Table C-40.2. Data Block Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
188	A.5.7.4 (continued)	If ARQ is required, the received but unacceptable data block shall be temporarily stored, and a DBM ARQ NAK shall be returned to the sender, who shall retransmit an exact duplicate DBM data block. Upon receipt of the duplicate, the receiving station shall again test the CRC. If the CRC is successful, the data block shall be passed through as described before, the previously unacceptable data block should be deleted, and a DBM ARQ ACK shall be returned. If the CRC fails again, both the duplicate and the previously stored data blocks shall be used to correct, as possible, errors and to create an “improved” data block. See figure A-48 for an example of data block reconstruction. The “improved” data block shall then be CRC tested. If the CRC is successful, the “improved” data block is passed through, the previously unacceptable data blocks should be deleted, and a DBM ARQ ACK shall be returned. If the CRC test fails, the “improved” data block shall also be stored and a DBM ARQ NAK shall be returned. This process shall be repeated until: (a) a received duplicate, or an “improved” data block passes the CRC test (and the data block is passed through, and a DBM ARQ ACK is returned); (b) the maximum number of duplicates (such as seven or more) have been sent without success (with actions by the sender as described above); or (c) the operators or controllers terminate or redirect the DBM protocol.				

Table C-40.2. Data Block Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
188	A.5.7.4 (continued)	During reception of frames and DBM data blocks, it is expected that fades, interferences, and collisions will occur. The receiving station shall have the capability to maintain synchronization with the frame and the DBM data block transmission, once initiated. It shall also have the capability to read and process any colliding and significantly stronger (that is, readable) ALE signals without confusing them with the DBM signal (basic ALE reception in parallel, and always listening). The DBM structures, especially the DBM EXTENDED, can tolerate significant fades, noise bursts, and collisions. Therefore, useful information which may be derived from readable collisions of ALE signals should not be arbitrarily rejected or wasted.				

Table C-40.2. Data Block Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
188	A.5.7.4 (continued)	The DBM constructions shall be as described herein. Within the DBM data block structure, a CMD DBM word shall be placed ahead of the encoded and interleaved data block itself. The DBM word shall alert the receiving station that a DBM data block is arriving, how long it is, what type of traffic it contains, what its interleaver depth is, what its message and block sequence is, and if ARQ is required. It shall also indicate the exact start of the data block itself (the end of the CMD DBM word itself) and shall initiate the reception, tracking, deinterleaving, decoding, and checking of the data contained within the block. The message data itself shall be either one of two types, binary bits or ASCII. The ASCII characters (typically used for text) shall be the standard 7-bit length, and the start, stop, and parity bits shall be removed at the sending (and restored at the receiving) station. The binary bits (typically used for other character formats, computer files, and cryptographic devices) may have any (or no) pattern or format, and they shall be transferred transparently, that is, exactly as they were input to the sending station, with the same length and without modification. The value of the interleaver depth shall be the smallest (multiple of 49) which will accommodate the quantity of ASCII or binary bits message data to be transferred in the DBM data block. If the message data to be transferred does not exactly fit the uncoded data field of the DBM block size selected (except for the last 16 bits, which are reserved for the CRC), the available empty positions shall be "stuffed" with ASCII "DEL" characters or all "1" bits.				

Table C-40.2. Data Block Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
188	A.5.7.4 (continued)	The combined message and "stuff" data in the uncoded DBM data field shall then be checked by the CRC for error control in the DBM protocol. The resulting 16-bit CRC word shall always occupy the last 16 bits in the data field. All the bits in the field shall then be Golay FEC encoded, on a 12-bit basis, to produce rows of 24-bit code words, arranged from top to bottom in the interleaver matrix (or equivalent), as shown in figure A-50. The bits in the matrix are then read out by columns (of length equal to the interleaver depth) for transmission. Immediately after the CMD DBM word, the encoded and interleaved data blocks bits shall follow in bit format, three bits per symbol (tone).				

Table C-40.2. Data Block Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
188	A.5.7.4 (continued)	The DBM BASIC data block has a fixed size (interleaver depth 49) and shall be used to transfer any quantity of message data between zero and the maximum limits for the DBM BASIC structure, which is up to 572 bits or 81 ASCII characters. It is capable of counting the exact quantity of message data which it contains, on a bit-by-bit basis. It should be used as a single DBM for any message data within this range. It shall also be used to transfer any message data in this size range which is an "overflow" from the larger size (and increments) DBM EXTENDED data blocks (which shall immediately precede the DBM BASIC in the DBM sequence of sending). The DBM EXTENDED data blocks are variable in size, in increments of 49 times the interleaver depth. They should be used as a single, large DBM to maximize the advantages of DBM deep interleaving, FEC techniques, and higher speed (than DTM or AMD) transfer of data. The interleaver depth of the EXTENDED data block should be selected to provide the largest data field size which can be totally filled by the message data to be transferred. Any "overflow" shall be in a message data segment sent within an immediately following DBM EXTENDED or BASIC data block. Under operator or controller direction, multiple DBM EXTENDED data blocks, with smaller than the maximum appropriate interleaver depth sizes, should be selected if they will optimize DBM data transfer throughput and reliability.				

Table C-40.2. Data Block Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
188	A.5.7.4 (continued)	However, these multiple data blocks will require that the message data be divided into multiple segments at the sending station and sent only in the exact order of the segments in the message. The receiving stations must recombine the segments into a complete received message. When binary bits are being transferred, the EXTENDED data field shall be filled exactly to the last bit. When ASCII characters are being transferred, the EXTENDED data field may have 0 to 6 "stuff" bits inserted. Individual ASCII characters shall not be split between DBM data blocks and the receiving station shall read the decoded data field on a 7-bit basis, and it shall discard any remaining "stuff" bits (modulo-7 remainder). If stations are exchanging DBM data blocks and DBM ARQs, they may combine both functions in the same frames. They shall discriminate based on the direction of transmission and the sending and destination addressing. If ARQ is required in a given direction, only one DBM data block shall be allowed within any frame in that direction, and only one DBM ARQ shall be allowed in each frame in the return direction. If no ARQ is required in a given direction, multiple DBM data blocks may be included in				

Table C-40.2. Data Block Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
188	A.5.7.4 (continued)	frames in that direction, and multiple DBM ARQs may be included in the return direction. As always throughout the DBM protocol, any sequence of DBM data blocks to be transferred shall have their KB1 sequence control bits alternating with the preceding and following DBM data blocks (except duplicates for ARQ, which shall be exactly the same as their originally transmitted DBM data block). Also, all multiple DBM data blocks transferring multiple segments of a large data message shall all have their KB2 message control bits set to the same value, and opposite of the preceding and following messages. If a sequence of multiple but unrelated DBM data blocks are sent (such as several independent and short messages within several DBM BASIC data blocks), they may be sent in any sequence. However, when sent, the associated KB1 and KB2 sequence and message control bits shall alternate with those in the adjacent DBM data blocks.				

Table C-40.2. Data Block Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
188	A.5.7.4 (continued)	The CMD DBM words shall be constructed as shown in table A-XXXV. The preamble shall be CMD (110) in bits P3 through P1 (W1 through W3). The first character shall be "b" (1100010) in bits C1-7 through C1-1 (W4 through W10), which shall identify the DBM "block" function. For DBM BASIC, EXTENDED, and NULL, when the ARQ control bit KB4 (W11) is set to "0," no correct data receipt acknowledgement is required; and when set to "1," it is required. For DBM ARQ, ARQ control bit KB4 is set to "0" to indicate acknowledgement or correct data block receipt (ACK); and when set to "1," it indicates a failure to receive the data and is therefore a request-for-repeat (NAK). For DBM ARQ responding to a DBM NULL interrogation, KB4 "0" indicates non-participation in the DBM protocol or traffic type, and KB4 "1" indicates affirmative participation in both the DBM protocol and traffic type. For DBM BASIC, EXTENDED, and NULL, when the data type control bit KB3 (W12) is set to "0," the message data contained within the DBM data block shall be binary bits with no required format or pattern; and when KB3 is set to "1" the message data is 7-bit ASCII characters. For DBM ARQ, flow control bit KB3 is set to "0" to indicate that the DBM transfer flow should continue or resume; and when KB3 is set to "1" it indicates that the sending station should pause (until another and identical DBM ARQ is returned, except that KB3 shall be "0").				

Table C-40.2. Data Block Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
188	A.5.7.4 (continued)	For DBM BASIC, EXTENDED, and NULL, when the "message" control bit KB2 (W13) is set to the same value as the KB2 in any sequentially adjacent DBM data block, the message data contained within those adjacent blocks (after individual error control) shall be recombined with the message data within the present DBM data block to reconstitute (segment-by-segment) the original whole message; and when KB2 is set opposite to any sequentially adjacent DBM data blocks, those data blocks contain separate message data and shall not be combined. For DBM ARQ, "message" control bit KB2 shall be set to match the referenced DBM data block KB2 value to provide message confirmation. For DBM BASIC, EXTENDED, and NULL, the sequence control bit KB1 (W14) shall be set opposite to the KB1 value in the sequentially adjacent DBM BASIC, EXTENDED, or NULLs be sent (the KB1 values therefore alternate, regardless of their message dependencies). When KB1 is set the same as any sequentially adjacent DBM sent, it indicates a duplicate. For DBM ARQ, sequence control bit KB1 shall be set to match the referenced DBM data block or NULL KB1 value to provide sequence confirmation. When used for the DBM protocols, the ten DBM data code (BC) bits BC10 through BC1 (W15 through W24) shall indicate the DBM mode (BASIC, EXTENDED, ARQ, or NULL). They shall also indicate the size of the message data and the length of the data block. The DBM NULL BC value shall be "0" (0000000000), and it shall designate the single CMD DBM NULL word.				

Table C-40.2. Data Block Message Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
188	A.5.7.4 (continued)	The DBM EXTENDED BC values shall range from "1" (0000000001) to "445" (0110111101), and they shall designate the CMD DBM EXTENDED word and the data block multiple (of 49 INTERLEAVER DEPTH) which defines the variable data block sizes, in increments of 588 binary bits or 84 ASCII characters. The DBM BASIC BC values shall range from "448" (0111000000) to "1020" (1111111100), and they shall designate the CMD DBM BASIC word and the exact size of the message data in a fixed size (INTERLEAVER DEPTH = 49) data block, with up to 572 binary bits or 81 ASCII characters. The DBM ARQ BC value shall be "1021" (1111111101), and it shall designate the single CMD DBM ARQ word. NOTES: 1. The values "446" (0110111110) and "447" (0110111111) are reserved. 2. The values "1022" (1111111110) and "1023" (1111111111) are reserved until standardized (see table A-XXXIV).				

Legend: ALE – Automatic Link Establishment; AMD – Automatic Message Display; ARQ – automatic repeat request; ASCII – American Standard Code for Information Interchange; CRC – Cyclic Redundancy Check; DBM – Data Block Message; DCE – Data Control Equipment; DTE – Data Terminal Equipment; DTM – Data Text Message; FEC – Forward Error Correction; HF – High Frequency; MF – Medium Frequency; MIL-STD – Military Standard; NAK – non-acknowledgement

C-41 SUBTEST 41, CYCLIC REDUNDANCY CHECK (CRC)

C-41.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 157.

C-41.2 Criteria. CRC. This special error-checking function is available to provide data integrity assurance for any form of message in an ALE call.

NOTE: The CRC function is optional, but mandatory when used with the DTM or DBM modes.

The 16-bit frame check sequence (FCS) and method as specified by FED-STD 1003 shall be used herein. The FCS provides a probability of undetected error of 2^{-16}, independent of the number of bits checked.

The generator polynomial is: $X^{16} + X^{12} + X^{5} + 1$

The sixteen FCS bits are designated: (MSB) X^{15}, X^{14}, X^{13}, X^{12}...X^{1}, X^{0} (LSB)

The ALE CRC is employed two ways: within the DTM data words, and following the DBM data field, described in MIL-STD-188-141B paragraphs A.5.7.3 and A.5.7.4, respectively. The first, and the standard, usages are described in this section.

The CMD CRC word shall be constructed as shown in MIL-STD-188-141B, table A-XVII. The preamble shall be CMD (110) in bits P3 through P1 (W1 through W3). The first character shall be “x” (1111000), “y” (1111001), “z” (1111010), or “{” (1111011) in bits C1-7 through C1-1 (W4 through W10). Note that four identifying characters result from FCS bits X^{15} and X^{14} which occupy C1-2 and C1-1 (W9 and W10) in the first character field respectively. The conversion of FCS bits to and from ALE CRC format bits shall be as described in MIL-STD-188-141B, table A-XVII where X^{15} through X^{0} correspond to W9 through W24. The CMD CRC message should normally appear at the end of the message section of a transmission, but it may be inserted within the message section (but not within the message being checked) any number of times for any number of separately checked messages, and at any point except the first word (except as noted below). The CRC analysis shall be performed on all ALE words in the message section that precede the CMD CRC word bearing the FCS information, and which are bounded by the end of the calling cycle, or the previous CMD CRC word, whichever is closest. The selected ALE words shall be analyzed in their non-redundant and unencoded (or FEC decoded) basic ALE word (24-bit) form in the bit sequence (MSB) W1, W2, W3, W4...W24 (LSB), followed by the unencoded bits W1 through W24 from the next word sent (or received), followed by the bits of the next word, until the first CMD CRC is inserted (or found). Therefore, each CMD CRC inserted and sent in the message section ensures the data integrity of all the bits in the previous checked ALE words, including their preambles. If it is necessary to check the ALE words in the calling cycle (TO) preceding the message section, an optional calling cycle CMD CRC shall be used as the calling cycle terminator (first FROM or CMD), shall therefore appear first in the message section, and shall analyze the calling cycle words in their simplest (T_c), nonredundant and nonrotated form. If it is necessary to check the words in a conclusion (TIS or TWAS), an optional conclusion CRC shall directly precede the conclusion portion of the call, shall be at the end of the message section, and shall itself be directly preceded by a separate CMD CRC (which may be used to check the message section or calling cycle, as described herein). Stations shall perform CRC analysis on all received ALE transmissions and shall be prepared to compare analytical FCS values with any CMD CRC words which may be received. If a CRC FCS comparison fails, an ARC (or operator initiated) or other appropriate procedure may be used to correct the message, MIL-STD-188-141B, paragraph A.5.6.1.

C-41.3 Test Procedures

a. Test Equipment Required

(1) Receivers/Transmitters

(2) PC with Soundcard

(3) Attenuators

(4) Channel Simulator

(5) Directional Couplers

(6) Spectrum Analyzer

(7) UUT plus one additional outstation

b. Test Configuration. Configure the equipment as shown in figures C-41.1 and C-41.2.

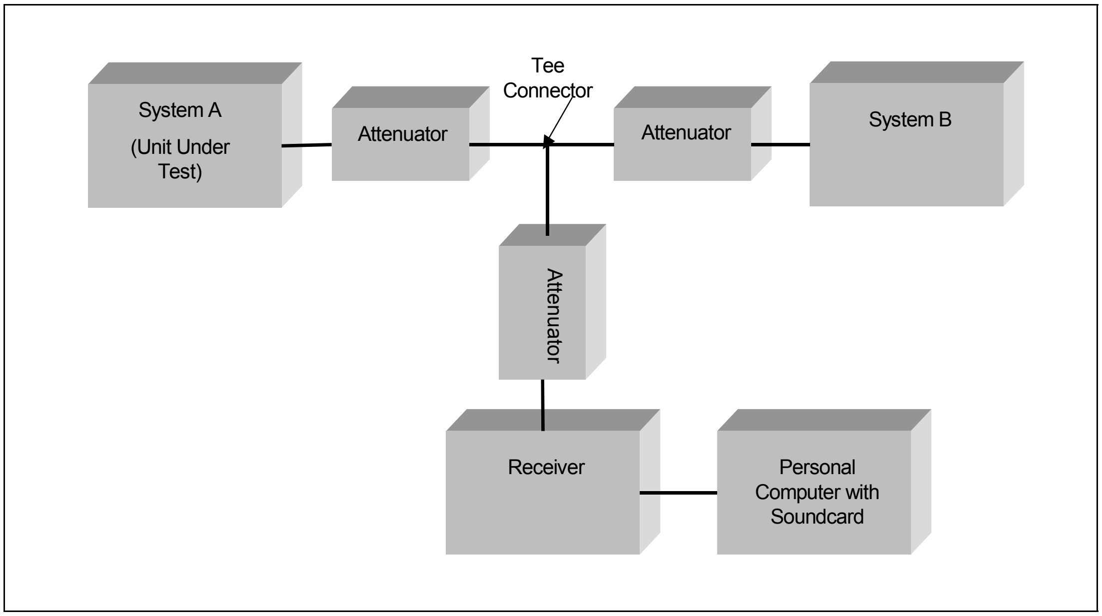

Figure C-41.1. Equipment Configuration for Cyclic Redundancy Check Subtest

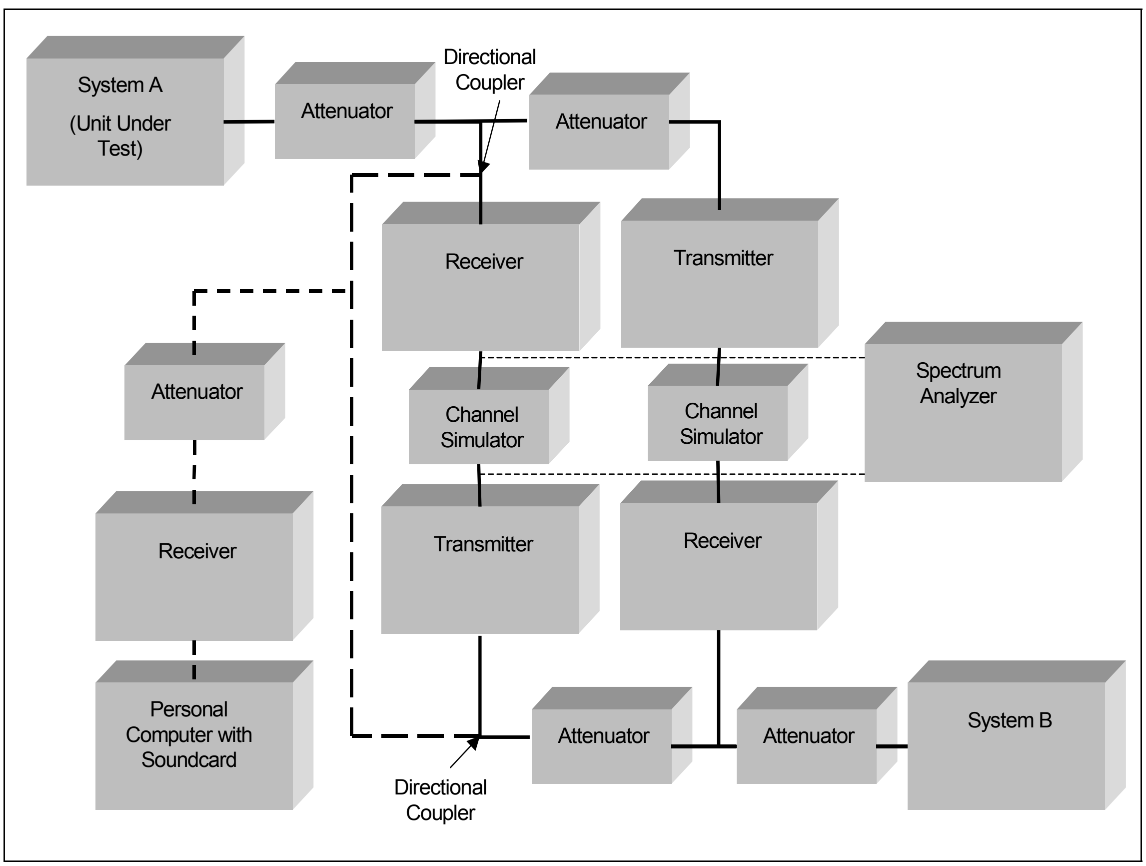

Figure C-41.2. Equipment Configuration for CRC ACK/NAK Test

c. Test Conduct. The procedures for this subtest are listed in table C-41.1.

Table C-41.1. Procedures for Cyclic Redundancy Check Subtest

Step	Action	Settings/Action	Result
The following procedure is for reference number 157.			
1	Set up equipment as shown in figure C-41.1.	Program radios in accordance with tables C-27.1 through C-27.6.	
2	Initialize the system for operation. Use preprogrammed channel information from subtest 27.	Radios required: UUT (system A) plus system B. System A (callsign: A01) links with system B (callsign: B01) in DTM mode.	
3	At the audio out, use the PC to record ALE tones in WAV format.	All WAV files must be sampled at 44.1 kHz, 16 bits, mono.	
4	Send the following DTM message from system A to system B: THE QUICK BROWN FOX!	Capture call in WAV format. Record file name.	
5	Record message received by System B.		
6	Use ALEOOWPP software to decode the captured WAV file. ALEOOWPP software and instructions are available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	Note: If ALEOOWPP is unable to decode the CRC portion of the call, manually decode call using the ALE Word Decode Matrix Forms. The first character of the CRC may be "x", "y", "z", or "{". See MIL-STD-188-141B, section A.5.6.1. It may be helpful to review figure A-48 and table A-XVI from MIL-STD-188-141B.	
7	Record decoded CRC.	Expected decode: CMD CRC 2C5B	
8	Set up equipment.	See figure C-41.2.	
9	Configure simulator for Gaussian noise with a 0-dB Signal-to-Noise Ratio.	Simulator settings: Single path Multipath: 0.0 msec Doppler Spread: 0.0 Hz	
10	Send the following DTM message from system A to system B: THE QUICK BROWN FOX!	Use personal computer to record DTM message in WAV format.	
11	Record message received by system B.		
12	Lower the Signal-to-Noise ratio on the channel simulator in 3-dB steps until System B is unable to receive a DTM message from system A in a single attempt.		
13	Send the following DTM message from system A to system B: THE QUICK BROWN FOX! Use personal computer to record DTM message in WAV format.	System A should make multiple attempts to send this message to system B. If system B incorrectly receives the message, system B should send NAK. When system B correctly receives the message, it should send ACK and display the DTM message to the operator. Record observations.	

Table C-41.1. Procedures for Cyclic Redundancy Check Subtest (continued)

Step	Action	Settings/Action	Result
14	Use ALEOOWPP software to decode the captured WAV files. ALEOOWPP software is available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	Record message decoded by ALEOOWPP.	
15	Record message received by system B.		
Legend: ACK – Acknowledgement; ALE – Automatic Link Establishment; ASCII – American Standard Code for Information Interchange; CMD – Command; CRC – Cyclic Redundancy Check; DTM – Data Text Message; Hz – hertz; JITC – Joint Interoperability Test Command; kHz – kilohertz; MIL-STD – Military Standard; NAK – non-acknowledgement; PC – Personal Computer; UUT – Unit Under Test; WAV – Wave			

C-41.4 Presentation of Results. The results will be shown in tabular format (table C-41.2) indicating the requirement and measured value or indications of capability.

Table C-41.2. Cyclic Redundancy Check Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
157	A.5.6.1	This special error-checking function is available to provide data integrity assurance for any form of message in an ALE call. The 16-bit frame check sequence (FCS) and method as specified by FEC-STD 1003 shall be used herein. The FCS provides a probability of undetected error of 2^{-16}, independent of the number of bits checked. The CMD CRC word shall be constructed as shown in table A-XVII. The preamble shall be CMD (110) in bits P3 through P1 (W1 through W3). The first character shall be "x" (1111000), "y" (1111001), "z" (1111010), or "{" (1111011) in bits C1-7 through C1-1 (W4 through W10). The conversion of FCS bits to and from ALE CRC format bits shall be as described in MIL-STD-188-141B table A-XVII where X^{15} through X^0 correspond to W9 through W24. The CRC analysis shall be performed on all ALE words in the message section that precede the CMD CRC word bearing the FCS information, and which are bounded by the end of the calling cycle, or the previous CMD CRC word, whichever is closest. The selected ALE words shall be analyzed in their non-redundant and unencoded (or FEC decoded) basic ALE word (24 bit) form in the bit sequence (MSB) W1, W2, W3, W4...W24 (LSB), followed by the unencoded bits W1 through W24 from the next word sent (or received), followed by the bits of the next word, until the first CMD CRC is inserted (or found).	CMD DTM DATA THE REP (sp)QU DATA ICK REP (sp)BR DATA OWN REP (sp)FO DATA X!(nul) CMD CRC 2C5B The first character of the CRC may be "x", "y", "z", or "{".			

Table C-41.2. Cyclic Redundancy Check Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
157 (continued)	A.5.6.1 (continued)	If it is necessary to check the ALE words in the calling cycle (TO) preceding the message section, an optional calling cycle CMD CRC shall be used as the calling cycle terminator (first FROM or CMD), shall therefore appear first in the message section, and shall analyze the calling cycle words in their simplest (T_c), nonredundant and nonrotated form. If it is necessary to check the words in a conclusion (TIS or TWAS), an optional conclusion CRC shall directly precede the conclusion portion of the call, shall be at the end of the message section, and shall itself be directly preceded by a separate CMD CRC (which may be used to check the message section or calling cycle, as described herein). Stations shall perform CRC analysis on all received ALE transmissions and shall be prepared to compare analytical FCS values with any CMD CRC words which may be received. If a CRC FCS comparison fails, an ARC (or operator initiated) or other appropriate procedure may be used to correct the message.	Message not received correctly: NAK Message correctly received: ACK			

Legend: ALE – Automatic Link Establishment; CMD – Command; CRC – Cyclic Redundancy Check; DBM – Data Block Message; DTM – Data Text Message; FCS – Frame Check Sequence; LSB – Least Significant Bit; MIL-STD – Military Standard; MSB – Most Significant Bit

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C-42 SUBTEST 42, TUNE AND WAIT, AND TIME-RELATED FUNCTIONS

C-42.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 162, 163, 164, 165, 166, 167, 168, 169, and 170.

C-42.2 Criteria

a. Tune and Wait. The CMD tune and wait special control function directs the receiving station(s) to perform the initial parts of the handshake, up through tune-up, and wait on channel for further instructions during the specified time limit. The time limit timer is essentially the WRTT as used in net slotted responses where its value T_{wrn} is set by the timing information in the special control instruction, and it starts from the detected end of the call. The CMD tune and wait instruction shall suppress any normal or preset responses. Except for the tune-up itself, the receiving station(s) shall make no additional emissions, and they shall quit the channel and resume scan if no further instructions are received.

NOTE: This special control function enables very slow tuning stations, or stations that must wait for manual operator interaction, to effectively interface with automated networks.

The CMD tune and wait shall be constructed as follows and as shown in table A-XIX. The preamble shall be CMD (110) in bits P3 through P1 (W1 through W3). The first character (C1) shall be “t” (1110100) in bits C1-7 through C1-1 (W4 through W10) and “t” (1110100) in bits C2-7 through C2-1 (W11 through W17), for “time, tune-up.” The “T” time bits TB7 through TB1 (W18 through W24) shall be values selected from table A-XX, and limited as shown in table A-XXI. The lowest value (00000) shall cause the tuning to be performed immediately, with zero waiting time, resulting in immediate return to normal scan after tuning, MIL-STD-188-141B, paragraph A.5.6.4.1.

b. Scheduling Commands. These special control functions permit the manipulation of timing in the ALE system. They are based on the standard “T” time values, presented in table A-XX, which have the following ranges based on exact multiples of T_w (130.66...msec) or T_{rw} (392 msec).

0 to 4 seconds in 1/8 second (T_w) increments
0 to 36 seconds in 1 second (3 T_{rw}) increments
0 to 31 minutes in 1 minute (153 T_{rw}) increments
0 to 29 hours in 1 hour (9184 T_{rw}) increments

There are several specific functions that utilize these special timing controls. All shall use the CMD (110) preamble in bits P3 through P1 (W1 through W3). The first character is “t” (1110100) for “time.” The second character indicates the function as shown in table A-XXI. The basic structure is the same as in table A-XIX, MIL-STD-188-141B, paragraph A.5.6.4.2.

c. Command Words. Time exchange command words Time Is and Time Request that are used to request and to provide time of day (TOD) data, shall be formatted as shown in figure A-38. The three most-significant bits (W1-3) shall contain the standard CMD preamble (110). The next seven bits (W4-10) shall contain the ASCII character '~'(1111110), indicating the magnitude of time uncertainty at the sending station in accordance with paragraph A.5.6.4.6, MIL-STD-188-141B, paragraph A.5.6.4.3.1.

d. Time Is Command. The Time Is command word carries the fine time current at the sending station as of the start of transmission of the word following the Time Is command word, and is used in protected time requests and all responses. In a Time Is command word, the seconds field shall be set to the current number of seconds elapsed in the current minute intervals which have elapsed in the current second (0-24). The time quality shall reflect the sum of the uncertainty of the local time and the uncertainty of the time of transmission of the Time Is command, in accordance with table A-XXII and paragragh A.5.6.4.6. When a protocol requires transmission of the Time Is command word, but no time value is available, a NULL Time Is command word shall be sent, containing a time quality of 7 and the seconds and ticks fields both set to all 1s, MIL-STD-188-141B, paragraph A.5.6.4.3.2.

e. Time Request command. The Time Request command word shall be used to request time when no local time value is available, and is used only in non-protected transmissions. In a Time Request command word, time quality shall be set to 7, the seconds field to all 1s, and the ticks field set to 30 (11110), MIL-STD-188-141B, paragraph A.5.6.4.3.3.

f. Other Encodings. All encodings of the seconds and ticks fields not specified here are reserved, and shall not be used until standardized, MIL-STD-188-141B, paragraph A.5.6.4.3.4.

g. Coarse Time Word. Coarse time words shall be formatted as shown in figure A-39, and shall contain the coarse time current as of the beginning of that word, MIL-STD-188-141B, paragraph A.5.6.4.4.

h. Authentication Word. Authentication words, formatted as shown in figure A-39, shall be used to authenticate the times exchanged using the time protocols. The 21-bit authenticator shall be generated by the sender as follows:

1. All 24-bit words in the time exchange message preceding the authentication word (starting with the Time Is or Time Request command word which begins the message) shall be exclusive-or'd.

2. If the message to be authenticated is in response to a previous time exchange message, the authenticator from that message shall be exclusive-or'd with the result of (1). The 21 least significant bits of the final result shall be used as the authenticator, MIL-STD-188-141B, paragraph A.5.6.4.5.

i. Time Quality. Every time exchange command word transmitted shall report the current uncertainty in TOD at the sending station, whether or not time is transmitted in the command word. The codes listed in table A-XXII shall be employed for this purpose. The time uncertainty windows on the table are upper bounds on total uncertainty (with respect to coordinated universal time).

For example, an uncertainty of ±6 seconds is 12 seconds total and requires a transmitted time quality value of 6. Stations shall power up from a cold start with a time quality of 7. Time uncertainty is initialized when time is entered (see paragraph B.5.2.2.1) and shall be maintained thereafter as follows:

1. The uncertainty increases at a rate set by oscillator stability (e.g., 72 msec per hour with a ±10 parts per million (ppm) time base).

2. Until the uncertainty is reduced upon the acceptance of time with less uncertainty from an external source after which the uncertainty resumes increasing at the above rate.

A station accepting time from another station shall add its own uncertainty due to processing and propagation delays to determine its new internal time uncertainty. For example, if a station receives time of quality 2, it adds to the received uncertainty of 100 msec (±50 msec) its own processing delay uncertainty of, say ±100 msec, and a propagation delay bound of ±35 msec, to obtain a new time uncertainty of ±185 msec, or 370 msec total, for a time quality of 3. With a ±10 ppm time source, this uncertainty window would grow by 72 msec per hour, so after two hours, the uncertainty becomes 514 msec, and the time quality has dropped to 4. If a low-power clock is used to maintain time while the rest of the unit is powered off, the quality of this clock shall be used to assign time quality upon resumption of normal operation. For example, if the backup clock maintains an accuracy of ±100 ppm under the conditions expected while the station is powered off, the time uncertainty window shall be increased by 17 seconds per day. Therefore, such a radio, which has been powered-off for much over three days, shall not be presumed to retain even coarse synchronization (sync), despite its backup clock, and may require manual entry of time, MIL-STD-188-141B, paragraph A.5.6.4.6.

C-42.3 Test Procedures

a. Test Equipment Required

(1) Receiver

(2) PC with Soundcard

(3) Attenuators

(4) Tee Connector

(5) UUT plus one additional outstation

b. Test Configuration. Configure the equipment as shown in figure C-42.1.

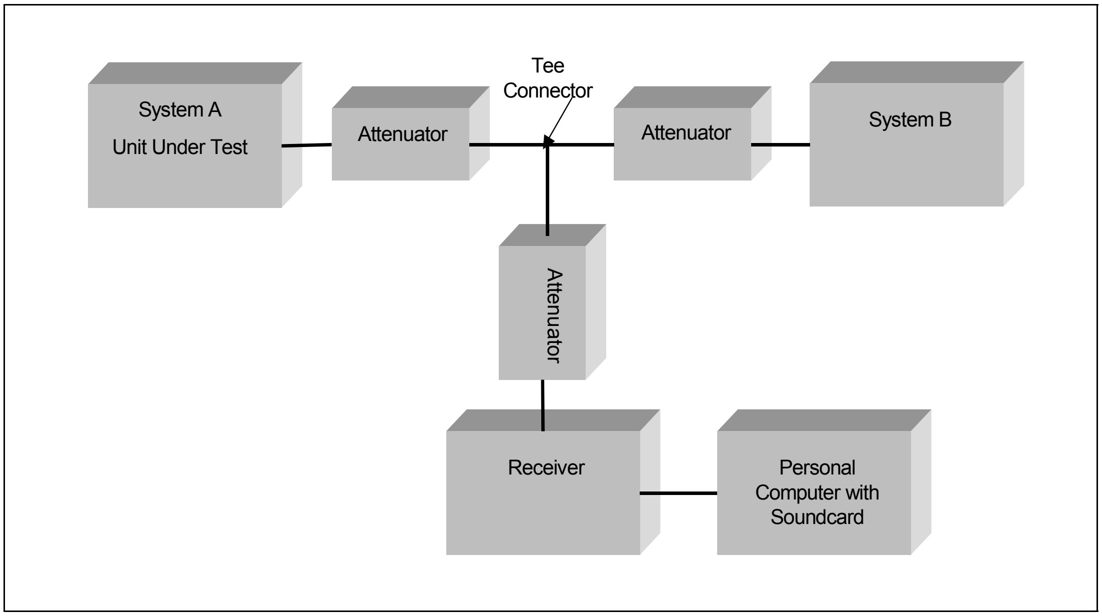

Figure C-42.1. Equipment Configuration for Tune and Wait, and Time-Related Functions

c. Test Conduct. The procedures for this subtest are listed in table C-42.1.

Table C-42.1. Procedures for Tune and Wait, and Time-Related Functions

Step	Action	Settings/Action	Result
The following procedure is for reference number 162.			
1	Set up equipment as shown in figure C-42.1.	Program radios in accordance with tables C-27.1 through C-27.6.	
2	Initialize the system for operation. Use preprogrammed channel information from subtest 27. “Tune and Wait” Required radios: UUT plus one additional outstation. Scenario: System B (callsign: B01) places call to System A (callsign: A01) with COMMAND Tune and Wait information.	Observe system A. Record observations. (System A should stop scanning, tune up, not respond, and wait 36 sec for instructions.)	
3	Configure the PC to record audio files in WAV format.	All WAV files must be sampled at 44.1 kHz, 16 bits, mono.	
4	Place call.	At the audio out, use the PC to record the complete set of tones in WAV format.	

Table C-42.1. Procedures for Tune and Wait, and Time-Related Functions (continued)

Step	Action	Settings/Action	Result
5	Record file name. This file will be recalled using ALEOOWPP software for analysis of the word content data.		
The following procedure is for reference number 163.			
6	Proceed with operation in the following scenario: "Adjust Slot Width" UUT plus one additional outstation. System A (callsign: A01) places call to system B (callsign: B01) with COMMAND Adjust Slot Width information.	Observe system B. Record observations. Using a stopwatch, record the slot width time. (System B should add increments of 130.66 msec to the width of all slots for this response.)	
7	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled using ALEOOWPP software for analysis of the word content data.	
8	Proceed with operation in the following scenario: "Halt and Wait" UUT plus one additional outstation. System A (callsign A01) places call to system B (callsign: B01) with COMMAND Halt and Wait information	Observe system B. Record observations. (System B should stops scanning; not tune or respond, and waits up to 36 sec for instructions.)	
9	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled using ALEOOWPP software for analysis of the word content data.	
10	Proceed with operation in the following scenario: "Operator NAK" UUT plus one additional outstation. System A (callsign: A01) places call to system B (callsign: B01) with COMMAND Operator NAK information.	Observe system B. Record observations. (System B should scanning at T. If no operator input, it should proceed with automatic tune up and respond (THIS IS) in any available slots.)	
11	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled using ALEOOWPP software for analysis of the word content data.	
12	Proceed with operation in the following scenario: "Operator ACK" UUT plus one additional outstation. System A (callsign: A01) places call to system B (callsign: B01) with COMMAND Operator ACK information.	Observe system B. Record observations. (System B should stop scanning, and alerts the operator to manually input ACK, which causes tune up. If no input by 2 minutes, B should quit.)	
13	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled using ALEOOWPP software for analysis of the word content data.	

Table C-42.1. Procedures for Tune and Wait, and Time-Related Functions (continued)

Step	Action	Settings/Action	Result
14	Proceed with operation in the following scenario: “Respond and Wait” UUT plus one additional outstation. System A (callsign: A01) places call to system B (callsign: B01) with COMMAND Respond and Wait information.	Observe system B. Record observations. (System B should stop scanning, tune up, respond, and wait 36 seconds for instructions.)	
15	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled using ALEOOWPP software for analysis of the word content data.	
16	Proceed with operation in the following scenario: “Width of Slot” UUT plus one additional outstation. System A (callsign: A01) places call to system B (callsign: B01) with COMMAND Slot Width information.	Observe system B. Record observations. (System B should set width of all slots to 1176 msec.)	
17	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled using ALEOOWPP software for analysis of the word content data.	
The following procedure is for reference numbers 164, 165, 166, and 169.			
18	Proceed with operation in the following scenario: “Time Is” UUT plus one additional outstation. System A (callsign: A01) places call to system B (callsign: B01) with COMMAND Time Is information.	Observe system B. Record observations. (System A should provide time of day data.)	
19	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled using ALEOOWPP software for analysis of the word content data.	
20	Proceed with operation in the following scenario: “Time Request” UUT plus one additional outstation. System A (callsign: A01) places call to system B (callsign: B01) with COMMAND Time Request information.	Observe system B. Record observations. (System B should provide time of day data. System A should add its own time uncertainty due to processing and propagation delays to determine its new internal time uncertainty.)	
21	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled using ALEOOWPP software for analysis of the word content data.	
22	Use ALEOOWPP software to decode each file for word content data.	ALEOOWPP software and instructions are available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	

Table C-42.1. Procedures for Tune and Wait, and Time-Related Functions (continued)

Step	Action	Settings/Action	Result
The following procedure is for reference numbers 162 through 169.			
23	Review the decoded Tune and Wait command message.	Expected decode: Constructed as shown in MIL-STD-188-141B, table A-XIX. Record actual results.	
24	Review the decoded Adjust Slot Width command, Halt and Wait command, Operator NAK, Operator ACK, Respond and Wait command, and Width of Slot command messages.	Expected decode: Characters as shown in MIL-STD-188-141B, table A-XXI, and time values as shown in MIL-STD-188-141B, table A-XX. Record actual results.	
25	Review the decoded Time Is command message.	Expected decode: Formatted as shown in MIL-STD-188-141B, figure A-38. Record actual results.	
26	Review the decoded Time Request command message.	Expected decode: Formatted as shown in MIL-STD-188-141B, figure A-38. Record actual results.	
Legend: JITC – Joint Interoperability Test Command; kHz – kilohertz; MIL-STD – Military Standard; NAK – non-acknowledgement; PC – Personal Computer; UUT – Unit Under Test; WAV – Wave			

C-42.4 Presentation of Results. The results will be shown in tabular format (table C-42.2) indicating the requirement and measured value or indications of capability.

Table C-42.2. Tune and Wait, and Time-Related Function Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
162	A.5.6.4.1	Tune and Wait. The CMD tune and wait special control function directs the receiving station(s) to perform the initial parts of the handshake, up through tune-up, and wait on channel for further instructions during the specified time limit. The time limit timer is essentially the WRTT as used in net slotted responses where its value T_{wrn} is set by the timing information in the special control instruction, and it starts from the detected end of the call. The CMD tune and wait instruction shall suppress any normal or preset responses. Except for the tune-up itself, the receiving station(s) shall make no additional emissions, and they shall quit the channel and resume scan if no further instructions are received. The CMD tune and wait shall be constructed as follows and as shown in table A-XIX. The preamble shall be CMD (110) in bits P3 through P1 (W1 through W3). The first character (C1) shall be “t” (1110100) in bits C1-7 through C1-1 (W4 through W10) and “t” (1110100) in bits C2-7 through C2-1 (W11 through W17), for “time, tune-up.” The “T” time bits TB7 through TB1 (W18 through W24) shall be values selected from table A-XX, and limited as shown in table A-XXI. The lowest value (00000) shall cause the tuning to be performed immediately, with zero waiting time, resulting in immediate return to normal scan after tuning.	Constructed as shown in MIL-STD-188-141B, table A-XIX.			

Table C-42.2. Tune and Wait, and Time-Related Function Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
163	A.5.6.4.2	Scheduling Commands. These special control functions permit the manipulation of timing in the ALE system. They are based on the standard "T" time values, presented in table A-XX, which have the following ranges based on exact multiples of T_w (130.66...msec) or T_{rw} (392 msec). 0 to 4 seconds in 1/8-second (T_w) increments 0 to 36 seconds in 1-second (3 T_{rw}) increments 0 to 31 minutes in 1-minute (153 T_{rw}) increments 0 to 29 hours in 1-hour (9184 T_{rw}) increments There are several specific functions that utilize these special timing controls. All shall use the CMD (110) preamble in bits P3 through P1 (W1 through W3). The first character is "t" (1110100) for "time." The second character indicates the function as shown in table A-XXI. The basic structure is the same as in table A-XIX.	Characters in accordance with table A-XXI and time values are in accordance with table A-XX of MIL-STD-188-141B.			
164	A.5.6.4.3.1	Command Words. Time exchange command words Time Is and Time Request that are used to request and to provide time of day (TOD) data, shall be formatted as shown in figure A-38. The three most-significant bits (W1-3) shall contain the standard CMD preamble (110). The next seven bits (W4-10) shall contain the ASCII character '~'(1111110), indicating the magnitude of time uncertainty at the sending station in accordance with A.5.6.4.6.	Formatted as shown in MIL-STD-188-141B, figure A-38.			

Table C-42.2. Tune and Wait, and Time-Related Function Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
165	A.5.6.4.3.2	Time Is Command. The Time Is command word carries the fine time current at the sending station as of the start of transmission of the word following the Time Is command word, and is used in protected time requests and all responses. In a Time Is command word, the seconds field shall be set to the current number of seconds elapsed in the current minute intervals which have elapsed in the current second (0-24). The time quality shall reflect the sum of the uncertainty of the local time and the uncertainty of the time of transmission of the Time Is command, in accordance with table A-XXII and A.5.6.4.6. When a protocol requires transmission of the Time Is command word, but no time value is available, a NULL Time Is command word shall be sent, containing a time quality of 7 and the seconds and ticks fields both set to all 1s.	Formatted as shown in MIL-STD-188-141B, figure A-38.			
166	A.5.6.4.3.3	Time Request Command. The Time Request command word shall be used to request time when no local time value is available, and is used only in non-protected transmissions. In a Time Request command word, time quality shall be set to 7, the seconds field to all 1s, and the ticks field set to 30 (11110).	Formatted as shown in MIL-STD-188-141B, figure A-38.			
167	A.5.6.4.3.4	Other Encodings. All encodings of the seconds and ticks fields not specified here are reserved, and shall not be used until standardized.	Not used until standardized.			
168	A.5.6.4.4	Coarse Time Word. Coarse time words shall be formatted as shown in figure A-39, and shall contain the coarse time current as of the beginning of that word.	Formatted as shown in MIL-STD-188-141B, figure A-39.			

Table C-42.2. Tune and Wait, and Time-Related Function Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
169	A.5.6.4.5	Authentication Word. Authentication words, formatted as shown in figure A-39, shall be used to authenticate the times exchanged using the time protocols. The 21-bit authenticator shall be generated by the sender as follows: a. All 24-bit words in the time exchange message preceding the authentication word (starting with the Time Is or Time Request command word which begins the message) shall be exclusive-or'd. b. If the message to be authenticated is in response to a previous time exchange message, the authenticator from that message shall be exclusive-or'd with the result of (1). The 21 least-significant bits of the final result shall be used as the authenticator.	Formatted as shown in MIL-STD-188-141B, figure A-39.			

Table C-42.2. Tune and Wait, and Time-Related Function Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result: Required Value	Result: Measured Value	Finding: Met	Finding: Not Met
170	A.5.6.4.6	Time Quality. Every time exchange command word transmitted shall report the current uncertainty in TOD at the sending station, whether or not time is transmitted in the command word. The codes listed in table A-XXII shall be employed for this purpose. The time uncertainty windows on the table are upper bounds on total uncertainty (with respect to coordinated universal time). For example, an uncertainty of ±6 seconds is 12 seconds total and requires a transmitted time quality value of 6. Stations shall power up from a cold start with a time quality of 7. Time uncertainty is initialized when time is entered (see B.5.2.2.1) and shall be maintained thereafter as follows: a. The uncertainty increases at a rate set by oscillator stability (e.g., 72 msec per hour with a ±10 parts per million (ppm) time base). b. Until the uncertainty is reduced upon the acceptance of time with less uncertainty from an external source after which the uncertainty resumes increasing at the above rate. A station accepting time from another station shall add its own uncertainty due to processing and propagation delays to determine its new internal time uncertainty.	Time quality is in accordance with MIL-STD-188-141B, table A-XXII. Station accepting time from another station shall add its own uncertainty.			

Legend: ALE – Automatic Link Establishment; CMD – Command; MIL-STD – Military Standard; msec – millisecond; ppm – parts per million; TOD – Time of Day; WRTT – Wait-for-Response-and-Tune-Timeout

C-43 SUBTEST 43, USER UNIQUE FUNCTIONS

C-43.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 181.

C-43.2 Criteria. User Unique Functions (UUFs). UUFs are for special uses, as coordinated with specific users or manufacturers, which use the ALE system in conjunction with unique, nonstandard, or non-ALE, purposes. There are 16384 specific types of CMD UUF codes available, as indicated by a 14-bit (or two-character) unique index (UI). Each unique type of special function that employees a UUF shall have a specific UI assigned to it to ensure interoperability, compatibility, and identification. The UI shall be assigned for use before any transmission of the UUF or the associated unique activity and the ALE UUF shall always include the appropriate UI when sent.

The UUF shall be used only among stations that are specifically addressed and included within the protocol, and shall be used only with stations specifically capable of participating in the UUF activity, and all other (non-participating) stations should be terminated. There are two exceptions for stations that are not capable of participating in the UUF and are required to be retained in the protocol until concluded. They shall be handled using either of the two following procedures. First, the calling station shall direct all the addressed and included stations to stay linked for the duration of the UUF, to read and use anything that they are capable of during that time, and to resume acquisition and tracking of the ALE frame and protocol after the UUF ends. To accomplish this, and immediately before the CMD UUF, the sending station shall send the CMD STAY, which shall indicate the time period (T) for which the receiving stations shall wait for resumption of the frame and protocol. Second, the sending station shall use any standard CMD function to direct the non-participating stations to wait or return later, or do anything else appropriate and controllable through the standard orderwire functions. If a CMD UUF is included within an ALE frame, it shall only be within the message section. The UUF activity itself should be conducted completely outside of the frame and should not interfere with the protocols. If the UUF activity itself must be conducted within the message section, will occupy time on the channel, and is incompatible with the ALE system, that activity shall be conducted immediately after the CMD UUF and it shall be for a limited amount of time (T). A CMD STAY shall precede the UUF instruction, as described herein, to indicate that time (T). The sending station shall resume the same previous redundant word phase when the frame and protocol resumes, to ensure synchronization. The STAY function preserves maintenance of the frame and link. It instructs the stations to wait, because the amount of time occupied by the UUF activity or its signaling may conflict with functions such as the wait-for-activity timer (T_{wa}). This may interfere with the protocols or maintenance of the link. In any case, the users of the UUF shall be responsible for noninterference with other stations and users, and also for controlling their own stations and link management functions to avoid these conflicts.

The UUF shall be constructed as follows and as shown in table A-XXX. The UUF word shall use the CMD (110) preamble in bits P3 through P1 (W1 through W3). The character in the first position shall be the pipe "¦" or vertical bar "|" (1111100) in bits C1-7 through C1-1 (W4 through W10), which shall identify the "unique" function. The user or manufacturer-specific UI shall be a 14-bit (or two-character, 7-bit ASCII) code using bits UI-14 through UI-1 (W11 through W24). All unassigned UI codes shall be reserved and shall not be used until assigned for a specific use, MIL-STD-188-141B, paragraph A.5.6.9.

C-43.3 Test Procedures

a. Test Equipment Required

(1) Receiver

(2) PC with Soundcard

(3) Attenuators

(4) Tee Connector

(5) UUT plus one additional outstation

b. Test Configuration. Configure the equipment as shown in figure C-43.1.

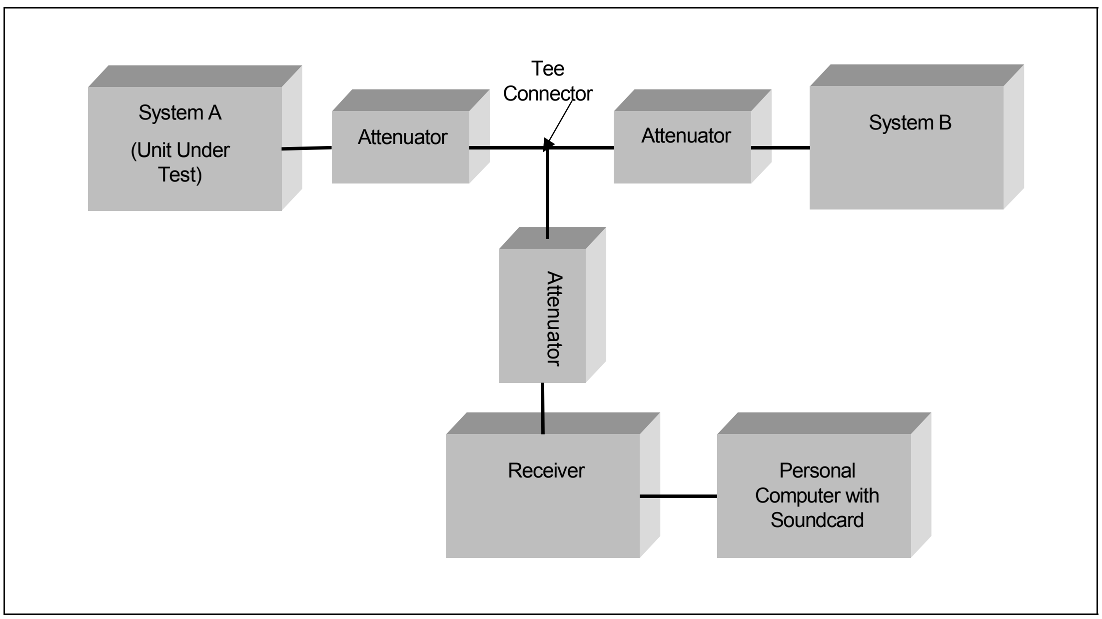

Figure C-43.1. Equipment Configuration User Unique Functions Subtest

c. Test Conduct. The procedures for this subtest are listed in table C-43.1.

Table C-43.1. Procedures for User Unique Functions Subtest

Step	Action	Settings/Action	Result
The following procedure is for reference number 181.			
1	Set up equipment as shown in figure C-43.1.	Program radios in accordance with tables C-27.1 through C-27.6.	
2	Initialize the system for operation. Use preprogrammed channel information from subtest 27.	Radios required: UUT plus system B.	
3	Configure the PC to record audio files in WAV format.	All WAV files must be sampled at 44.1 kHz, 16 bits, mono.	
4	Place call.	System A (callsign: 3AS) places a Command UUF call to system B (callsign: 3BS). (Send Command STAY to preserve the link.)	
5	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name. This file will be recalled using ALEOOWPP software for analysis.	
6	Use ALEOOWPP software to decode wave file.	ALEOOWPP software and instructions are available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	
7	Review decoded file.	Expected: 1) Command UUF words should be constructed in accordance with table A-XXX of MIL-STD-188-141B. 2) The Command UUF should appear in the message section of the call. 3) The Command UUF word should be preceded by a Command STAY. Record actual results.	
Legend: ASCII – American Standard Code for Information Interchange; JITC – Joint Interoperability Test Command; kHz – kilohertz; MIL-STD – Military Standard; PC – Personal Computer; UUF – Unique User Function; UUT – Unit Under Test; WAV – Wave			

C-43.4 Presentation of Results. The results will be shown in tabular format (table C-43.2) indicating the requirement and measured value or indications of capability.

Table C-43.2. User Unique Function Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
181	A.5.6.9	User Unique Functions (UUFs). UUFs are for special uses, as coordinated with specific users or manufacturers, which use the ALE system in conjunction with unique, nonstandard, or non-ALE, purposes. There are 16384 specific types of CMD UUF codes available, as indicated by a 14-bit (or two-character) unique index (UI). Each unique type of special function that employees a UUF shall have a specific UI assigned to it to ensure interoperability, compatibility, and identification. The UI shall be assigned for use before any transmission of the UUF or the associated unique activity, and the ALE UUF shall always include the appropriate UI when sent.	Constructed in accordance with table A-XXX. CMD UUF appears in the message section. CMD UUF word preceded by CMD STAY.			
Legend: ALE – Automatic Link Establishment; CMD – Command; MIL-STD – Military Standard; UI – Unique Index; UUF – Unique User Function						

C-44 SUBTEST 44, POWER, FREQUENCY, MODEM CONTROL, AND CAPABILITIES

C-44.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 158, 159, 160, 161, 171, 172, 173, 174, 175, 176, 177, 178, 179, and 180.

C-44.2 Criteria

a. Power Control (optional). The power control orderwire function is used to advise parties to a link that they should raise or lower their RF power for optimum system performance. The power control CMD word format shall be as shown in figure A-36. The KP control bits shall be used as shown in table XVIII.

The procedure shall be:

1. When KP_3 is set to 1, the power control command is a request to adjust the power from the transmitter. If KP_2 is 1, the adjustment is relative to the current operating power, i.e., to raise (KP_1 = 1) or lower (KP_1 = 0) power by the number of dB indicated in the relative power field. If KP_2 is 0, the requested power is specified as an absolute power in a decibel measure to one watt (dBW).
2. When KP_3 is set to 0, the power control command reports the current power output of the transmitter, in dB relative to nominal power if KP_2 is 1, or in absolute dBW if KP_2 is 0.
3. KP_1 shall be set to 0 whenever KP_2 is 0.
4. Normally, a station receiving a power control request (KP_3 = 1) should approximate the requested effect as closely as possible, and respond with a power report (KP_3 = 0) indicating the result of its power adjustment, MIL-STD-188-141B, paragraph A.5.6.2.

b. Channel Designation. When two or more stations need to explicitly refer to channels or frequencies other than the one(s) in use for a link, the following encodings shall be used. A frequency is designated using binary-coded-decimal (BCD). The standard frequency designator is a five-digit string (20 bits), in which the first digit is the 10 MHz digit, followed by 1 MHz, 100 kHz, 10 kHz, and 1 kHz digits. A frequency designator is normally used to indicate an absolute frequency. When a bit in the command associated with a frequency designator indicates that a frequency offset is specified instead, the command shall also contain a bit to select either a positive or a negative frequency offset, MIL-STD-188-141B, paragraph A.5.6.3.1.

c. Frequency Designation. A channel differs from a frequency in that a channel is a logical entity that implies not only a frequency (or two frequencies for a full-duplex channel), but also various operating mode characteristics, as defined in paragraph A.4.3.1. As in the case of frequency designators, channels may be specified either absolutely or relatively. In either case, a 7 bit binary integer shall be used that is interpreted as an unsigned integer in the range 0 through 127. Bits in the associated command shall indicate whether the channel designator represents an absolute channel number, a positive offset, or a negative offset.

1. The frequency select CMD word shall be formatted as shown in figure A-37. A frequency designator (in accordance with paragraph A.5.6.3.1) is sent in a DATA word immediately following the frequency select CMD; bit W4 of this DATA word shall be set to 0, as shown.

2. The 100-Hz and 10-Hz fields in the frequency select CMD word contain BCD digits that extend the precision of the standard frequency designator. These digits shall be set to 0 except when it is necessary to specify a frequency that is not an even multiple of 1 kHz (e.g., when many narrowband modem channels are allocated within a 3-kHz voice channel).

3. The control field shall be set to 000000 to specify a frequency absolutely, to 100000 to specify a positive offset, or to 110000 to specify a negative offset.

4. A station receiving a frequency select CMD word shall make whatever response is required by an active protocol on the indicated frequency, MIL-STD-188-141B, paragraph A.5.6.3.2.

d. Full-Duplex Independent Link Establishment (optional). Full duplex independent link establishment is an optional feature; however, if this option is selected the transmit and receive frequencies for use on a link shall be negotiated independently as follows:

1. The caller shall select a frequency believed to be propagating to the distant station (the prospective responder) and places a call on that frequency. The caller embeds a frequency select CMD word in the call to ask the responder to respond on a frequency chosen for good responder-to-caller propagation (probably from sounding data in the caller's LQA matrix).

2. If the responder hears the call, it shall respond on the second frequency, asking the caller to switch to a better caller-to-responder frequency by embedding a frequency select CMD word in its response (also based upon sounding data).

3. The caller shall send an acknowledgement on the frequency chosen by the responder (the original frequency by default), and the full duplex independent link is established, MIL-STD-188-141B, paragraph A.5.6.3.3.

e. Mode Control Functions (optional). If any of these features are selected, however, they shall be implemented in accordance with this standard. Many of the advanced features of an ALE controller are "modal" in the sense that when a particular option setting is selected, that selection remains in effect until changed or reset by some protocol event. The mode control CMD is used to select many of these operating modes, as described in the following paragraphs. The CMD word shall be formatted as shown in figure A-40. The first character shall be 'm' to identify the mode control command; the second character identifies the type of mode selection being made; the remaining bits specify the new setting for that mode, MIL-STD-188-141B, paragraph A.5.6.5.

f. Modem Negotiation and Handoff. An ALE data link can be used to negotiate a modem to be used for data traffic by exchanging modem negotiation messages. A modem negotiation message shall contain one modem selection command.

NOTE: This function may best be implemented in a high frequency node controller (HFNC) to avoid retrofit to existing ALE controllers, and for the greater flexibility inherent in network management information bases, MIL-STD-188-141B, paragraph A.5.6.5.1.

g. Modem Selection CMD. The modem selection CMD word shall be formatted as shown in figure A-41, and may be followed by one or more DATA words, as described below. The defined modem codes are listed in table A-XXIII. Codes not defined are reserved, and shall not be used until standardized, MIL-STD-188-141B, paragraph A.5.6.5.1.1.

h. Modem Negotiating. Modem negotiating shall employ modem negotiation messages in the following protocol:

1. The station initiating the negotiation will send a modem selection CMD word containing the code of the modem it wants to use.
2. The responding station(s) may either accept this modem selection or suggest alternatives. A station accepting a suggested modem shall send a modem selection CMD word containing the code of that modem.
3. A station may negotiate by sending a modem selection CMD word containing all 1s in the modem code field, followed by one or more DATA words containing the codes of one or more suggested modems. Modem codes shall be listed in order of preference in the DATA word(s). Unused positions in the DATA word(s) shall be filled with the all 1s code.
4. The negotiation is concluded when the most recent modem negotiation message from all participating stations contains an identical modem selection CMD word with the same modem code (not all 1's). When this occurs, the station that initiated the negotiation will normally begin sending traffic using the selected modem, MIL-STD-188-141B, paragraph A.5.6.5.1.2.

i. Crypto Negotiation and Handoff. When crypto negotiation and handoff are required, the following applies:

1. An ALE data link can also be used to negotiate an encryption device to be used for voice or data traffic by exchanging crypto negotiation messages. The crypto selection CMD word is formatted as shown in figure A-42. The defined crypto codes are listed in table A-XXIV. Codes not defined are reserved, and shall not be used until standardized.

NOTE: This function may best be implemented in an HFNC to avoid retrofit to existing ALE controllers, and for the greater flexibility inherent in network management information bases.

2. Crypto negotiation shall employ crypto negotiation messages in the protocol described above for modem negotiation, MIL-STD-188-141B, paragraph A.5.6.5.2.

j. Version CMD (mandatory). The version CMD function is used to request ALE controller version identification. The first character is ‘v’ to indicate the version family of ALE CMD word functions. The second character shall be set to ‘s’ to select a summary report.

NOTE: The capabilities function in paragraph A.5.6.6.2 is a variant of this function that provides more detailed information.

1. The response to a version CMD is a printable ASCII message in manufacturer-specific format that indicates a manufacturers’ identification, the version(s) of hardware, operating firmware and software, and/or management firmware and software of the responding ALE controller, as requested by control bits KVC_{1-3} of the version CMD format (see figure A-43 and table A- XXV).

2. The requesting station specifies acceptable formats for the response in control bits KVF_{1-4} in accordance with table A-XXVI. A controller responding to a version function shall attempt to maximize the utility of its response and: (1) shall report the version(s) of all of the components requested by the KVC control bits that are present in the controller. (2) shall use the ALE message format that represents the highest level of mutual capability of itself and the requesting station by comparing the message types that it can generate with those desired by the requesting station, and selecting the message type in the intersection of these two sets that correspond to the highest-numbered KFV bit, MIL-STD-188-141B, paragraph A.5.6.6.1.

k. Capabilities Query. The capabilities query, shown in figure A-44, consists of a single ALE CMD word. The second character position shall be set to ‘c’ to select a full capabilities report (rather than a summary as in the version CMD). The third character position shall be set to ‘q’ in a capabilities query to request a capabilities report, MIL-STD-188-141B, paragraph A.5.6.6.2.1.

l. Capabilities Report CMD. The capabilities report shall consist of a CMD word followed by five DATA words, as shown in figure A-45. The second character position of the capabilities report CMD word shall be set to ‘c’ and the third character position shall be set to ‘r’. (The DATA preamble in the second and fourth DATA words shall be replaced by REP for transmission, as required by the ALE protocol), MIL-STD-188-141B, paragraph A.5.6.6.2.2.

m. Data Format. The format of the DATA words in a capabilities report is constant, regardless of the capabilities reported, to simplify the software that implements the capabilities command. The data fields of the capabilities report shall be encoded in accordance with tables A-XXVII, A-XXVIII, and A-XXIX. The values encoded shall represent the current operational capabilities of the responding ALE controller, i.e., the timing or functions currently programmed. All timing fields shall be encoded as unsigned integers, MIL-STD-188-141B, paragraph A.5.6.6.2.3.

n. Do Not Respond CMD. When an ALE controller receives this CMD in a transmission, it shall not respond unless a response is specifically required by some other CMD in the transmission (e.g., an LQA request or a DTM or DBM with ARQ requested). In a Do Not Responds CMD, no three-way ALE handshake needs to be completed, MIL-STD-188-141B, paragraph A.5.6.7.

C-44.3 Test Procedures

a. Test Equipment Required

(1) Receiver monitoring 12.000 MHz, USB

(2) PC with Soundcard

(3) Attenuators

(4) Tee Connector

(5) UUT plus one additional outstation

b. Test Configuration. Configure the equipment as shown in figure C-44.1.

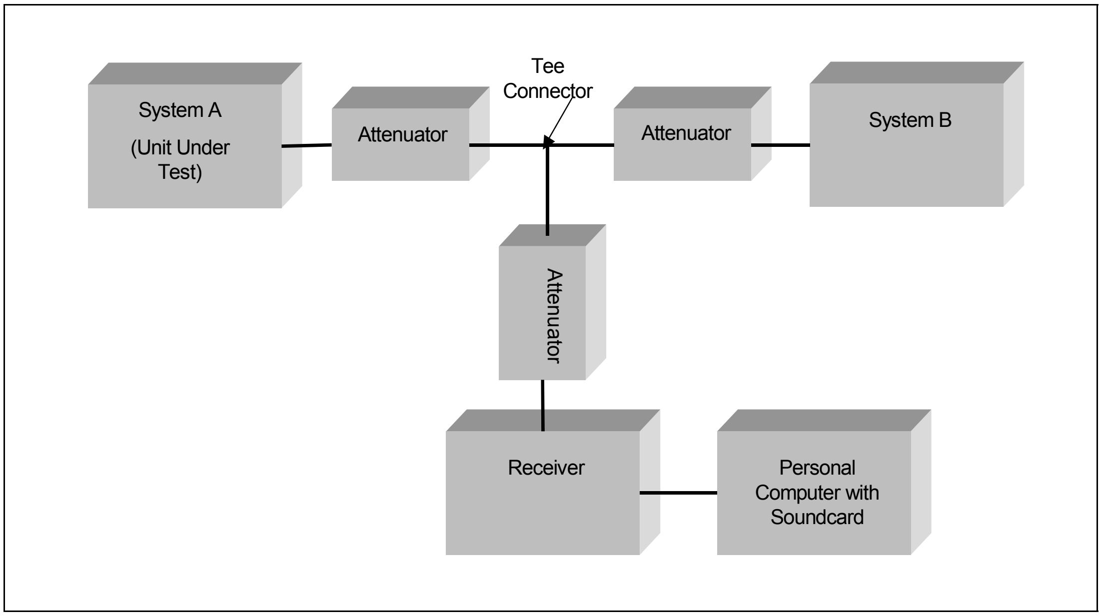

Figure C-44.1. Equipment Configuration for Power, Frequency, Modem Control, and Capabilities

c. Test Conduct. The procedures for this subtest are listed in table C-44.1.

Table C-44.1. Procedures for Power, Frequency, Modem Control, and Capabilities

Step	Action	Settings/Action	Result
The following procedure is for reference number 158.			
1	Set up equipment as shown in figure C-44.1.	Program radios in accordance with tables C-27.1 through C-27.6.	
2	Is the UUT is capable of employing the optional power control orderwire function? If no, proceed to step 7.	If yes, proceed with operation in the following scenario: “Power Control” UUT plus system B. UUT (callsign: A01) reports current absolute power level (in dBW).	
3	Configure the PC to record audio files in WAV format.	All WAV files must be sampled at 44.1 kHz, 16 bits, mono.	
4	Place the individual call as required.		
5	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name.	
6	Use ALEOOWPP software to decode the wave file. ALEOOWPP software and instructions are available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	Expected decode: CMD 1110000 (‘p’: power control) 000 [Power] Record actual results.	

Table C-44.1. Procedures for Power, Frequency, Modem Control, and Capabilities (continued)

Step	Action	Settings/Action	Result
		The following procedure is for reference number 159.	
7	Initialize the system for operation.	"Channel Designation" Radios required: UUT plus system B.	
8	Place call.	System A (callsign: A01) places call to System B (callsign: B01) with channel designation information.	
9	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name.	
10	Use ALEOOWPP software to decode the wave file.	Expected decode: Channel designation information formatted as defined in MIL-STD-188-141B, paragraph A.5.6.3.1. Record actual results.	
		The following procedure is for reference number 160.	
11	Initialize the system for operation.	"Frequency Designation" Radios required: UUT plus system B.	
12	Place call.	System A (callsign: A01) places call to system B (callsign: B01) with frequency designation information.	
13	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name.	
14	Use ALEOOWPP software to decode the wave file. ALEOOWPP software is available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	Expected decode: 1) Frequency select command words formatted as shown in MIL-STD-188-141B, figure A-37. 2) Frequency designation information meets criteria given in MIL-STD-188-141B, paragraph A.5.6.3.2. Record actual results.	
		The following procedure is for reference number 161.	
15	Is the UUT capable of employing optional full duplex independent link establishment? If no, proceed to step 18.	If yes, proceed with operation in the following scenario: "Full duplex" Radios required: UUT plus system B. System A (callsign: A01) places full duplex independent link establishment request to system B (callsign: B01).	
16	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name.	
17	Use ALEOOWPP software to decode the wave file.	Expected decode: Link establishment handshake proceed as required in MIL-STD-188-141B, paragraph A.5.6.3.3. Record actual results.	

Table C-44.1. Procedures for Power, Frequency, Modem Control, and Capabilities (continued)

Step	Action	Settings/Action	Result
The following procedure is for reference numbers 171, 172, 173, and 174.			
18	Is the UUT capable of employing optional modem control? If no, proceed to step 21.	If yes, proceed with operation in the following scenario: "Modem Control" Radios required: UUT plus system B. Use ALE data link to negotiate a modem. System A (callsign: A01) places call to System B (callsign: B01) with Command Modem Selection.	
19	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name.	
20	Use ALEOOWPP software to decode the wave file.	Expected decode: 1) Modem selection Command word formatted as shown in MIL-STD-188-141B figure A-41. 2) UUT uses the defined modem codes listed in MIL-STD-188-141B table A-XXIII. 3) Modem negotiation carried out as defined in MIL-STD-188-141B paragraph A.5.6.5.1.2. Record actual results.	
The following procedure is for reference number 175.			
21	Proceed with operation in a new scenario.	"Crypto Negotiation and Handoff" Radios required: UUT plus system B.	
22	Place call.	Use ALE data link to negotiate an encryption device. System A (callsign: A01) places call to system B (callsign: B01) with Command Crypto Selection.	
23	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name.	
24	Use ALEOOWPP software to decode the wave file.	Expected decode: 1) Crypto selection Command words formatted as shown in MIL-STD-188-141B, figure A-42. 2) Defined crypto codes used as listed in MIL-STD-188-141B, table A-XXIV. Record actual results.	
The following procedure is for reference number 176.			
25	Proceed with operation in a new scenario.	"Version" Radios required: UUT plus system B.	
26	Place call.	System A (callsign: A01) places call to system B (callsign: B01) with Command Version.	
27	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name.	
28	View the response from system B.	Record response.	

Table C-44.1. Procedures for Power, Frequency, Modem Control, and Capabilities (continued)

Step	Action	Settings/Action	Result
29	Use ALEOOWPP software to decode the wave file.	Expected decode: 1) Version Command formatted as shown in MIL-STD-188-141B, figure A-43. 2) Component selection bits used as shown in MIL-STD-188-141B, table A-XXV. 3) The requesting station specifies acceptable formats for the response in accordance with MIL-STD-188-141B, table A-XXVI. Record actual results.	
The following procedure is for reference number 177.			
30	Proceed with operation in a new scenario.	“Capabilities Query” Radios required: UUT plus system B.	
31	Place call.	System A (callsign: A01) places call to system B (callsign: B01) with Command Capabilities Query.	
32	Use ALEOOWPP software to decode the file for word content data.	Record file name.	
33	Use ALEOOWPP software to decode the wave file.	Expected decode: Capabilities query Command formatted as shown in MIL-STD-188-141B, figure A-44. Record actual results.	
The following procedure is for reference numbers 178 and 179.			
34	Proceed with operation in a new scenario.	“Capabilities Report” Radios required: UUT plus system B.	
35	Place call.	System A (callsign: A01) places call to system B (callsign: B01) with Command Capabilities Report.	
36	Use ALEOOWPP software to decode the wave file.	Record file name.	
37	Use ALEOOWPP software to decode the wave file.	Expected decode: 1) Capability report consist of a Command word followed by five DATA words as shown in MIL-STD-188-141B, figure A-45. 2) The data fields of the capabilities report are encoded in accordance with MIL-STD-188-141B, tables A-XXVII, A-XXVIII, and A-XXIX. Record actual results.	
The following procedure is for reference number 180.			
38	Proceed with operation in a new scenario.	“Do Not Respond” Radios required: UUT plus system B.	
39	Place call	System A (callsign: A01) places call to system B (callsign: B01) with Command Do Not Respond.	

Table C-44.1. Procedures for Power, Frequency, Modem Control, and Capabilities (continued)

Step	Action	Settings/Action	Result
40	Observe system B during and after call.	Expected action: System B should not respond. Record observations.	
Legend: ALE – Automatic Link Establishment; ASCII – American Standard Code for Information Interchange; CMD – Command; kHz – kilohertz; JITC – Joint Interoperability Test Command; MIL-STD – Military Standard; PC – Personal Computer; UUT – Unit Under Test; WAV – Wave			

C-44.4 Presentation of Results. The results will be shown in tabular format (table C-42.2) indicating the requirement and measured value or indications of capability.

Table C-44.2. Power, Frequency, Modem Control, and Capabilities Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
158	A.5.6.2	Power Control (optional). The power control orderwire function is used to advise parties to a link that they should raise or lower their RF power for optimum system performance. The power control CMD word format shall be as shown in figure A-36. The KP control bits shall be used as shown in table XVIII. The procedure shall be: a. When KP_3 is set to 1, the power control command is a request to adjust the power from the transmitter. If KP_2 is 1, the adjustment is relative to the current operating power, i.e., to raise (KP_1 = 1) or lower (KP_1 = 0) power by the number of dB indicated in the relative power field. If KP_2 is 0, the requested power is specified as an absolute power in dBW. b. When KP_3 is set to 0, the power control command reports the current power output of the transmitter, in dB relative to nominal power if KP_2 is 1, or in absolute dBW if KP_2 is 0. c. KP_1 shall be set to 0 whenever KP_2 is 0. d. Normally, a station receiving a power control request (KP_3 = 1) should approximate the requested effect as closely as possible, and respond with a power report (KP_3 = 0) indicating the result of its power adjustment.	Formatted as shown in MIL-STD-188-141B, figure A-36.			

Table C-44.2. Power, Frequency, Modem Control, and Capabilities Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
159	A.5.6.3.1	When two or more stations need to explicitly refer to channels or frequencies other than the one(s) in use for a link, the following encodings shall be used. A frequency is designated using binary-coded-decimal (BCD). The standard frequency designator is a five-digit string (20 bits), in which the first digit is the 10-megahertz (MHz) digit, followed by 1-MHz, 100-kilohertz (kHz), 10-kHz, and 1-kHz digits. A frequency designator is normally used to indicate an absolute frequency. When a bit in the command associated with a frequency designator indicates that a frequency offset is specified instead, the command shall also contain a bit to select either a positive or a negative frequency offset.	Formatted as defined in MIL-STD-188-141B A.5.6.3.1.			

Table C-44.2. Power, Frequency, Modem Control, and Capabilities Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
160	A.5.6.3.2	Frequency Designation. A channel differs from a frequency in that a channel is a logical entity that implies not only a frequency (or two frequencies for a full-duplex channel), but also various operating mode characteristics, as defined in A.4.3.1. As in the case of frequency designators, channels may be specified either absolutely or relatively. In either case, a 7-bit binary integer shall be used that is interpreted as an unsigned integer in the range 0 through 127. Bits in the associated command shall indicate whether the channel designator represents an absolute channel number, a positive offset, or a negative offset. a. The frequency select CMD word shall be formatted as shown in figure A-37. A frequency designator (in accordance with A.5.6.3.1) is sent in a DATA word immediately following the frequency select CMD; bit W4 of this DATA word shall be set to 0, as shown. b. The 100-Hz and 10-Hz fields in the frequency select CMD word contain BCD digits that extend the precision of the standard frequency designator. These digits shall be set to 0 except when it is necessary to specify a frequency that is not an even multiple of 1 kHz (e.g., when many narrowband modem channels are allocated within a 3-kHz voice channel). c. The control field shall be set to 000000 to specify a frequency absolutely, to 100000 to specify a positive offset, or to 110000 to specify a negative offset. d. A station receiving a frequency select CMD word shall make whatever response is required by an active protocol on the indicated frequency.	Formatted as shown in MIL-STD-188-141B, figure A-37. Criteria given in MIL-STD-188-141B, paragraph A.5.6.3.2.			

Table C-44.2. Power, Frequency, Modem Control, and Capabilities Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
161	A.5.6.3.3	Full-Duplex Independent Link Establishment (optional). Full duplex independent link establishment is an optional feature; however, if this option is selected the transmit and receive frequencies for use on a link shall be negotiated independently as follows: a. The caller shall select a frequency believed to be propagating to the distant station (the prospective responder) and places a call on that frequency. The caller embeds a frequency select CMD word in the call to ask the responder to respond on a frequency chosen for good responder-to-caller propagation (probably from sounding data in the caller's LQA matrix). b. If the responder hears the call, it shall respond on the second frequency, asking the caller to switch to a better caller-to-responder frequency by embedding a frequency select CMD word in its response (also based upon sounding data). c. The caller shall send an acknowledgement on the frequency chosen by the responder (the original frequency by default), and the full duplex independent link is established.	Link establishment handshake proceeds as required in MIL-STD-188-141B, paragraph A.5.6.3.3.			

Table C-44.2. Power, Frequency, Modem Control, and Capabilities Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
171	A.5.6.5	Mode Control Functions (optional). If any of these features are selected, however, they shall be implemented in accordance with this standard. Many of the advanced features of an ALE controller are “modal” in the sense that when a particular option setting is selected, that selection remains in effect until changed or reset by some protocol event. The mode control CMD is used to select many of these operating modes, as described in the following paragraphs. The CMD word shall be formatted as shown in figure A-40. The first character shall be ‘m’ to identify the mode control command; the second character identifies the type of mode selection being made; the remaining bits specify the new setting for that mode.	Formatted as shown in MIL-STD-188-141B, figure A-40.			
172	A.5.6.5.1	Modem Negotiation and Handoff. An ALE data link can be used to negotiate a modem to be used for data traffic by exchanging modem negotiation messages. A modem negotiation message shall contain one modem selection command. NOTE: This function may best be implemented in a high frequency node controller (HFNC) to avoid retrofit to existing ALE controllers, and for the greater flexibility inherent in network management information bases.	Modem negotiation message contains one modem selection command.			
173	A.5.6.5.1.1	Modem Selection CMD. The modem selection CMD word shall be formatted as shown in figure A-41, and may be followed by one or more DATA words, as described below. The defined modem codes are listed in table A-XXIII. Codes not defined are reserved, and shall not be used until standardized.	Formatted as shown in MIL-STD-188-141B, figure A-41. Defined modem codes listed in MIL-STD-188-141B, table A-XXIII.			

Table C-44.2. Power, Frequency, Modem Control, and Capabilities Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
174	A.5.6.5.1.2	Modem Negotiating. Modem negotiating shall employ modem negotiation messages in the following protocol: a. The station initiating the negotiation will send a modem selection CMD word containing the code of the modem it wants to use. b. The responding station(s) may either accept this modem selection or suggest alternatives. A station accepting a suggested modem shall send a modem selection CMD word containing the code of that modem. c. A station may negotiate by sending a modem selection CMD word containing all 1s in the modem code field, followed by one or more DATA words containing the codes of one or more suggested modems. Modem codes shall be listed in order of preference in the DATA word(s). Unused positions in the DATA word(s) shall be filled with the all 1s code. d. The negotiation is concluded when the most recent modem negotiation message from all participating stations contains an identical modem selection CMD word with the same modem code (not all 1s). When this occurs, the station that initiated the negotiation will normally begin sending traffic using the selected modem.	The modem negotiation is carried out as defined in MIL-STD-188-141B, paragraph A.5.6.5.1.2.			

Table C-44.2. Power, Frequency, Modem Control, and Capabilities Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
175	A.5.6.5.2	Crypto Negotiation and Handoff. When crypto negotiation and handoff are required, the following applies: a. An ALE data link can also be used to negotiate an encryption device to be used for voice or data traffic by exchanging crypto negotiation messages. The crypto selection CMD word is formatted as shown in figure A-42. The defined crypto codes are listed in table A-XXIV. Codes not defined are reserved, and shall not be used until standardized. NOTE: This function may best be implemented in an HFNC to avoid retrofit to existing ALE controllers, and for the greater flexibility inherent in network management information bases. b. Crypto negotiation shall employ crypto negotiation messages in the protocol described above for modem negotiation.	Formatted as shown in MIL-STD-188-141B, figure A-42. The defined crypto codes are used as listed in MIL-STD-188-141B, table A-XXIV.			

Table C-44.2. Power, Frequency, Modem Control, and Capabilities Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
176	A.5.6.6.1	Version CMD (Mandatory). The version CMD function is used to request ALE controller version identification. The first character is 'v' to indicate the version family of ALE CMD word functions. The second character shall be set to 's' to select a summary report. a. The response to a version CMD is a printable ASCII message in manufacturer-specific format that indicates a manufacturers' identification, the version(s) of hardware, operating firmware and software, and/or management firmware and software of the responding ALE controller, as requested by control bits KVC_{1-3} of the version CMD format (see figure A-43 and table A- XXV). b. The requesting station specifies acceptable formats for the response in control bits KVF_{1-4} in accordance with table A-XXVI. A controller responding to a version function shall attempt to maximize the utility of its response and: (1) shall report the version(s) of all of the components requested by the KVC control bits that are present in the controller. (2) shall use the ALE message format that represents the highest level of mutual capability of itself and the requesting station by comparing the message types that it can generate with those desired by the requesting station, and selecting the message type in the intersection of these two sets that correspond to the highest-numbered KFV bit.	Formatted as shown in MIL-STD-188-141B, figure A-43. Bits are used as shown in MIL-STD-188-141B, table A-XXV. Response to this CMD is a printable ASCII message. The requesting station specifies acceptable formats for response in accordance with MIL-STD-188-141B, table A-XXVI.			

Table C-44.2. Power, Frequency, Modem Control, and Capabilities Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
177	A.5.6.6.2.1	Capabilities Query. The capabilities query, shown in figure A-44, consists of a single ALE CMD word. The second character position shall be set to ‘c’ to select a full capabilities report (rather than a summary as in the version CMD). The third character position shall be set to ‘q’ in a capabilities query to request a capabilities report.	2nd Character: ‘c’ 3rd Character: ‘q’			
178	A.5.6.6.2.2	Capabilities Report CMD. The capabilities report shall consist of a CMD word followed by five DATA words, as shown in figure A-45. The second character position of the capabilities report CMD word shall be set to ‘c’ and the third character position shall be set to ‘r’. (The DATA preamble in the second and fourth DATA words shall be replaced by REP for transmission, as required by the ALE protocol.)	Formatted as shown in MIL-STD-188-141B, figures A-44 and A-45.			

Table C-44.2. Power, Frequency, Modem Control, and Capabilities Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
179	A.5.6.6.2.3	Data Format. The format of the DATA words in a capabilities report is constant, regardless of the capabilities reported, to simplify the software that implements the capabilities command. The data fields of the capabilities report shall be encoded in accordance with tables A-XXVII, A-XXVIII, and A-XXIX. The values encoded shall represent the current operational capabilities of the responding ALE controller, i.e., the timing or functions currently programmed. All timing fields shall be encoded as unsigned integers.	Encoded in accordance with MIL-STD-188-141B, tables A-XXVII, A-XXVIII, and A-XXIX.			
180	A.5.6.7	Do Not Respond CMD. When an ALE controller receives this CMD in a transmission, it shall not respond unless a response is specifically required by some other CMD in the transmission (e.g., an LQA request or a DTM or DBM with ARQ requested). In a Do Not Responds CMD, no three-way ALE handshake needs to be completed.	Does not respond.			
Legend: ALE – Automatic Link Establishment; ARQ – Automatic Repeat-Request; BCD – Binary Coded Decimal; CMD – Command; DBM – Data Block Messaging; DTM – Data Text Messaging; HFNC – High Frequency Node Controller; Hz – hertz; kHz – kilohertz; LQA – Link Quality Analysis; MHz – megahertz; MIL-STD – Military Standard; UUT – Unit Under Test						

C-45 SUBTEST 45, OCCUPANCY DETECTION AND LISTEN BEFORE TRANSMIT

C-45.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 53, 120, 121, 122, and 123.

C-45.2 Criteria

a. Stations designed to this appendix shall achieve at least the following probability of detecting the specified waveforms (MIL-STD-188-141B, paragraph A.5.4.7) under the indicated conditions, with false alarm rates of no more than 1 percent. The channel simulator shall provide additive white gaussian noise without fading or multipath. See table C-45.1, MIL-STD-188-141B, paragraph A.4.2.2.

Table C-45.1. Occupancy Detection Probability (Second and Third Generation)

Waveform	Signal-to-Noise Ratio (dB in 3 kHz)	Dwell Time(s)	Detection Probability
Automatic Link Establishment	0	2.0	0.80
	6	2.0	0.99
Single Sideband Voice	6	2.0	0.80
	9	2.0	0.99
Military Standard-188-110 (Serial Tone Phase Shift Keying)	0	2.0	0.80
	6	2.0	0.99
Standardization Agreement (STANAG) 4529	0	2.0	0.80
	6	2.0	0.99
STANAG 4285	0	2.0	0.80
	6	2.0	0.99
Legend: dB – decibel; kHz – kilohertz; STANAG – Standardization Agreement			

b. Before initiating a call or sound on a channel, an ALE controller shall listen for a programmable time (T_{wt}) for other traffic, and shall not transmit on that channel if traffic is detected. Normally, a sound aborted due to detected traffic will be rescheduled, while for a call another channel shall be selected, MIL-STD-188-141B, paragraph A.5.4.7.

c. The duration of the listen-before-transmit pause shall be programmable by the network manager. When the selected channel is known to be used only for ALE transmissions, the listen-before-transmit delay need be no longer than 2 Trw. For other channels, at least 2 seconds shall be used. When an ALE controller was already listening on the channel for a transmission, the time spent listening on the channel may be included in the listen-before-transmit time, MIL-STD-188-141B, paragraph A.5.4.7.1.

d. The listen-before-transmit function shall detect traffic on a channel in accordance with A.4.2.2. This may be accomplished using any combination of internal signal detection and external devices that provide a channel busy signal to the ALE controller, MIL-STD-188-141B, paragraph A.5.4.7.2.

e. The operator shall be able to override both the listen-before-transmit pause and the transmit lockout (for emergency use), MIL-STD-188-141B, paragraph A.5.4.7.3.

C-45.3 Test Procedures

a. Test Equipment Required

(1) PC with Soundcard

(2) Transmitter operating at 12.000 MHz, USB

(3) Attenuator

(4) Unit Under Test

b. Test Configuration. Configure the equipment as shown in figure C-45.1.

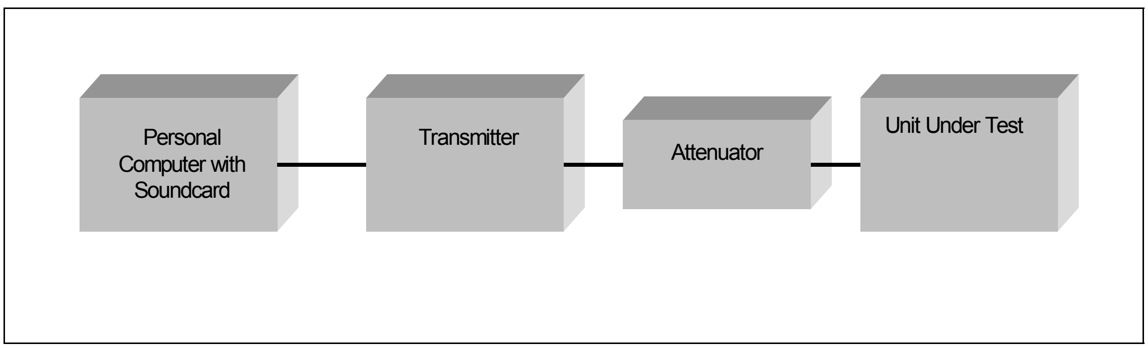

Figure C-45.1. Occupancy Detection Configuration

c. Test Conduct. Table C-45.2 contains procedures for verifying compliance to standards.

Table C-45.2. Procedures for Verifying Compliance to Standards of Occupancy Detection and Listen-Before-Transmit Wait Times

Step	Action	Settings/Action	Result
The following procedure is for reference numbers 53, 120, and 122.			
1	Set up equipment as shown in figure C-45.1.	Program radios in accordance with tables C-27.1 through C-27.6.	
2	Program UUT to scan channels 1 through 10.	Set listen-before-transmit time to 2 seconds.	
3	Play occupancy detection waveform file "ALE Tones 6 db.wav" on PC. Occupancy detection waveform files are available from the JITC.	Direct the UUT (callsign: A01) to make (100) individual calls to address B01. Record the results of each call as a go or no-go on the data collection form. Required detection probability: 99%	
4	Play occupancy detection waveform file "ALE Tones 0 db.wav" on PC.	Direct the UUT (callsign: A01) to make (100) individual calls to address B01. Record the results of each call as a go or no-go on the data collection form, page D-55. Required detection probability: 80%	
5	Play occupancy detection waveform file "MIL-STD-188-110 (Serial Tone PSK) 6 dB.wav" on PC.	Direct the UUT (callsign: A01) to make (100) individual calls to address B01. Record the results of each call as a go or no-go on the data collection form, page D-55. Required detection probability: 99%	
6	Play occupancy detection waveform file "MIL-STD-188-110 (Serial Tone PSK) 0 dB.wav" on PC.	Direct the UUT (callsign: A01) to make (100) individual calls to address B01. Record the results of each call as a go or no-go on the data collection form, page D-55. Required detection probability: 80%	
7	Play occupancy detection waveform file "SSB Voice 9 dB.wav" on PC.	Direct the UUT (callsign: A01) to make (100) individual calls to address B01. Record the results of each call as a go or no-go on the data collection form, page D-55. Required detection probability: 99%	

Table C-45.2. Procedures for Verifying Compliance to Standards of Occupancy Detection and Listen-Before-Transmit Wait Times (continued)

Step	Action	Settings/Action	Result
8	Play occupancy detection waveform file "SSB Voice 6 dB.wav" on PC.	Direct the UUT (callsign: A01) to make (100) individual calls to address B01. Record the results of each call as a go or no-go on the data collection form, page D-55. Required detection probability: 80%	
9	Play occupancy detection waveform file "STANAG 4285 6 dB.wav" on PC.	Direct the UUT (callsign: A01) to make (100) individual calls to address B01. Record the results of each call as a go or no-go on the data collection form, page D-55. Required detection probability: 99%	
10	Play occupancy detection waveform file "STANAG 4285 0 dB.wav" on PC.	Direct the UUT (callsign: A01) to make (100) individual calls to address B01. Record the results of each call as a go or no-go on the data collection form, page D-55. Required detection probability: 80%	
11	Play occupancy detection waveform file "STANAG 4529 6 dB.wav" on PC.	Direct the UUT (callsign: A01) to make (100) individual calls to address B01. Record the results of each call as a go or no-go on the data collection form, page D-55. Required detection probability: 99%	
12	Play occupancy detection waveform file "STANAG 4529 0 dB.wav" on PC.	Direct the UUT (callsign: A01) to make (100) individual calls to address B01. Record the results of each call as a go or no-go on the data collection form, page D-55. Required detection probability: 80%	
The following procedure is for reference number 121.			
13	Program UUT.	With listen-before-transmit time of 0.5 seconds.	
14	Place UUT in scanning mode.	Because the time spent listening on a channel may be included in the listen-before-transmit time, this may cause erroneous data to be collected.	
15	Place a call from the UUT and record the listen-before-transmit time with a stopwatch.	Time measured from the press of the PTT button to the sound of the first ALE tone.	

Table C-45.2. Procedures for Verifying Compliance to Standards of Occupancy Detection and Listen-Before-Transmit Wait Times (continued)

Step	Action	Settings/Action	Result
16	Program UUT.	With listen-before-transmit time of 3 seconds.	
17	Place a call from the UUT and record the listen-before-transmit time with a stopwatch.	Time measured form the press of the PTT button to the sound of the first ALE tone.	
The following procedure is for reference number 123.			
18	Program UUT.	Override both the listen-before-transmit pause and the transmit lockout.	
19	Place a call from the UUT and record the listen-before-transmit time with a stopwatch.	Time measured form the press of the PTT button to the sound of the first ALE tone.	
Legend: ALE – Automatic Link Establishment; JITC – Joint Interoperability Test Command; MIL-STD – Military Standard; PC – Personal Computer; PSK – Phase Shift Keying; PTT – Push to talk; STANAG – Standardization Agreement; UUT – Unit Under Test			

C-45.4 Presentation of Results. The results will be shown in tabular format (table C-45-3) indicating the requirement and measured value or indications of capability.

Table C-45.3. Occupancy Detection Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result			Finding	
			Required Value SNR (dB in 3 Hz) and Detection Probability		Measured Results	Met	Not Met
53	A.4.2.2	Automatic Link Establishment	0	.8			
			6	.99			
		Single Sideband Voice	6	.8			
			9	.99			
		MIL-STD-188-110 (Serial Tone Phase Shift Keying)	0	.8			
			6	.99			
		STANAG 4529	0	.8			
			6	.99			

Table C-45.3. Occupancy Detection Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result			Finding	
			Required Value SNR (dB in 3 Hz) and Detection Probability		Measured Results	Met	Not Met
		STANAG 4285	0	.8			
			6	.99			
120	A.5.4.7	ALE controller shall not transmit on a channel if traffic is detected.	Not transmit.				
121	A.5.4.7.1	The listen-before-transmit pause shall be program-mable by the network manager.	At least two seconds.				
122	A.5.4.7.2	The listen-before-transmit function shall detect traffic on a channel in accordance with A.4.2.2.	Detect traffic.				
123	A.5.4.7.3	The operator shall be able to override both the listen-before-transmit pause and the transmit lockout.	Override listen-before-transmit and transmit lockout.				

Notes:
1. The single sideband voice test signal shall be taken from The Wireless Network Samples NMSU-EE-CC-021.
2. The Phase Shift Keying test signal shall be taken from The Wireless Network Samples NMSU-EE-CC-021.

Legend: ALE – Automatic Link Establishment; dB – decibels; Hz – hertz; MIL-STD – Military Standard; SNR – Signal-to-Noise Ratio; STANAG – Standardization Agreement

C-46 SUBTEST 46, ALTERNATIVE QUICK CALL (AQC)-AUTOMATIC LINK ESTABLISHMENT (ALE) LINKING PROBABILITY SUBTEST

C-46.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 55 and 56.

C-46.2 Criteria

a. When the optional AQC-ALE protocol (see details in section A.5.8, MIL-STD-188-141B) is implemented, the probability of linking shall conform to table C-46.1 with the following additional criteria:

(1) The protocol used shall be quick AQC individual calling protocol with no message passing.

(2) Addresses shall be one to six characters in the 38-character basic ASCII subset.

(3) Units being called shall be scanning 10 channels.

(4) Call initiation shall be performed with the Unit Under Test transmitter stopped and tuned to the calling frequency.

(5) The initial call probe shall not exceed 10 T_{rw} (respond and wait time), the call response shall not exceed 4T_{rw}, and the acknowledgement shall not exceed 2 T_{rw}, MIL-STD-188-141B, paragraph A.4.2.3.1.

b. AQC-ALE linking performance shall not be degraded in link protection level 1 or 2. Scan rates of two or five channels per second may degrade performance because insufficient redundant words are emitted during the call probe, MIL-STD-188-141B, paragraph A.4.2.3.2.

Table C-46.1. Probability of Linking

SNR (Decibel in 3 kilohertz)			
Probability of Linking	Gaussian Noise Channel	Modified CCIR Good Channel	Modified CCIR Poor Channel
≥ 25%	-2.5	+0.5	+1.0
≥ 50%	-1.5	+2.5	+3.0
≥ 85%	-0.5	+5.5	+6.0
≥ 95%	0.0	+8.5	+11.0
Multipath (millisecond)	0.0	0.52	2.2
Doppler spread (hertz)	0.0	0.10	1.0
Legend: CCIR – International Radio Consultative Committee; SNR – Signal-to-Noise Ratio			

C-46.3 Test Procedures

a. Test Equipment Required

(1) Channel Simulator

(2) Transmitters/Receivers

(3) Attenuators

(4) PC with Soundcard

(5) Directional Couplers

(6) UUT plus one additional outstation

(7) Spectrum Analyzer

b. Test Configuration. Configure the equipment as shown in figure C-46.1.

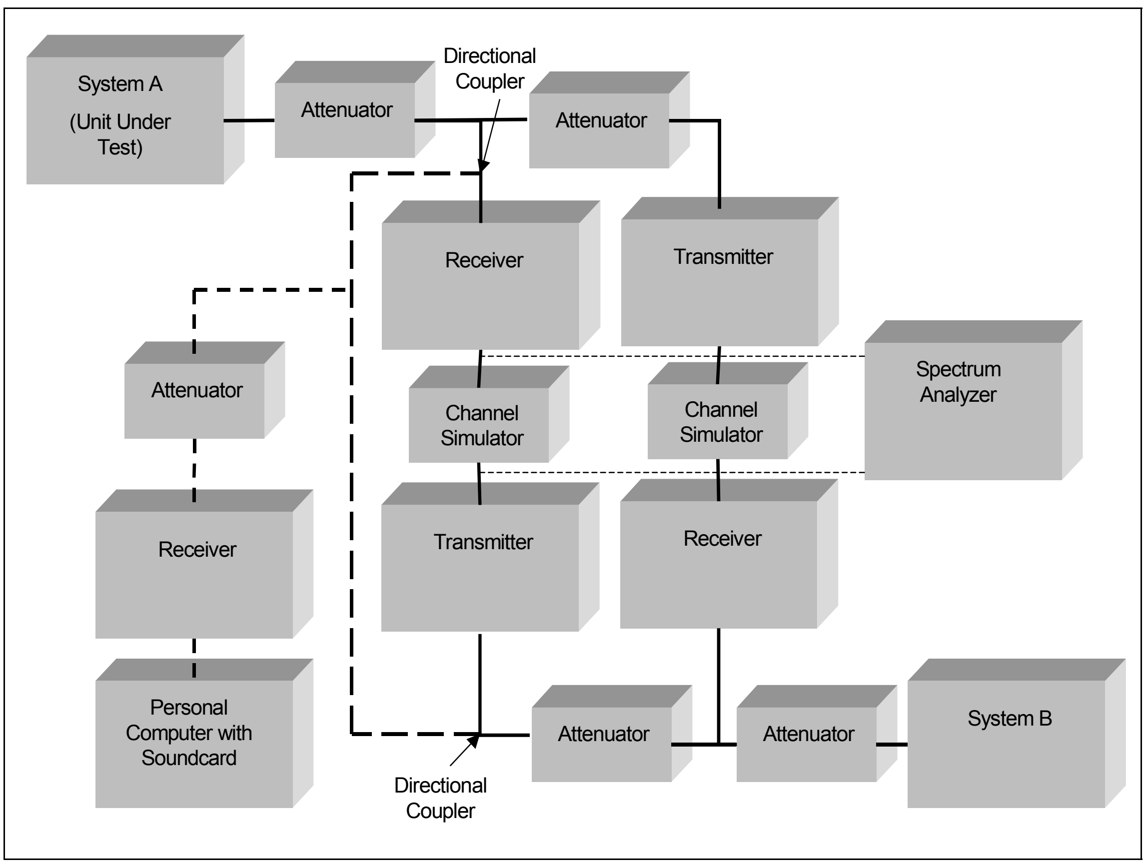

Figure C-46.1. Linking Probability Configuration

c. Test Conduct. Table C-46.2 contains procedures for verifying compliance to standards.

Table C-46.2. Procedures for Linking Probability

Step	Action	Settings/Action	Result
The following procedure is for reference number 55.			
1	Setup equipment as shown in figure C-46.1. Program radios in accordance with tables C-27.1 through C-27.6.	AQC mode Link Protection (LP) – 0 1 to 6 character call sign/self address.	
2	Program the transmit UUT A.	Single frequency.	
3	Program the receive UUT B.	Scanning channels 1 through 10.	
4	Program each channel simulator for a Gaussian Channel.	Single path SNR: -2.5 Multipath 0.0 msec Doppler spread 0.0 hertz (Hz)	
5	Configure PC to record a call in WAV format.		
6	From UUT A to UUT B. Make one complete call.	Record this call.	
7	Review WAV file captured in previous step using wave editor software.	Measure the length (in seconds) of the initial call probe, the call response, and the acknowledgement.	
8	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
9	Program each channel simulator for a Gaussian Channel.	Single path SNR: -1.5 Multipath 0.0 msec Doppler spread 0.0 Hz	
10	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
11	Program each channel simulator for a Gaussian Channel	Single path SNR: -0.5 Multipath 0.0 msec Doppler spread 0.0 Hz	
12	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
13	Program each channel simulator for a Gaussian Channel.	Single path SNR: 0 Multipath 0.0 msec Doppler Spread 0.0 Hz	
14	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	

Table C-46.2. Procedures for Linking Probability (continued)

Step	Action	Settings/Action	Result
15	Program each channel simulator for a International Radio Consultative Committee (CCIR) Good Channel.	Two paths SNR: +0.5 Multipath 0.52 msec (second channel only). Doppler spread 0.1 Hz	
16	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
17	Program each channel simulator for a CCIR Good Channel.	Two paths SNR: +2.5 Multipath 0.52 msec (second channel only). Doppler spread 0.1 Hz	
18	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
19	Program each channel simulator for a CCIR Good Channel.	Two paths SNR: +5.5 Multipath 0.52 msec (second channel only) Doppler spread 0.1 Hz	
20	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
21	Program each channel simulator for a CCIR Good Channel.	Two paths SNR: +8.5 Multipath 0.52 msec (second channel only) Doppler spread 0.1 Hz	
22	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
23	Program each channel simulator for a CCIR Poor Channel.	Two paths SNR: +1.0 Multipath 2.2 msec (second channel only) Doppler spread 1.0 Hz	
24	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
25	Program each channel simulator for a CCIR Poor Channel.	Two paths SNR: +3.0 Multipath 2.2 msec (second channel only) Doppler spread 1.0 Hz	

Table C-46.2. Procedures for Linking Probability (continued)

Step	Action	Settings/Action	Result
26	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
27	Program each channel simulator for a CCIR Poor Channel.	Two paths SNR: +6.0 Multipath 2.2 msec (second channel only) Doppler spread 1.0 Hz	
28	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
29	Program each channel simulator for a CCIR Poor Channel.	Two paths SNR: +11.0 Multipath 2.2 msec (second channel only) Doppler spread 1.0 Hz	
30	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
The following procedure is for reference number 56.			
31	Program UUT A and UUT B. Link Protection – LP 1.	Note: Scan rates of two or five channels per second may degrade performance because insufficient redundant words are emitted during the call probe.	
32	Program each channel simulator for a Gaussian Channel.	Single path SNR: -2.5 Multipath 0.0 msec Doppler spread 0.0 Hz	
33	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
34	Program each channel simulator for a Gaussian Channel.	Single path SNR: -1.5 Multipath 0.0 msec Doppler spread 0.0 Hz	
35	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning)	Record the number of successful links as a percentage.	
36	Program each channel simulator for a Gaussian Channel.	Single path SNR: -0.5 Multipath 0.0 msec Doppler spread 0.0 Hz	
37	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	

Table C-46.2. Procedures for Linking Probability (continued)

Step	Action	Settings/Action	Result
38	Program each channel simulator for a Gaussian Channel.	Single path SNR: -0.5 Multipath 0.0 msec Doppler spread 0.0 Hz	
39	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
40	Program each channel simulator for a CCIR Good Channel.	Two paths SNR: +0.5 Multipath 0.52 msec (second channel only) Doppler spread 0.1 Hz	
41	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
42	Program each channel simulator for a CCIR Good Channel.	Two paths SNR: +2.5 Multipath 0.52 msec (second channel only) Doppler spread 0.1 Hz	
43	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
44	Program each channel simulator for a CCIR Good Channel.	Two paths SNR: +5.5 Multipath 0.52 msec (second channel only) Doppler spread 0.1 Hz	
45	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
46	Program each channel simulator for a CCIR Good Channel.	Two paths SNR: +8.5 Multipath 0.52 msec (second channel only) Doppler spread 0.1 Hz	
47	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
48	Program each channel simulator for a CCIR Poor Channel.	Two paths SNR: +1.0 Multipath 2.2 msec (second channel only) Doppler spread 1.0 Hz	

Table C-46.2. Procedures for Linking Probability (continued)

Step	Action	Settings/Action	Result
49	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
50	Program each channel simulator for a CCIR Poor Channel.	Two paths SNR: +3.0 Multipath 2.2 msec (second channel only) Doppler spread 1.0 Hz	
51	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
52	Program each channel simulator for a CCIR Poor Channel.	Two paths SNR: +6.0 Multipath 2.2 msec (second channel only) Doppler spread 1.0 Hz	
53	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
54	Program each channel simulator for a CCIR Poor Channel.	Two paths SNR: +11.0 Multipath 2.2 msec (second channel only) Doppler spread 1.0 Hz	
55	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
56	Program UUT A and UUT B.	AQC mode LP – 2 1 to 6 character call sign/self address Note: Scan rates of two or five channels per second may degrade performance because insufficient redundant words are emitted during the call probe.	
57	Program the Transmit UUT A.	Single Frequency	
58	Program the Receive UUT B.	Scanning channels 1 through 10.	
59	Program each channel simulator for a Gaussian Channel.	Single path SNR: -2.5 Multipath 0.0 msec Doppler Spread 0.0 hertz (Hz)	
60	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	

Table C-46.2. Procedures for Linking Probability (continued)

Step	Action	Settings/Action	Result
61	Program each channel simulator for a Gaussian Channel.	Single path SNR: -1.5 Multipath 0.0 msec Doppler spread 0.0 Hz	
62	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
63	Program each channel simulator for a Gaussian Channel.	Single path SNR: -0.5 Multipath 0.0 msec Doppler spread 0.0 Hz	
64	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
65	Program each channel simulator for a Gaussian Channel.	Single path SNR: -0.5 Multipath 0.0 msec Doppler spread 0.0 Hz	
66	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
67	Program each Channel Simulator for a International Radio Consultative Committee (CCIR) Good Channel.	Two paths SNR: +0.5 Multipath 0.52 msec (second channel only) Doppler spread 0.1 Hz	
68	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
69	Program each channel simulator for a CCIR Good Channel.	Two paths SNR: +2.5 Multipath 0.52 msec (second channel only) Doppler spread 0.1 Hz	
70	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
71	Program each channel simulator for a CCIR Good Channel.	Two paths SNR: +5.5 Multipath 0.52 msec (second channel only) Doppler spread 0.1 Hz	
72	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	

Table C-46.2. Procedures for Linking Probability (continued)

Step	Action	Settings/Action	Result
73	Program each channel simulator for a CCIR Good Channel.	Two paths SNR: +8.5 Multipath 0.52 msec (second channel only) Doppler spread 0.1 Hz	
74	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
75	Program each channel simulator for a CCIR Poor Channel.	Two paths SNR: +1.0 Multipath 2.2 msec (second channel only) Doppler spread 1.0 Hz	
76	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
77	Program each channel simulator for a CCIR Poor Channel.	Two paths SNR: +3.0 Multipath 2.2 msec (second channel only) Doppler spread 1.0 Hz	
78	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
79	Program each channel simulator for a CCIR Poor Channel.	Two paths SNR: +6.0 Multipath 2.2 msec (second channel only) Doppler spread 1.0 Hz	
80	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
81	Program each channel simulator for a CCIR Poor Channel.	Two paths SNR: +11.0 Multipath 2.2 msec (second channel only) Doppler spread 1.0 Hz	
82	From UUT A to UUT B. Make series of 100 individual calls. (Ensure after a failed attempt that UUT B is returned to scanning.)	Record the number of successful links as a percentage.	
Legend: AQC – Alternative Quick Call; CCIR – International Radio Consultative Committee; Hz – hertz; LP – Link Protection; msec – millisecond; PC – Personal Computer; SNR – Signal to Noise Ratio; UUT – Unit Under Test			

C-46.4 Presentation of Results. The results will be shown in tabular format (table C-46.3) indicating the requirement and measured value.

Table C-46.3. Linking Probability Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Results	Met	Not Met
55	A.4.2.3.1	Gaussian Noise Signal-to-Noise Ratio (SNR) -2.5 Link Protection (LP) 0	Greater than or equal to (≥) 25%			
55	A.4.2.3.1	Gaussian Noise SNR –1.5 LP 0	≥ 50%			
55	A.4.2.3.1	Gaussian Noise SNR –0.5 LP 0	≥ 85%			
55	A.4.2.3.1	Gaussian Noise SNR 0.0 LP 0	≥ 95%			
55	A.4.2.3.1	International Radio Consultative Committee (CCIR) Good SNR +0.5 LP 0	≥ 25%			
55	A.4.2.3.1	CCIR Good SNR +2.5 LP 0	≥ 50%			
55	A.4.2.3.1	CCIR Good SNR +5.5 LP 0	≥ 85%			
55	A.4.2.3.1	CCIR Good SNR +8.5 LP 0	≥ 95%			
55	A.4.2.3.1	CCIR Poor SNR +1.0 LP 0	≥ 25%			
55	A.4.2.3.1	CCIR Poor SNR +3.0 LP 0	≥ 50%			
55	A.4.2.3.1	CCIR Poor SNR +6.0 LP 0	≥ 85%			
55	A.4.2.3.1	CCIR Poor SNR +11.0 LP 0	≥ 95%			
55	A.4.2.3.1	The initial call probe shall not exceed 10 T_{rw}	≤ 10 T_{rw} (3920 msec)			
55	A.4.2.3.1	The call response shall not exceed 4 T_{rw}	≤ 4 T_{rw} (1568 msec)			
55	A.4.2.3.1	Acknowledgement shall not exceed 2 T_{rw}	≤ 2 T_{rw} (784 msec)			
56	A.4.2.3.2	Gaussian Noise SNR -2.5 Link Protection (LP) 1	≥ 25%			
56	A.4.2.3.2	Gaussian Noise SNR –1.5 LP 1	≥ 50%			
56	A.4.2.3.2	Gaussian Noise SNR –0.5 LP 1	≥ 85%			

Table C-46.3. Linking Probability Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Results	Met	Not Met
56	A.4.2.3.2	Gaussian Noise SNR 0.0 LP 1	≥ 95%			
56	A.4.2.3.2	CCIR Good SNR +0.5 LP 1	≥ 25%			
56	A.4.2.3.2	CCIR Good SNR +2.5 LP 1	≥ 50%			
56	A.4.2.3.2	CCIR Good SNR +5.5 LP 1	≥ 85%			
56	A.4.2.3.2	CCIR Good SNR +8.5 LP 1	≥ 95%			
56	A.4.2.3.2	CCIR Poor SNR +1.0 LP 1	≥ 25%			
56	A.4.2.3.2	CCIR Poor SNR +3.0 LP 1	≥ 50%			
56	A.4.2.3.2	CCIR Poor SNR +6.0 LP 1	≥ 85%			
56	A.4.2.3.2	CCIR Poor SNR +11.0 LP 1	≥ 95%			
56	A.4.2.3.2	Gaussian Noise SNR –2.5 LP 2	≥ 25%			
56	A.4.2.3.2	Gaussian Noise SNR –1.5 LP 2	≥ 50%			
56	A.4.2.3.2	Gaussian Noise SNR –0.5 LP 2	≥ 85%			
56	A.4.2.3.2	Gaussian Noise SNR 0.0 LP 2	≥ 95%			
56	A.4.2.3.2	CCIR Good SNR +0.5 LP 2	≥ 25%			
56	A.4.2.3.2	CCIR Good SNR +2.5 LP 2	≥ 50%			
56	A.4.2.3.2	CCIR Good SNR +5.5 LP 2	≥ 85%			
56	A.4.2.3.2	CCIR Good SNR +8.5 LP 2	≥ 95%			
56	A.4.2.3.2	CCIR Poor SNR +1.0 LP 2	≥ 25%			
56	A.4.2.3.2	CCIR Poor SNR +3.0 LP 2	≥ 50%			
56	A.4.2.3.2	CCIR Poor SNR +6.0 LP 2	≥ 85%			
56	A.4.2.3.2	CCIR Poor SNR +11.0 LP 2	≥ 95%			

Legend: CCIR – International Radio Consultative Committee; LP – Linking Protection; MIL-STD; Military Standard; SNR – Signal-to-Noise Ratio

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C-47 SUBTEST 47, ALTERNATIVE QUICK CALL (AQC)-AUTOMATIC LINK ESTABLISHMENT (ALE) UNIT CALL STRUCTURE SUBTEST

C-47.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 223, 224, 225, 226, and 227.

C-47.2 Criteria

a. A unit call in AQC-ALE follows the same principles as a standard ALE unit call with the following changes. In the Leading Call section of the Call and Response, the address shall appear once instead of twice. In the Acknowledgement frame, only the conclusion section shall be sent. See figure C-47.1 for an example of a unit call sequence from source to target.

(1) See A.5.8.2.1, Calling Cycle to determine the maximum number of words to send during the scanning call portion of the call.

(2) The optional Phase Shift Keyed (PSK) tone sequence shall be available during any leg of the handshake.

(3) An InLink Event Transaction shall be used in lieu of the Acknowledgement frame when ALE data traffic is available for the InLink State in AQC-ALE.

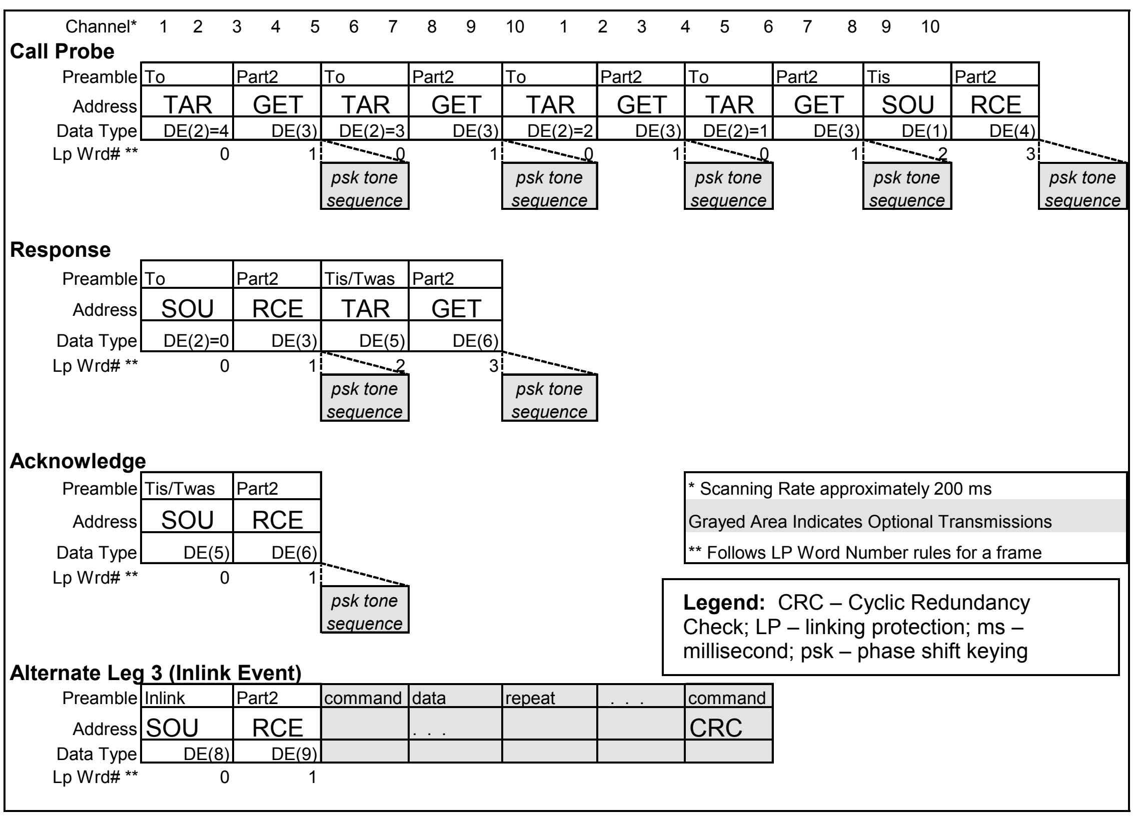

Figure C-47.1. Example of Unit Call Format

(MIL-STD-188-141B, paragraph A.5.8.2.2)

b. The call probe shall be identical to a unit call where the star net address replaces the unit address. The slotted response portion shall always use a two word address for the TO and TIS addresses. Just as in Baseline 2G ALE, the slotted response shall be 5 Tw wider than the 6 Tw needed to transmit the TIS/TWAS address. Slot 0 shall be 17 Tw to accommodate a non-net member participating in the call. Slot 1 and all remaining slots shall be 11 Tw wide. No LQA information shall be emitted in the Acknowledgement portion of the Start Net Call except as provided through the data exchange bits. The optional PSK tone sequence shall be available during any frame of the handshake. The slot width does not change, even when the optional PSK tone sequence is used.

The Data Exchange values shall be per figure C-47.2.

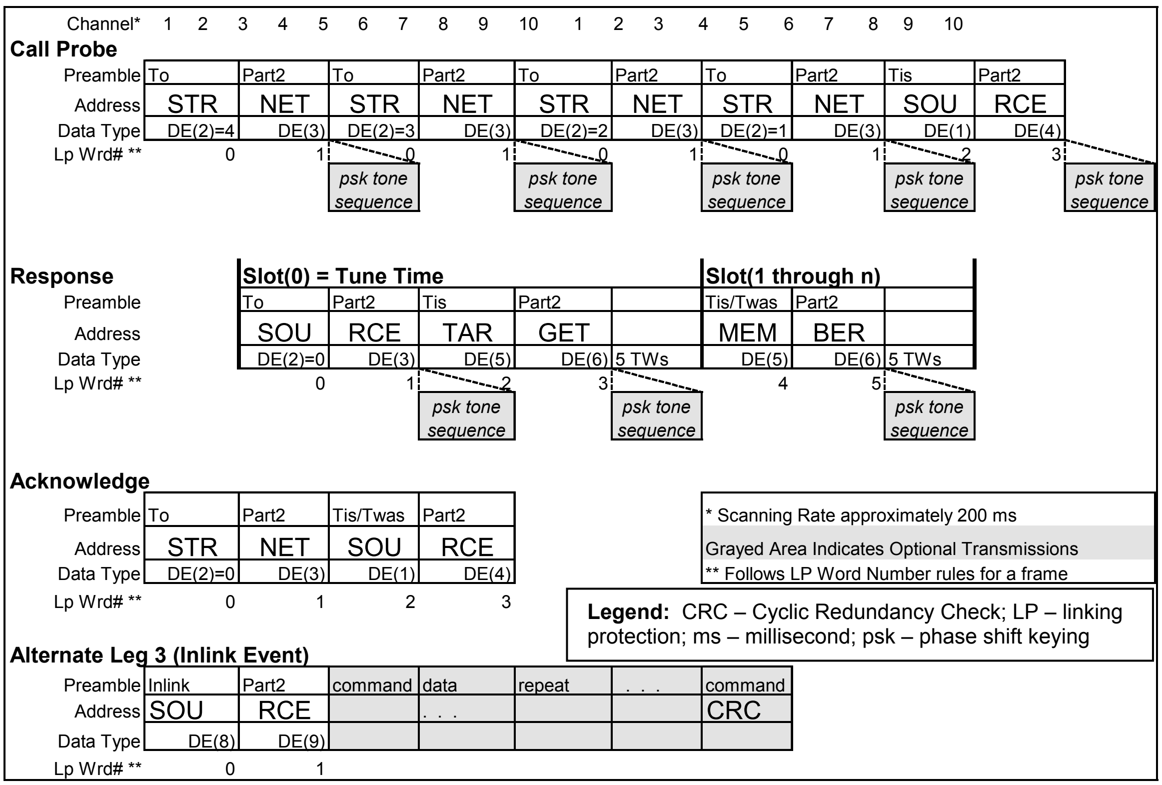

Figure C-47.2. Example of Star Net Format

An InLink Event frame may be used for the Acknowledgement frame. Slots 1 and beyond may be expanded by fixed number of Trw for certain types of AQC-ALE InLink Messages, MIL-STD-188-141 A.5.8.2.3.

c. A station placing an AllCall shall issue the call using the calling cycle definition in A.5.8.2.1. The actions taken shall be as described for baseline 2G ALE

AllCalls. The Data Exchange values shall be per figure C-47.3, AllCall Frame Format. Selective AllCall shall be supported.

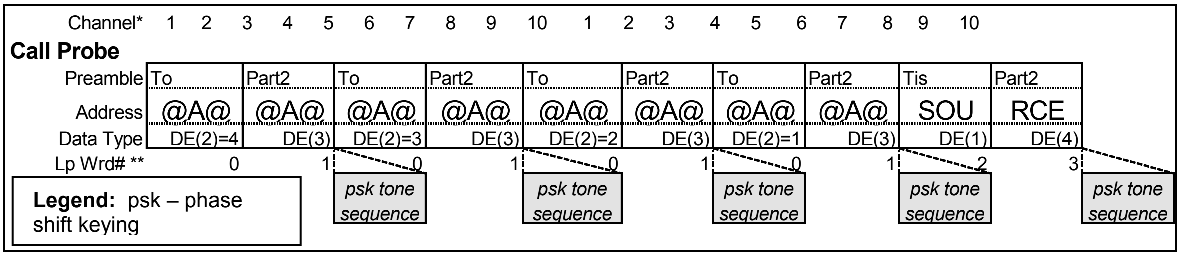

Figure C-47.3. Example AllCall Frame Format

(MIL-STD-188-141B, paragraph A.5.8.2.4)

d. A station placing an AnyCall shall issue the call using the calling cycle definition in A.5.8.2.1. The actions taken shall be a described for baseline 2G ALE AnyCalls except that the Slot width shall be fixed at 17 Tw. The leading address section and conclusion shall be used for each slotted response. The Data Exchange values shall be per figure C-47.4. Selective AnyCall and Double Selective AnyCall shall be supported.

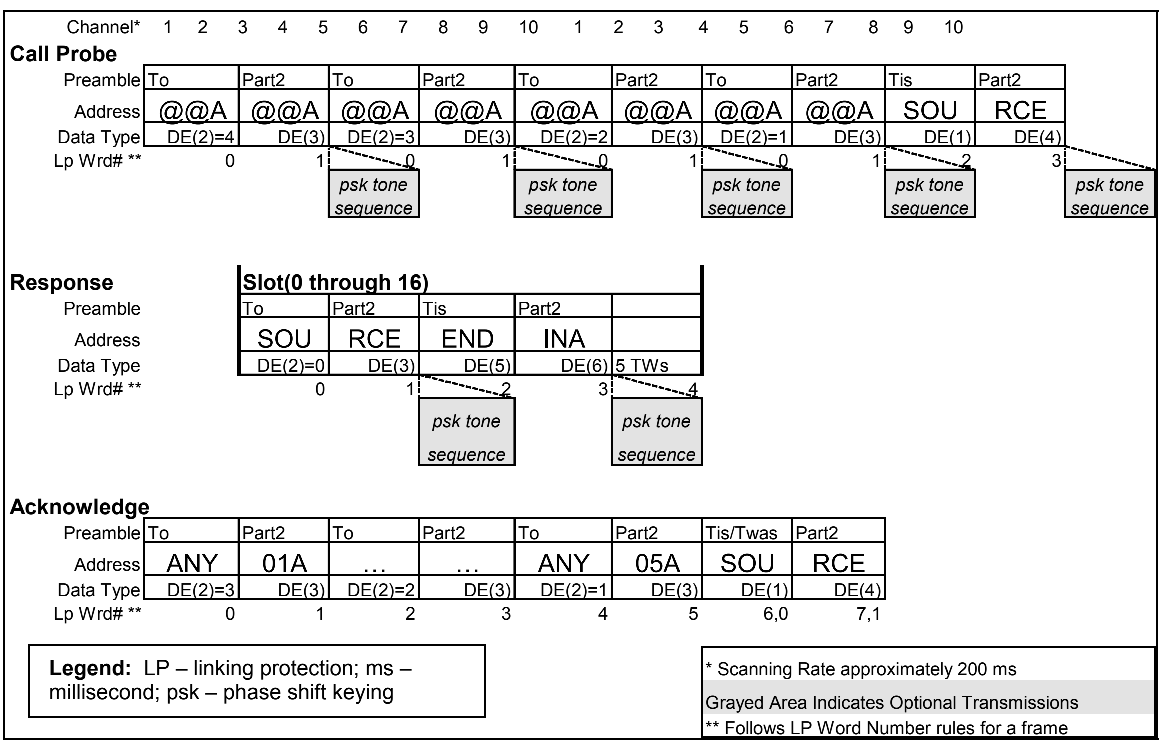

Figure C-47.4. Example AnyCall Frame Format

An InLink Event frame shall not be used for the Acknowledgement frame, MIL-STD-188-141B, paragraph A.5.8.2.5.

e. The sounding cycle shall be composed of the station's address broadcast for at least the period defined as the sound duration for the radio. Data exchange values shall be as denoted in figure C-47.5. When the call duration is not evenly divisible by 2 triple redundant word times, then the additional full address may be transmitted. When an entire address is not used to complete a fractional portion of the sound duration, the caller shall begin the transmission with the second half of the target address using the PART2 preamble. In this case, the LP word number shall be 1. As shown in figure C-47.5, the LP word number shall toggle between 0 and 1.

When the radio is programmed to automatically derive the sound duration, the equation shall be:

Number of Channels * 0.196 + 0.784

See table A-58 for the minimum and maximum number of Trw to broadcast automatically.

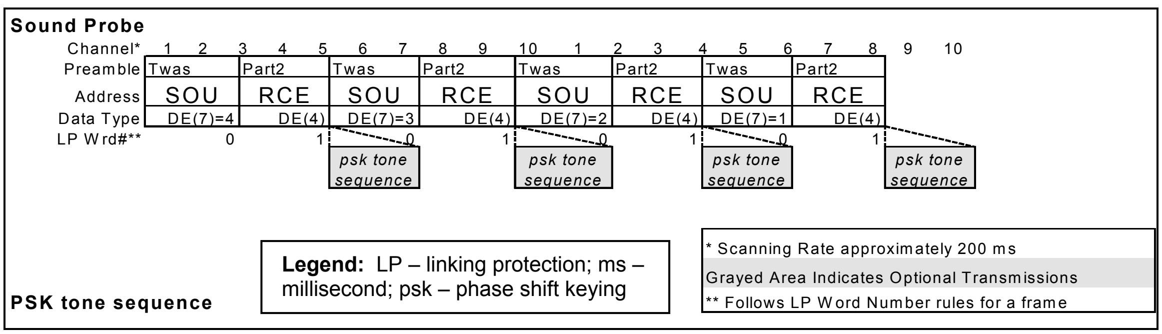

Figure C-47.5. Example of Sounding Frame Format

(MIL-STD-188-141B, paragraph A.5.8.2.6)

C-47.3 Test Procedures

a. Test Equipment Required

(1) PC with Soundcard

(2) Receiver monitoring 12.000 MHz, USB

(3) Attenuators

(4) Tee Connector

(5) UUT plus one additional outstation

b. Test Configuration. Configure the equipment as shown in figure C-47.6.

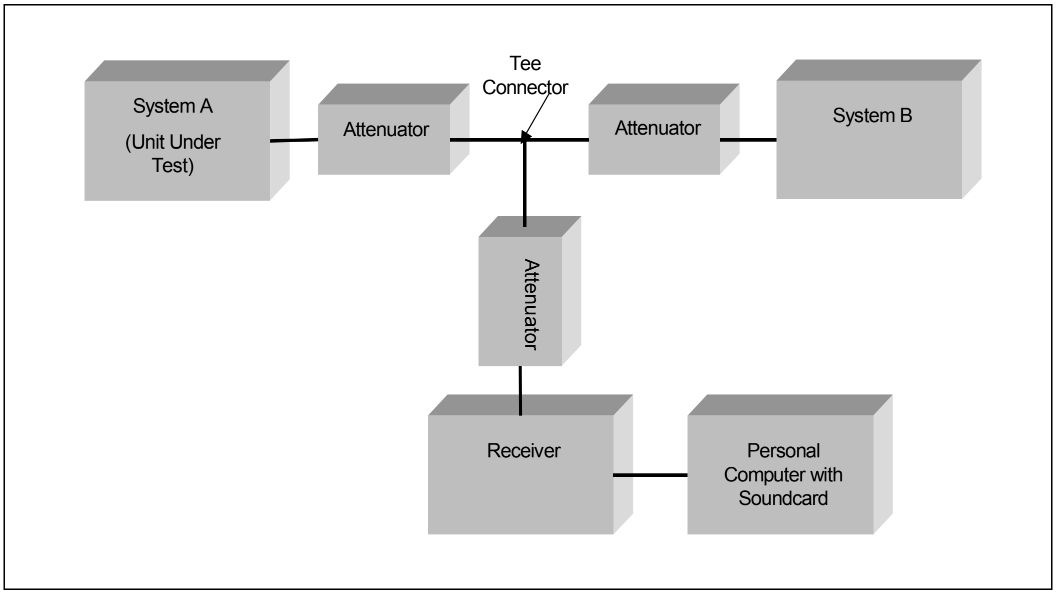

Figure C-47.6. Unit Call Structure Configuration

c. Test Conduct. The procedures for this subtest are listed in table C-47.1.

Table C-47.1. Procedures for Verifying Compliance to Unit Call Structure Standards

Step	Action	Action/Setting	Results
The following procedure is for reference number 223.			
1	Set up equipment as shown in figure C-47.6.	Program radios in accordance with tables C-27.1 through C-27.6.	
2	Program system A with Self Address ABC.	Program system B with Self Address 123.	
3	Place call from System A to System B. Capture audio tones from ALE call.	Use PC to capture data in WAV format.	
4	Use Matlab algorithm from step 17, and ALE Word Decode Matrix Forms to decode the WAV file.	See table C-47.1.	
5	View captured WAV file. Measure and record the time from the first tone of the Initial Call to the last tone of the Initial Call.		
6	Record the number of triple redundant words in the Initial Call.		
7	View captured WAV file. Measure and record the time from the first tone of the Response Call to the last tone of the Response Call.		

Table C-47.1. Procedures for Verifying Compliance to Unit Call Structure Standards (continued)

Step	Action	Action/Setting	Results
8	Record the number of triple redundant words in the Response Call.		
9	View captured WAV file. Measure and record the time from the first tone of the Acknowledge Call to the last tone of the Acknowledge Call.		
10	Record the number of triple redundant words in the Acknowledge Call.		
11	How many times does the address of UUT A appear in the Initial Call?	Expected: once	
12	How many times does the address of UUT B appear in the Response Call?	Expected: once	
13	What does the Acknowledgement Call contain?	Expected: only the conclusion	
14	Does radio comply with figure C-47.1?		
The following procedure is for reference number 224.			
15	Program system A to place a Net Call.		
16	Capture ALE call sequence audio tones.	Use PC to capture data in WAV format. Sample at 44.1 kHz, 16 bits, mono.	

17	Use wave editor software to remove any noise at the beginning or end of the captured WAV file. The following Matlab algorithm should be used to measure the frequency of each 8 millisecond audio tone transmitted during the ALE call sequence.
	
	for i = 0:1000
	[wave,fs]=wavread('FILENAME.wav',[(i*353 + 1), (353*(i+1))]);
	wavefft=abs(fft(wave));
	wavefft1 = wavefft(1:176);
	peak = max(wavefft1);
	location = find(wavefft1 == peak);
	frequency = (44100*(location-1)/352.8)
	end
		Each 8 millisecond tone represents 3 data bits as follows:
		
		750 Hz = 000
		1000 Hz = 001
		1250 Hz = 011
		1500 Hz = 010
		1750 Hz = 110
		2000 Hz = 111
		2250 Hz = 101
		2500 Hz = 100
		
		Use the ALE Word Decode Matrix Forms to decode the ALE call sequence.	

18	Verify that the Net Call is the same as the Individual Call with exception to the Net Address.	The call probe is to be identical to the Individual Call where the star net address replaces the individual address.	
19	Does Net call comply with word sequence from figure C-47.2?		

Table C-47.1. Procedures for Verifying Compliance to Unit Call Structure Standards (continued)

Step	Action	Action/Setting	Results
The following procedure is for reference number 225.			
20	Program system A with Self Address ABC.		
21	Place AllCall from system A.		
22	Capture ALE call sequence audio tones.	Use PC to capture data in WAV format.	
23	Use Matlab algorithm from step 17, and ALE Word Decode Matrix Forms to decode the WAV file.	See table C-47.1.	
24	View captured WAV file. Measure and record the time from the first tone of the Initial Call to the last tone of the Initial Call.		
25	Record the number of triple redundant words in the Initial Call.		
26	Does AllCall comply with word sequence from figure C-47.3?		
The following procedure is for reference number 226.			
27	Place AnyCall from system A.		
28	Program system B with Self Address 123.		
29	Capture ALE call sequence audio tones.	Use PC to capture data in WAV format.	
30	Use Matlab algorithm from step 17, and ALE Word Decode Matrix Forms to decode the WAV file.		
31	View captured WAV file. Measure and record the time from the first tone of the Initial Call to the last tone of the Initial Call.		
32	Record the number of triple redundant words in the Initial Call.		
33	Measure and record the time from the first tone of the Response Call to the last tone of the Response Call.		
34	Record the number of triple redundant words in the Response Call.		
35	Measure and record the time from the first tone of the Acknowledgement Call to the last tone of the Acknowledgement Call.		
36	Record the number of triple redundant words in the Acknowledgement Call.		
37	Does AnyCall comply with word sequence from figure C-47.4?		
38	Program system A with Self Address ABC.		

Table C-47.1. Procedures for Verifying Compliance to Unit Call Structure Standards (continued)

Step	Action	Action/Setting	Results
The following procedure is for reference number 227.			
39	Place Sounding call from system A.		
40	Capture ALE call sequence audio tones.	Use PC to capture data in WAV format.	
41	Use Matlab algorithm from step 17 and ALE Word Decode Matrix Forms to decode the WAV file.		
42	View captured WAV file. Measure and record the time from the first tone of the Initial Call to the last tone of the Sound.		
43	Record the number of triple redundant words in the Initial Call.		
44	Does Sounding call comply with word sequence from figure C-47.5?		
Legend: ALE – Automatic Link Establishment; Hz – hertz; PC – Personal Computer; UUT – Unit Under Test; WAV - Wave			

C-47.4 Presentation of Results. The results will be shown in tabular format (table C-47.2) indicating the requirement and measured value or indications of capability.

Table C-47.2. Unit Call Structure Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
223	A.5.8.2.2	A unit call in Alternative Quick Call (AQC)-Automatic Link Establishment (ALE) follows the same principles as a standard ALE unit call. See figure C-47.1.	Paragraph A.5.8.2.1 gives number of words to send; optional PSK tone sequence; InLink Event Transaction.			
224	A.5.8.2.3	Call probe shall be identical to a Unit call where the star net address replaces the unit address.	Data exchange values per figure C-47.2.			
225	A.5.8.2.4	A station placing the AllCall shall issue the call using the calling cycle definition in A.5.8.2.1. See figure C-47.3.	Data exchange values per figure C-47.3.			
226	A.5.8.2.5	A station placing the AnyCall shall issue the call using the calling cycle definition in A.5.8.2.1 See figure C-47.4.	Data exchange values per figure C-47.4.			
227	A.5.8.2.6	Sounding in AQC-ALE shall follow the example in figure C-47.5 for the minimum and maximum Trw and word sequence.	Data exchange values per figure C-47.5.			

Legend: ALE – Automatic Link Establishment; AQC – Alternative Quick Call; MIL-STD – Military Standard; PSK – Phase Shift Key; Trw – Triple redundant word

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C-48 SUBTEST 48, ALTERNATIVE QUICK CALL (AQC)-AUTOMATIC LINK ESTABLISHMENT (ALE) INLINK TRANSACTION SUBTEST

C-48.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 228, 229, 230, 231, and 232.

C-48.2 Criteria

a. AQC-ALE stations shall have the capability to transfer information within the InLink state of the radio. A special purpose frame is defined for the purpose of separating link establishment transactions from transactions that occur during the InLink state. Two types of InLink transactions are defined, InLink Event and InLink Event Sequence. Either transaction can have an optional address section appended to the beginning of the frame. This optional address section indicates that the transaction is targeted at the addresses defined in this section of the frame.

The InLink frame uses Data Exchange DE(8) and DE(9). DE(8) informs the recipient of the type of transaction and whether this frame needs to be acknowledged. See A.5.8.3.8. DE(9) data content indicates to the caller the exact form of the data and identifies if the sender intends to remain in the linked state with all those represented in the address section of the frame. When the address section is omitted, the frame shall be targeted to all stations currently linked with the transmitting station. See MIL-STD-188-141B, paragraph A.5.8.3.9.

The data Exchange values shall be per figure C-48.1. This figure outlines the general format of both types of InLink transaction events.

InLink Event

Preamble	to	part2	InLink	Part2
Address	Address	Section	SOU	RCE
Data Type	DE(2)	DE(3)=15	DE(8)	DE(9)
Lp Wrd# **			0	1

* Scanning Rate approximately 200 ms
Grayed Area Indicates Optional Transmissions
** Follows LP Word Number rules for a frame

InLink Event Sequence

Preamble	to	part2	InLink	Part2	Command	Data	Repeat	Data	Repeat	. . .	Command
Address	Address	Section	SOU	RCE	CTRL	V(2)	V(3)	V(4)	V(5)	. . .	CRC
Data Type	DE(2)	DE(3)=15	DE(8)	DE(9)							(16 bit)
Lp Wrd# **			0	1	2	3	4	5	6,0	7,1	8,2

Address Section

Preamble	To	Part2	To	Part2	To	Part2	To	Part2
Address	MBR	001	…	…	…	…	MBR	004
Data Type	DE(2)=4	DE(3)=15	DE(2)=3	DE(3)=15	DE(2)=2	DE(3)=15	DE(2)=1	DE(3)=15
Lp Wrd# **	0	1	2	3	4	5	6,0	7,1

Legend: CRC – Cyclic Redundancy Check; LP – linking protection; ms – millisecond

Figure C-48.1. Example of Link Transaction Triple Redundant Word Sequences

(MIL-STD-188-141B, paragraph A.5.8.2.7)

b. The InLink Event or the InLink Event Sequence shall be used as the Acknowledgement frame of a handshake whenever the calling radio has a message for the radios entering the InLink state. If the INLINK preamble is replacing a TIS preamble indicating that the radios were to remain in an InLink state, then the I'M LINKED bit shall be set to 1. If a TWAS preamble would normally be used for this transmission, the I'M LINKED bit shall be set to 0. Thus, the calling station can minimize over the airtime for any transaction by judicious use of InLink state and associated control bits, MIL-STD-188-141B, paragraph A.5.8.2.7.1.

c. As seen in figure C-48.1, a command section of an InLink event sequence shall consist of the Command preamble, followed by the data associated with the command using the preambles DATA and REPEAT. The InLink event sequence frame shall be terminated with a Command preamble containing the CRC of the data contained in all words starting with the first Command preamble. This CRC shall be computed exactly as the CRC for a standard ALE DTM (See A.5.6.1). The receiver shall maintain a history of failed CRC. The history may be displayed to the operator or used in channel selection algorithms for follow-on traffic, MIL-STD-188-141B, paragraph A.5.8.2.7.2.

d. The address section of an InLink transaction, when present, shall indicate that the addressed stations in the link are to react to the information contained in the message section, MIL-STD-188-141B, paragraph A.5.8.2.7.3.

e. When an acknowledgement has been requested, each radio in the address section shall be assigned a response slot in the same manner as a standard ALE group call. The slot width shall be as specified for AQC-ALE StarNet call, A.5.8.2.4. When the address section contains a StarNet address, the slot assignments shall be per the StarNet definition. When no slot assignment can be determined and an acknowledgement is requested, the receiving radio shall respond as quickly as possible.

Slotted responses shall use an InLink transaction frame beginning with the InLink preamble. The address section shall not be permitted in the slotted response. When a the transmitting station issues a message that requires a responding message, such as time-request to Time-is, the slot widths for slot 1 and greater shall automatically expand by a fixed number of Trw to satisfy the response.

When a response could be variable in length, the maximum slot width shall be used. The maximum width in Tw for an InLink transaction shall be 44 Tw. This could represent an AMD message of up to 27 characters, MIL-STD-188-141B, paragraph A.5.8.2.7.4.

C-48.3 Test Procedures

a. Test Equipment Required.

(1) PC with Soundcard

(2) Receiver monitoring 12.000 MHz, USB

(3) Attenuators

(4) UUT plus one additional outstation

(5) Tee Connector

b. Test Configuration. Configure the equipment as shown in figure C-48.2.

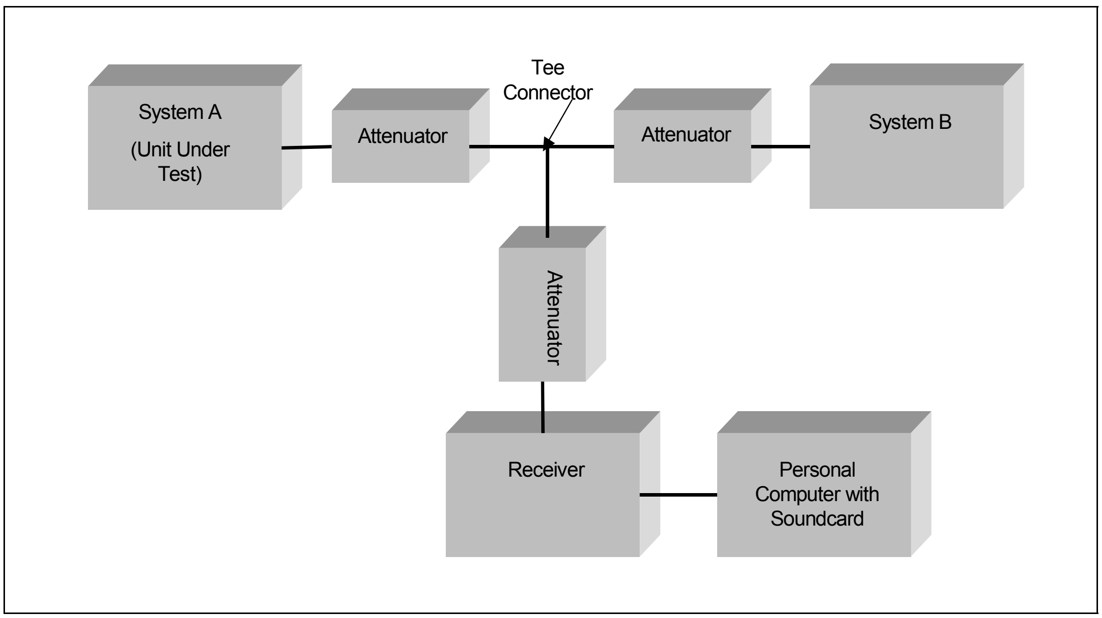

Figure C-48.2. InLink Transaction Configuration

c. Test Conduct. The procedures for this subtest are listed in table C-48.1.

Table C-48.1. Procedures for Decoding Automatic Quick Call (AQC)-Automatic Link Establishment (ALE) InLink Call

Step	Action	Action/Setting	Recorded Value
The following procedure is for reference numbers 230, 231, and 232.			
1	Set up equipment as shown in figure C-48.2.	Program radios in accordance with tables C-27.1 through C-27.6.	
2	Use PC with soundcard to capture data in WAV format.	Data must be captured at 44.1 kHz, 16 bits, mono.	
3	Place an InLink call from system A to system B.	Capture call in WAV format.	
4	Use Matlab algorithm given in table C-47.1 step 17 to decode the WAV file.		
5	Record decoded bits of the preamble from the first word of the Acknowledgement.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form (Expect 010, TO or 001, InLink).	
6	Decode bits A4 to B8 on ALE Word Decode Matrix Form.	If word 1 preamble is "TO," then bits A5 to B8 should be the called address. See table C-48.1 to decode to ASCII. If word 1 preamble is "InLink," then bits A4 to B5 should be in DE(9) format. They should contain the first three characters of the calling address. See table C-47.1 to decode to ASCII.	
7	Record decoded bits of the preamble from the second word of the Acknowledgement.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form (Expect 100, Part 2).	
8	Record second 3 characters of the address.	Bits A5 to B8 from ALE Word Decode Matrix should be the second part of the address from step 5.	
9	Skip steps 9 through 12 if the first word preamble was "InLink."		
10	Record decoded bits of the preamble from the third word of the Acknowledgement.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form (Expect 001, InLink).	
11	Record first 3 characters of the address from word 3.	Bits A5 to B8 from ALE Word Decode Matrix should be the first part of the calling radio's address.	
12	Record decoded bits of the preamble from the fourth word of the Acknowledgement.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form (Expect 100, Part 2).	
13	Record last 3 characters of the address from word 3.	Bits A5 to B8 should be the second part of the calling radio's address.	
The following procedure is for reference number 229.			

Table C-48.1. Procedures for Decoding Automatic Quick Call (AQC)-Automatic Link Establishment (ALE) InLink Call (continued)

Step	Action	Action/Setting	Recorded Value
14	If there are no more tones in the Acknowledgement, then this is an InLink Event. Generate an InLink Event Sequence to decode. Start from step 1.		
15	Record decoded bits of the preamble from the next word of the Acknowledgement.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form (Expect 110, CMD).	
16	Record command message.	Decode bits A4 to B12 on ALE Word Decode Matrix Form.	
17	Is decoded bits the command that was generated in the InLink Call?	Yes/No	
18	Record decoded bits of the preamble from the next word of the Acknowledgement.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form (Expect 000, Data).	
19	Record data message.	Decode bits A4 to B12 on ALE Word Decode Matrix Form.	
20	Is decoded bits the command that was generated in the InLink Call?	Yes/No	
The following procedure is for reference number 228.			
21	Follow figure C-48.1, decoding words and preambles for the rest of the Acknowledgement to ensure that the acknowledgement follows the example.		
Legend: ALE – Automatic Link Establishment; AQC – Alternate Quick Call; ASCII – American Standard Code for Information Interchange; CMD – Command; Hz – hertz; PC – Personal Computer; WAV – Wave			

C-48.4 Presentation of Results. The results will be shown in tabular format (table C-48.2) indicating the requirement and observed value or indications of capability.

Table C-48.2. Alternative Quick Call (AQC)-Automatic Link Establishment (ALE) Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
228	A.5.8.2.7	AQC-ALE stations shall have the capability to transfer information within the InLink state of the radio.	Data Exchange values per figure C-48.1.			
229	A.5.8.2.7.1	InLink Event shall be used as the Acknowledgement frame of a handshake whenever the calling radio has a message.	InLink Event			

Table C-48.2. Alternative Quick Call (AQC)-Automatic Link Establishment (ALE) Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
230	A.5.8.2.7.2	Command section of an InLink event sequence shall consist of the COMMAND preamble, followed by the data associated with the command using the preambles DATA and REPEAT.	COMMAND followed by data using DATA and REPEAT preambles.			
230	A.5.8.2.7.2	Command section of an InLink event shall be terminated with a COMMAND preamble containing the circuit redundancy controller (CRC) of the data contained in all words starting with the first COMMAND preamble. The CRC shall be computed exactly as the CRC for a standard ALE Data Text Message. The receiver shall maintain a history of failed CRC.	See paragraph A.5.6.1 and figure C-48.1.			
231	A.5.8.2.7.3	The address section of an InLink transaction, when present, shall indicate that the addressed stations in the link are to react to the information contained in the message section.	Indicate addressed stations to react to message.			
232	A.5.8.2.7.4	When the address section contains a StarNet address, the slot assignments shall be per the StarNet definition. When no slot assignment can be determined and an acknowledgement is requested, the receiving radio shall respond as quickly as possible. The maximum slot width shall be used when a response could be variable in length.	Slot width shall be as specified for AQC-ALE StarNet call, A.5.8.2.4.			
ALE – Automatic Link Establishment; AQC – Alternate Quick Call; CRC – Circuit Redundancy Controller; MIL-STD – military standard						

C-49 SUBTEST 49, ALTERNATIVE QUICK CALL (AQC)-AUTOMATIC LINK ESTABLISHMENT (ALE) SUBTEST

C-49.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 51, 52, 189, 190, 191, 192, 193, 194, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, and 206.

C-49.2 Criteria

a. In the optional AQC-ALE protocol, the system shall be capable of variable dwell rates while scanning such that traffic can be detected in accordance with table C-49.1, MIL-STD-188-141B, paragraph A.4.2.1.1.

Table C-49.1. Probability of Linking

Probability of Linking	Signal-to-Noise Ratio (Decibel in 3 Kilohertz)		
	Gaussian Noise Channel	Modified CCIR Good Channel	Modified CCIR Poor Channel
≥ 25%	-2.5	+0.5	+1.0
≥ 50%	-1.5	+2.5	+3.0
≥ 85%	-0.5	+5.5	+6.0
≥ 95%	0.0	+8.5	+11.0
Multipath (millisecond)	0.0	0.52	2.2
Doppler spread (hertz)	0.0	0.10	1.0
Legend: CCIR - International Radio Consultative Committee			

b. Radios equipped with the optional AQC-ALE shall provide scanning at scan rates of two channels per second or five channels per second for backward compatibility to non-AQC-ALE networks, MIL-STD-188-141B, paragraph A.4.2.1.2.

c. The AQC-ALE signaling structure is identical to that described previously in this appendix, except as provided below and in the remaining subsections of this section:

A Phase Shift Keying (PSK) tone sequence may optionally be inserted between AQC-ALE words during calling handshakes or sounds (see A.5.8.1.6). All compliant implementation of AQC-ALE shall correctly process the AQC-ALE words in calling handshakes and sounds whether or not such PSK tone sequences are present, and whether or not the implementation can extract useful channel data from such PSK tone sequences, MIL-STD-188-141B, paragraph A.5.8.1.

d. The AQC-ALE word shall consist of a three-bit preamble, an address differentiation flag, a 16-bit packed address field, and a 4-bit data exchange field. These fields shall be formatted and used as described in the following paragraphs. Every AQC-ALE word shall have the form shown in figure C-49.1, AQC-ALE word. The data values associated with a particular AQC-ALE word is defined by the context of the frame transmission (see A.5.8.2), MIL-STD-188-141B, paragraph A.5.8.1.1.

e. Addresses shall be from 1 to 6 characters, MIL-STD-188-141B, paragraph A.5.8.1.3.1.

f. The address character set shall be the same ASCII-38 character set as for baseline 2G ALE. [American National Standard Institute (ANSI) X3.4-1986 (1997). Information Systems - Coded Character Sets – 7 Bit American National Standard Code for Information Interchange (7 Bit ASCII)], MIL-STD-188-141B, paragraph A.5.8.1.3.2.

g. AQC-ALE packs the 21 bits representing three address characters in the 38-character ASCII subset into 16 bits. This is performed by assigning an ordinal value between 0 and 39 to each member of the 38-character subset. Base 40 arithmetic is used to pack the mapped data into a 16-bit number. The ASCII characters used for addressing shall be mapped to the values defined in table C-49.2, Address Character Ordinal Values, with character 1's value multiplied by 1600, Character 2’s value multiplied by 40, and Character 3’s value multiplied by 1. The sum of the three values shall be used as the 16-bit packed address (see example below).

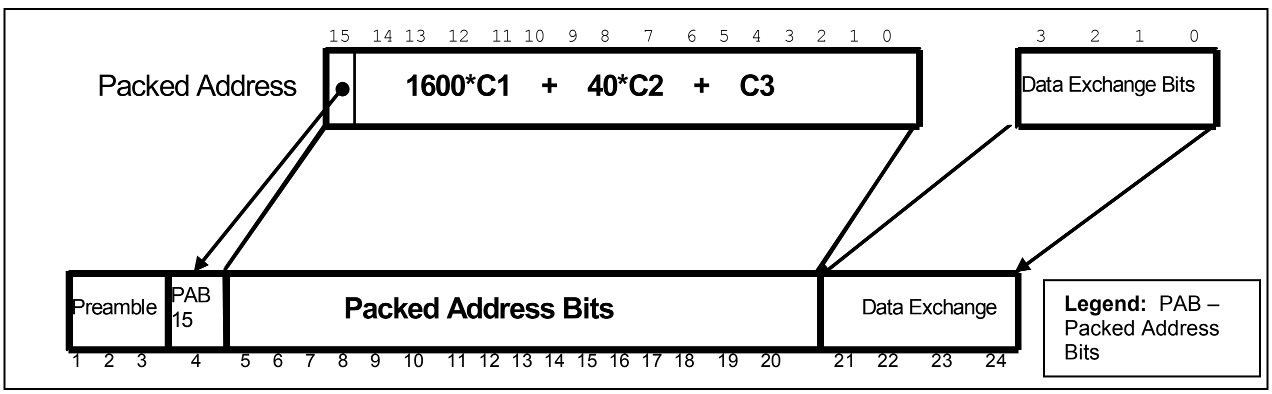

Figure C-49.1. Alternative Quick Call-Automatic Link Establishment Data Exchange Word

Table C-49.2. Alternative Quick Call Address Character Ordinal Value

Character	Value
*	0
0 to 9	1 to 10
?	11
@	12
A to Z	13 to 38
_ (Underscore)	39

Note: The "*" and "_" characters are not part of the standard ALE ASCII-38 character set. These characters shall not be used in station addresses in any network that is required to interoperate with stations that support only baseline 2G ALE.

<u>Example</u>:

Using table C-49.2, the address 'ABC' would be computed as:

(Value('A') * 1600) + (Value('B')* 40) + Value('C')
which is
(13 * 1600) + (14 * 40) + 15 = 21,375

The smallest valued legal address is "000" for a packed value of → 1,641
A legal address such as "ABC" would have a packed value of → 21,375
The largest valued legal address is "ZZZ" for a packed value of → 62,358"
(MIL-STD-188-141B, paragraph A.5.8.1.1.1)

h. Bit 4 of the AQC-ALE word shall be a copy of the most significant bit of the 16-bit packed address. This combination results in no legal address in AQC-ALE being legal in baseline 2G ALE and vice versa. The packed address shall occupy the next 16 bits of the 21-bit data portion of the address, MIL-STD-188-141B, paragraph A.5.8.1.1.2.

i. The preambles shall be as shown in table C-49.3 AQC-ALE word types (and preambles).

Table C-49.3. Alternative Quick Call (AQC)-Automatic Link Establishment (ALE) Word Types (and Preambles)

Word Type	Code Bits	Functions	Significance
INLINK	001	Direct routing	Transaction for linked members.
TO	010		See table A-VIII.
CMD	110		See table A-VIII.
PART2	100	Direct routing	Indicates this is the second part of the full AQC-ALE address.
TIS	101		See table A-VIII, MIL-STD-188-141B.
TWAS	011		See table A-VIII, MIL-STD-188-141B.
DATA	000	Extension of information	Used only in message section to extend information being sent.
REP	111	Duplication and extension of information	Used only in message section to extend information being sent.
Legend: ALE – Automatic Link Establishment; AQC – Alternative Quick Call; MIL-STD – military standard			

(MIL-STD-188-141B, paragraph A.5.8.1.2)

(1) This preamble shall have a binary value of 010 and is functionally identical to the TO preamble in A.5.2.3.2.1. The AQC-ALE TO preamble shall represent the first of two words identifying the address of the station or net, MIL-STD-188-141B, paragraph A.5.8.1.2.1.

(2) This preamble shall have a binary value of 101. The preamble is functionally identical to the TIS preamble in A.5.2.3.2.2. The AQC-ALE TIS preamble identifies the AQC-ALE word as containing the first three characters of the calling or sounding station address, MIL-STD-188-141B, paragraph A.5.8.1.2.2.

(3) This preamble shall have a binary value of 011. This preamble is functionally identical to the TWAS preamble in A.5.2.3.2.3. The AQC-ALE TWAS preamble identifies the AQC-ALE word as containing the first three characters of the calling or sounding station address, MIL-STD-188-141B, paragraph A.5.8.1.2.3.

(4) This preamble shall have a binary value of 100. This preamble is shared with the baseline 2G ALE preamble of FROM. This preamble identifies the second set of three characters in an AQC-ALE address. This preamble shall be used for the second word of every AQC-ALE packed address transmission, MIL-STD-188-141B, paragraph A.5.8.1.2.4.

(5) This preamble shall have a binary value of 001. This preamble is shared with the baseline 2G ALE preamble of THRU. This preamble shall be used by AQC-ALE whenever a transmission to stations already in an established link is required. This preamble identifies the AQC-ALE word as containing the first three characters of the transmitting station address. This preamble may also be used in the

acknowledgement frame of a three-way handshake as described in A.5.8.2.3, MIL-STD-188-141B, paragraph A.5.8.1.2.5.

(6) The CMD word (110) is a special orderwire designator, which shall be used for system-wide coordination, command, control, status, information, interoperation, and other special purposes. CMD shall be used in any combination between ALE stations and operators. CMD is an optional designator, which is used only within the message section of the ALE frame; it shall have (at some time in the frame) a preceding call and a following conclusion, to ensure designation of the intended receivers and identification of the sender. The first CMD terminates the calling cycle and indicates the start of the message section of the ALE frame. The orderwire functions are directed with the CMD itself, or when combined with the REP and DATA words. See A.5.6 for message words (orderwire messages) and functions, MIL-STD-188-141B, paragraph A.5.8.1.2.6.

j. A.5.8.1.3 AQC-ALE address characteristics (NT).

(1) To support an ISDN address requirement, the station shall be capable of mapping any 15-character address to and from a 6-character address for displaying or calling. This optional mapping shall be available for at least one Self-Address and all programmed Other Addresses in the radio, MIL-STD-188-141B, paragraph A.5.8.1.3.3.

(2) A two AQC-ALE word sequence shall be broadcast for any AQC-ALE address. The @ shall be used as the stuff character to complete an address that contains fewer than six characters. The sequence shall be an AQC-ALE word with the preamble TO, TIS, TWAS, or INLINK for the first three characters of the address followed by an AQC-ALE word with the preamble PART2 for the last three address characters, MIL-STD-188-141B, paragraph A.5.8.1.3.4.

k. A.5.8.1.4 Address formats by call type.

(1) A unit or other address shall be from one to six characters, MIL-STD-188-141B, paragraph A.5.8.1.4.1.

(2) A StarNet address shall be from one to six characters, MIL-STD-188-141B, paragraph A.5.8.1.4.2.

(3) AQC-ALE AllCall address shall be six characters. The second three characters of the AllCall address shall be the same as the first three characters. Thus, a global AllCall sequence would look like: (MIL-STD-188-141B, paragraph A.5.8.1.4.4)

“TO-**@?@**|PART2-**@?@**."

(4) AQC-ALE AnyCall address shall be six characters. The second three characters of the AnyCall address shall be the same as the first three characters. Thus, a global AnyCall sequence would look like: (MIL-STD-188-141B, paragraph A.5.8.1.4.5).

"TO-**@@?**|PART2-**@@?**."

C-49.3 Test Procedures

a. Test Equipment Required.

(1) PC with Soundcard

(2) Receiver monitoring 12.000 MHz, USB

(3) Attenuators

(4) Tee Connector

(5) UUT plus one additional outstation

b. Test Configuration. Configure the equipment as shown in figure C-49.2.

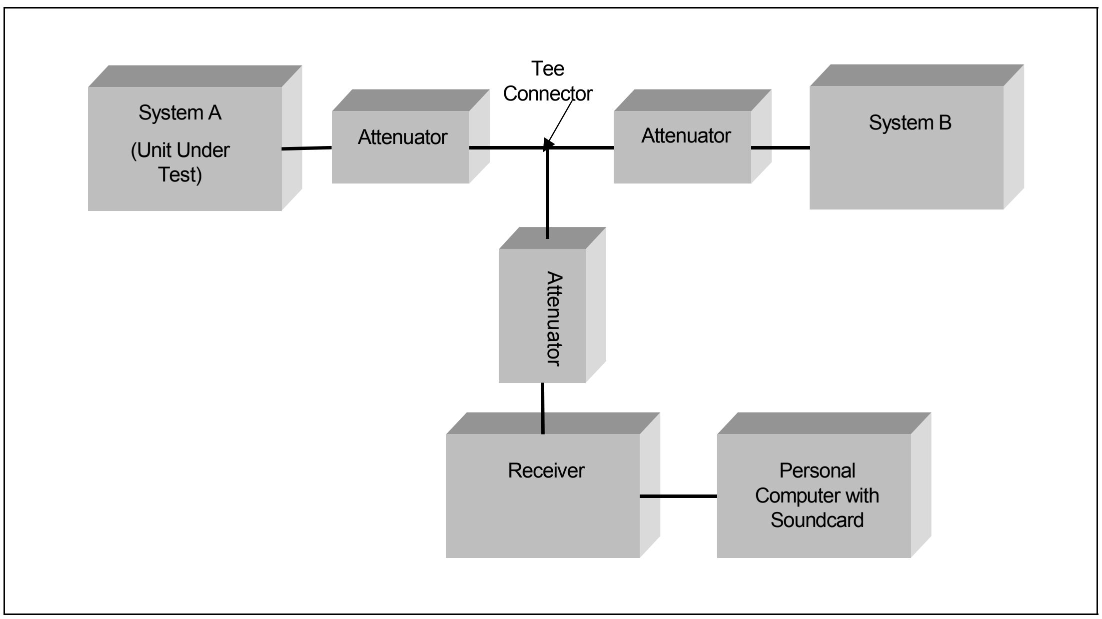

Figure C-49.2. Alternative Quick Call Configuration

c. Test Conduct

(1) The procedures in table C-49.4 will be used to determine scan rate.

Table C-49.4. Procedures for Alternative Quick Call (AQC) Variable Scan Rate

Step	Action	Settings/Action	Result
The following procedure is for reference numbers 51 and 52.			
1	Setup equipment as shown in figure C-49.2. Program radios in accordance with tables C-27.1 through C-27.6.	AQC mode Squelch off All channels will be USB. 10 Channel Scan List. Maximum channels 10 Link Protection – 0 Scan Rate 2 Channels per second.	
2	Connect RF signal generator to receive in connector on the UUT.	Set RF Level to -80 decibels.	
3	Place UUT in SCAN mode.		
4	Monitor the audio output of the UUT.	Measure the time in milliseconds between the audible tone, and record the channels per second by dividing the measured time by 10.	
5	Program the UUT.	Scan rate 5 channels per second.	
6	Monitor the audio output of the UUT.	Measure the time in milliseconds between the audible tone, and record the channels per second by dividing the measured time by 10.	
7	Reprogram UUT.	AQC mode Squelch off All channels will be USB. 10 Channel Scan List. Maximum channels 10 Link Protection – 0 Scan Off	
Legend: AQC – Alternative Quick Call; RF – Radio Frequency; UUT – Unit Under Test			

(2) The procedures in table C-49.5 will be used for verifying AQC-ALE addresses and words.

Table C-49.5. Procedures for Verifying Alternative Quick Call (AQC)-Automatic Link Establishment (ALE) Addresses and Words

Step	Action	Description	Recorded Value
The following procedure is for reference numbers 189, 190, 192, 193, 198, 199, and 202.			
1	Program system A with Self Address ABC, and system B with Self Address 111.		
2	Place call from system A to system B.		
3	Capture AQC-ALE call sequence audio tones in WAV format.	Data must be captured at 44.1 kHz, 16 bits, mono.	

Table C-49.5. Procedures for Verifying Alternative Quick Call (AQC)-Automatic Link Establishment (ALE) Addresses and Words (continued)

Step	Action	Description	Recorded Value
4	Use Matlab algorithm given in table C-47.1 step 17 to decode the words of the initial call.	See table C-49.6.	
The following procedure is for reference number 194.			
5	Record decoded bits of the preamble from the first word of initial call.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form (expect 010).	
6	Compare the Pack Bit to Most Significant Bit of the 16 bit packed address.	Decoded bits A4 and A5 on ALE Word Decode Matrix Form should be identical.	
7	Record first 3 characters of the called address from the first word.	Decoded bits A5 to B8 should be 0000011001101001. See table C-49.3 to decode to ASCII.	
8	Is the word Triple Redundant?	Yes/No	
The following procedure is for reference numbers 193, and 197.			
9	Record decoded bits of the preamble from the second word of initial call.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form. (expect 100)	
10	Compare the Pack Bit to Most Significant Bit of the 16-bit packed address.	Decoded bits A4 and A5 on ALE Word Decode Matrix Form should be identical.	
The following procedure is for reference numbers 191, and 200.			
11	Record second 3 characters of the called address from the second word of Initial Call.	Decoded bits A5 to B8 should be 0100110011101100. See table C-49.3 to decode to ASCII.	
12	Is the word Triple Redundant?	Yes/No	
13	Are odd numbered Decoded Words between word 1 and the next to last word the same as Decoded Word 1 in initial call?	Initial Call may be more than 4 words long.	
14	Are even numbered Decoded Words between word 2 and the last word the same as Decoded Word 2 in initial call?	Initial Call may be more than 4 words long.	
15	Record decoded bits of the preamble from the next to last word in initial call.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form. (expect 101)	
16	Compare the Pack Bit to Most Significant Bit of the 16-bit packed address.	Decoded bits A4 and A5 on ALE Word Decode Matrix Form should be identical.	
17	Record first 3 characters of the called address from the next to last word in initial call.	Decoded bits A5 to B8 should be 0101001101111111. See table C-49.3 to decode to ASCII.	
18	Is the word Triple Redundant?	Yes/No	
19	Record decoded bits of the preamble from the last word.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form. (expect 010)	
20	Compare the Pack Bit to Most Significant Bit of the 16-bit packed address.	Decoded bits A4 and A5 on ALE Word Decode Matrix Form should be identical.	

Table C-49.5. Procedures for Verifying Alternative Quick Call (AQC)-Automatic Link Establishment (ALE) Addresses and Words (continued)

Step	Action	Description	Recorded Value
21	Record last 3 characters of the called address from the last word.	Decoded bits A5 to B8 should be 0100110011101100. See table C-49.3 to decode to ASCII.	
22	Is the word Triple Redundant?	Yes/No	
The following procedure is for reference numbers 201 and 203.			
23	Program System A to call address 6L7M8N.		
24	Capture AQC-ALE call sequence audio tones in WAV format.		
25	Decode the words of the initial call.	See table C-49.6.	
26	Record decoded bits of the preamble from the first word.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form. (expect 010)	
27	Compare the Pack Bit to Most Significant Bit of the 16-bit packed address.	Decoded bits A4 and A5 on ALE Word Decode Matrix Form should be identical.	
28	Record first 3 characters of the called address from the first word of initial call.	Decoded bits A5 to B8 should be 0100000000001100. See table C-49.3 to decode to ASCII.	
29	Is the word Triple Redundant?	Yes/No	
30	Record decoded bits of the preamble from the second word of Initial Call.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form. (expect 100)	
31	Compare the Pack Bit to Most Significant Bit of the 16-bit packed address.	Decoded bits A4 and A5 on ALE Word Decode Matrix Form should be identical.	
32	Record second 3 characters of the called address from the second word.	Decoded bits A5 to B8 should be 1001110111000010. See table C-49.3 to decode to ASCII.	
33	Is the word Triple Redundant?	Yes/No	
34	Are odd numbered Decoded Words between word 1 and the next to last word the same as Decoded Word 1 in Initial Call?	Initial Call may be more than 4 words long.	
35	Are even numbered Decoded Words between word 2 and the last word the same as Decoded Word 2 in initial call?	Initial Call may be more than 4 words long.	
The following procedure is for reference number 194.			
36	Record decoded bits of the preamble from the next to last word in initial call.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form. (expect 101)	
37	Compare the Pack Bit to Most Significant Bit of the 16-bit packed address.	Decoded bits A4 and A5 on ALE Word Decode Matrix Form should be identical.	
38	Record first 3 characters of the called address from the next to last word in Initial Call.	Decoded bits A5 to B8 should be 0101001101111111. See table C-49.3 to decode to ASCII.	
39	Is the word Triple Redundant?	Yes/No	

Table C-49.5. Procedures for Verifying Alternative Quick Call (AQC)-Automatic Link Establishment (ALE) Addresses and Words (continued)

Step	Action	Description	Recorded Value
The following procedure is for reference number 197.			
40	Record decoded bits of the preamble from the last word.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form. (expect 100)	
41	Compare the Pack Bit to Most Significant Bit of the 16-bit packed address.	Decoded bits A4 and A5 on ALE Word Decode Matrix Form should be identical.	
42	Record last 3 characters of the called address from the last word.	Decoded bits A5 to B8 should be 0100110011101100. See table C-49.3 to decode to ASCII.	
43	Is the word Triple Redundant?	Yes/No	
44	Program system A with self address ABC.		
The following procedure is for reference number 204.			
45	Program system A to call StarNet Address NA1.		
46	Capture AQC-ALE call sequence audio tones in WAV format.		
47	Decode first two words and last two words of the initial call.	See table C-49.2.	
48	Record decoded bits of the preamble from the first word of initial call.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form. (expect 010, TO)	
49	Record first 3 characters of the called address from the first word of initial call.	Decoded bits A5 to B8 should be 1011000100001010. See table C-49.2 to decode to ASCII.	
50	Record decoded bits of the preamble from the second word of initial call.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form. (expect 100, Part 2)	
51	Record second 3 characters of the called address from the second word of initial call.	Decoded bits A5 to B8 should be 0100110011101100. See table C-49.2 to decode to ASCII.	
52	Program system A with self address ABC.		
The following procedure is for reference number 205.			
53	Place AllCall form system A.		
54	Capture AQC-ALE call sequence audio tones in WAV format.		
55	Decode words 1 and 2 of the initial call.	See table C-49.4.	
56	Record decoded bits of the preamble from the first word.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form. (expect 010, TO)	
57	Record first 3 characters of the called address from the first word.	Decoded bits A5 to B8 should be 0100110011000100. See table C-49.2 to decode to ASCII.	
58	Record decoded bits of the preamble from the second word.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form. (expect 100, Part 2)	
59	Record second 3 characters of the called address from the second word.	Decoded bits A5 to B8 should be 0100110011000100. See table C-49.2 to decode to ASCII.	
60	Program system A with self address ABC.		

Table C-49.5. Procedures for Verifying Alternative Quick Call (AQC)-Automatic Link Establishment (ALE) Addresses and Words (continued)

Step	Action	Description	Recorded Value
The following procedure is for reference number 206.			
61	Place AnyCall from system A.		
62	Capture AQC-ALE call sequence audio tones in WAV format.	See table C-49.2.	
63	Decode words 1 and 2 of the initial call.	See table C-49.3.	
64	Record decoded bits of the preamble from the first word.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form. (expect 010, TO)	
65	Record first 3 characters of the called address from the first word.	Decoded bits A5 to B8 should be 0100110011101011. See table C-49.2 to decode to ASCII.	
66	Record decoded bits of the preamble from the second word.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form. (expect 100, Part 2)	
67	Record second 3 characters of the called address from the second word.	Decoded bits A5 to B8 should be 0100110011101011. See table C-49.2 to decode to ASCII.	
68	Program system A with self address JWC.		
69	Place call from system A to system B.		
70	Record the call termination in WAV format.		
71	Decode words.	See table C-49.2.	
The following procedure is for reference number 196.			
72	Record decoded bits of the preamble from the first word.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form. (expect 011, TWAS)	
73	Record first 3 characters of the called address from the first word.	Decoded bits A5 to B8 should be 1000111100000111. See table C-49.2 to decode to ASCII.	
74	Record decoded bits of the preamble from the second word.	Decoded bits A1 to A3 on ALE Word Decode Matrix Form. (expect 100, Part 2)	
75	Record second 3 characters of the called address from the second word.	Decoded bits A5 to B8 should be 0100110011101100. See table C-49.2 to decode to ASCII.	
Legend: ALE – Automatic Link Establishment; AQC – Alternate Quick Call; ASCII – American Standard Code for Information Interchange; kHz – kilohertz; UUT – Unit Under Test; WAV - Wave			

C-49.4 Presentation of Results. The results will be shown in tabular format (table C-49.6) indicating the requirement, measured value, and finding.

Table C-49.6. Alternative Quick Call (AQC)-Automatic Link Establishment (ALE) Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
51	A.4.2.1.1	Variable scan rates.	Variable scan rates.			
52	A.4.2.1.2	Scan Rates of 2 and 5 channels per second.	2 channels per second 5 channels per second.			
189	A.5.8.1	The AQC-ALE word is encoded differently.	See paragraph A.5.8.1.1.			
190	A.5.8.1.1	The AQC-ALE word shall consist of a 3-bit preamble, and address differentiation flag, a 16-bit packed address field, and a 4-bit Data Exchange field.	Every AQC-ALE word shall have the form shown in figure C-1.			
191	A.5.8.1.1.1	The American Standard Code for Information Interchange (ASCII) characters used for addressing shall be mapped to the values defined in table C-49.3.	See table C-49.3.			
192	A.5.8.1.1.2	Bit 4 of the AQC-ALE word shall be a copy of the most significant bit of the 16-bit packed address.	Bit 4 copy of MSB of packed address.			
193	A.5.8.1.2	The Preambles shall be as shown in table C-49.4.	See table C-49.4.			
194	A.5.8.1.2.1	The TO preamble shall have a binary value of 010.	Is functional-ly identical to "TO" pre-amble in paragraph A.5.2.3.2.1.			
194	A.5.8.1.2.2	The TIS preamble shall have a binary value of 101.	Is functional-ly identical to TIS pre-amble in paragraph A.5.2.3.2.2.			
196	A.5.8.1.2.3	The TWAS preamble shall have a binary value of 011.	Is functional-ly identical to TIS pre-amble in paragraph A.5.2.3.2.3.			

Table C-49.6. Alternative Quick Call (AQC)-Automatic Link Establishment (ALE) Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
197	A.5.8.1.2.4	The PART2 preamble shall have a binary value of 100.	This preamble shall be used for the second word of every AQC-ALE packed address transmission			
198	A.5.8.1.2.5	The InLink preamble shall have a binary value of 001.	001			
199	A.5.8.1.3.1	Addresses shall be from 1 to 6 characters.	1 to 6 characters			
200	A.5.8.1.3.2	The address character set shall be the same ASCII-38 character set as for baseline second generation ALE.	ASCII-38			
201	A.5.8.1.3.3	The station shall be capable of mapping any 15-character address to and from a 6-character address for displaying or calling.	Map 15-character address to and from 6-character address.			
202	A.5.8.1.3.4	A two AQC-ALE word sequence shall be broadcast for any AQC-ALE address. The "@" shall be used as the stuff character to complete an address that contains fewer than six characters.	Applies to words with preambles TO, TIS, TWAS, INLINK, and PART2.			
203	A.5.8.1.4.1	A unit or other address shall be from one to six characters.	1 to 6 characters			
204	A.5.8.1.4.2	A StarNet address shall be from one to six character.	1 to 6 characters			
205	A.5.8.1.4.4	AQC-ALE AllCall Address shall be six characters.	TO @?@ PART2 @?@			
206	A.5.8.1.4.5	AQC-ALE AnyCall Address shall be six characters.	TO @@? PART2 @@?			

Legend: ALE – Automatic Link Establishment; AQC – Alternate Quick Call; ASCII – American Standard Code for Information Interchange; MIL-STD – Military Standard

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C-50 SUBTEST 50, ALTERNATIVE QUICK CALL (AQC)-AUTOMATIC LINK ESTABLISHMENT (ALE) ORDERWIRE FUNCTIONS (OPTIONAL) SUBTEST

C-50.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 233, 234, 235, 236, 237, 238, 239, 240, 241, and 242.

C-50.2 Criteria

a. This optional message section is a means to poll every station to determine if a site is currently manned. The operator must respond to the request for acknowledgement in a timely manner. AMD messages formatted in accordance with table C-50.1 Operator ACK/NAK shall be used to define the values and meaning of the message. When a request for ACK is received, the operator shall have 15 seconds to respond. The ACK message shall be sent immediately as an InLink Event if the operator responds. If no response from the operator occurs the receiving station shall emit an Operator NAK response InLink Event, MIL-STD-188-141B, paragraph A.5.8.3.1.

Table C-50.1. Operator ACK/NAK Command

AMD Message Section Content	Action to be Taken
"REQ"	Receiving station should notify operator that a response to this message is required. The response must occur within 15 seconds.
"ACK"	The operator acknowledges receipt of last InLink event.
"NAK"	The operator failed to respond to the last InLink event.
Legend: ACK – acknowledgement; AMD – Automatic Message Display; NAK – negative-acknowledgement; REQ – request	

b. Table C-50.2 defines the values used to declare a AQC-ALE control message. When sending these commands, all commands in the frame shall be AQC-ALE control messages. Table C-50.1 defines which message types in an AQC-ALE message section are mandatory for all implementations of AQC-ALE and which messages are optional for AQC-ALE implementations.

Table C-50.2. Alternative Quick Call-Automatic Link Establishment Control Message Section Word Sequences

Value	Number of Words	Description	Handle Message Section
0	n	Automatic Message Display Dictionary Message	Mandatory
1	3	Channel Definition	Mandatory
2	1	Slot Assignment	Mandatory
3	1	List Content of Database	Optional
4	1	List Database Activation Time	Optional
5	2	Set Database Activation Time	Optional
6	n	Define Database Content	Optional
7	n	Database Content Listing	Optional

As seen in figure C-50.1, each word with a Command preamble contains a 5-bit Message Identification (MsgId) field to define the type of control message present. Because ALE orderwire functions are still allowed, MsgId values greater than 7 are not allowed, as these would overlap with existing ALE orderwire commands, MIL-STD-188-141B, paragraph A.5.8.3.2.

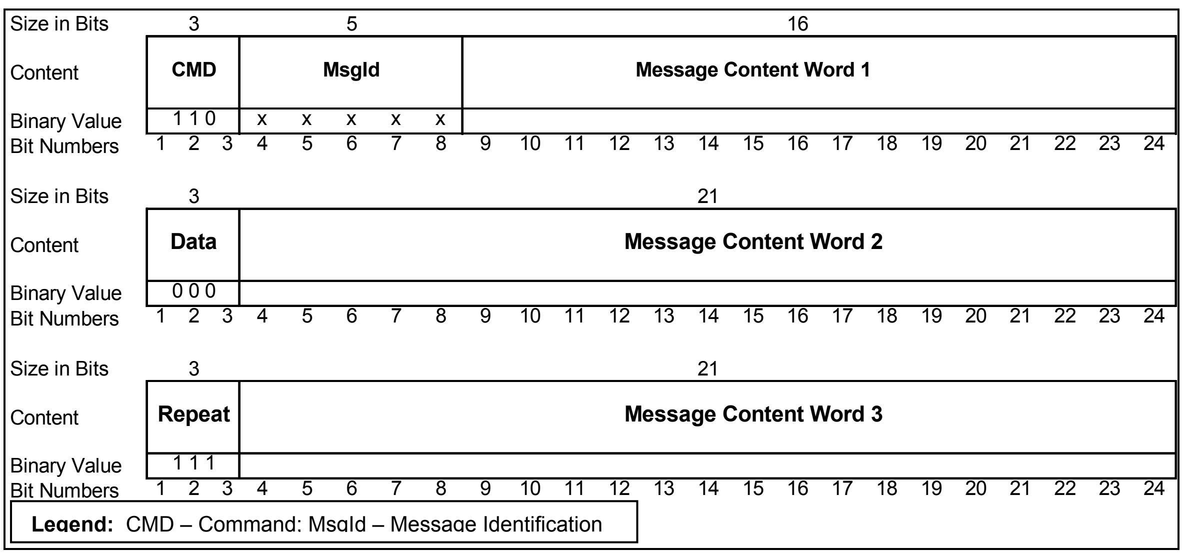

Figure C-50.1. Generalized Alternative Quick Call-Automatic Link Establishment Control Message Format

c. When a message section can be translated into a dictionary and all stations linked are using AQC-ALE, an AMD message may use the dictionary word as provided in table A-XLVIII. Each character in the AMD message will represent itself or a word/phrase found in one of three look-up tables. Because messages are short, when a transmission word is lost, the complete message could be rendered meaningless if a bit-packing approach was used. This method shall consist of a series of 7-bit values. This is the same size as currently used for an AMD message. At a minimum, a radio shall provide lookups for values 2 through 95. A mapped entry can be of any length. Every radio communicating with packed AMD formats must use the same programmed values for words or confusion in the message will result. Messages should be displayed in their unpacked form as looked up or optionally with curly braces around the numeric value of the lookup, i.e. <u>{2.5}</u> would indicate word is in Dictionary Set 2 at index position 5. (See figure C-50.2 for the format of an AQC-ALE Packed AMD message.)

The two dictionary sets provide a means to identify the most frequently used words communication for a mission. Dictionary Set 1 shall be the initial dictionary used for values 96 through 127. When a character with value 1 is received in a Packed AMD Message, then Dictionary Set 2 shall be the word list for character values 96 through 127 until the end of that message or receipt of a character with value 0 in that message, after which Dictionary Set 1 shall again be used, and so on.

Size in Bits	3	5	16			
Content	**CMD**	**MsgId**	**SP**	**SP**	**Look-up 1**	**Look-up 2**
Binary Value	1 1 0	x x x x x	0	0		
Bit Numbers	1 2 3	4 5 6 7 8	9	10	11 12 13 14 15 16 17	18 19 20 21 22 23 24

Size in Bits	3	21		
Content	**Data**	**Look-up 3**	**Look-up 4**	**Look-up 5**
Binary Value	0 0 0			
Bit Numbers	1 2 3	4 5 6 7 8 9 10	11 12 13 14 15 16 17	18 19 20 21 22 23 24

Size in Bits	3	21		
Content	**Repeat**	**Look-up 6**	**Look-up 7**	**Look-up 8**
Binary Value	1 1 1			
Bit Numbers	1 2 3	4 5 6 7 8 9 10	11 12 13 14 15 16 17	18 19 20 21 22 23 24

Legend: CMD – Command; MsgId – Message Identification

Figure C-50.2. Alternative Quick Call-Automatic Link Establishment Dictionary Lookup Message

A network manager might choose to minimize air time and provide some unique information using Dictionary Set 1 by placing tactical user phrases in the dictionary, such as "<u>**AT WAY POINT**</u>". To identify where the a unit is, the AMD message "<u>**AT WAY POINT 1**</u>" would be entered. What would be transmitted in the Packed AMD message would be a 4 TRW InLink event transmission consisting of INLINK, PART2, COMMAND, and REPEAT preambles. That is, the entire message would fit in one COMMAND TRW as:

(1) Message Type = AQC-ALE Packed AMD Message
(2) Look-up 1 = Index into Dictionary Set 1 for "<u>**AT WAY POINT**</u>"
(3) Look-up 2 = the character "<u>**1**</u>"

No spaces are needed because the look-up table transform shall place spaces into the expanded message as defined in table C-50.3.

Table C-50.3. Lookup Tables for Packed Automatic Message Display Messages

ASCII Ordinal Value	Dictionary Set 0 (0 to 31)	ASCII 64 Character Set (32 to 63)	ASCII 64 Character Set (64 to 95)	Dictionary Set 1 (96 to 127)	Dictionary Set 2 (96 to 127)
0	(Use Set 1)	Space	@	Programmable	Programmable
1	(Use Set 2)	!	A	Programmable	Programmable
2	A	"	B	Programmable	Programmable
3	AN	#	C	Programmable	Programmable
4	AND	$	D	Programmable	Programmable
5	ARE	%	E	Programmable	Programmable
6	AS	&	F	Programmable	Programmable
7	BE	'	G	Programmable	Programmable
8	CAN	(	H	Programmable	Programmable
9	EACH	)	I	Programmable	Programmable
10	EAST	*	J	Programmable	Programmable
11	FOR	+	K	Programmable	Programmable
12	FROM	,	L	Programmable	Programmable
13	IN	-	M	Programmable	Programmable
14	IS	.	N	Programmable	Programmable
15	NORTH	/	O	Programmable	Programmable
16	NOT	0	P	Programmable	Programmable
17	OF	1	Q	Programmable	Programmable
18	ON	2	R	Programmable	Programmable
19	OR	3	S	Programmable	Programmable
20	SIZE	4	T	Programmable	Programmable
21	SOUTH	5	U	Programmable	Programmable
22	SYSTEM	6	V	Programmable	Programmable
23	THAT	7	W	Programmable	Programmable
24	THE	8	X	Programmable	Programmable
25	THIS	9	Y	Programmable	Programmable
26	TO	:	Z	Programmable	Programmable
27	USE	;	[	Programmable	Programmable
28	WEST	<	\	Programmable	Programmable
29	WILL	=	]	Programmable	Programmable
30	WITH	>	^	Programmable	Programmable
31	YOU	?	_	Programmable	Programmable
Legend: ASCII – American Standard Code for Information Interchange					

(MIL-STD-188-141B, paragraph A.5.8.3.2.1)

Table C-50.4. Adding Spaces During Automatic Message Display Unpacking

	Message Value is in a Dictionary	**Message Value is in ASCII-64 and not Alphanumeric**	**Message is Value is Alphanumeric**
First Character of Message	No Leading Space	No Leading Space	No Leading Space
Last Expanded Character from Lookup	Add Leading Space	No Leading Space	Add Leading Space
Last Expanded Character is ASCII-64	Add Leading Space	No Leading Space	No Leading Space
Legend: ASCII – American Standard Code for Information Interchange			

d. The channel definition provides a system to reprogram the radio with a different frequency or to cause stations in a link to move to a traffic channel. This allows the radios to listen for general propagation characteristics in a common area and then move to a nearby channel to manage the InLink state transactions. By allowing a channel to be reprogrammed, the radio can adapt to a wide variety of conditions that may occur on a mission. If congestion is experienced on the assigned frequency, the stations shall return to the normal scan list and reestablish the call.

The channel index number is specified from a range of 0 to 255. A radio shall have at least 100 channels available for reprogramming. A channel index of 0 shall indicate that the receive and transmit frequencies are to be used for the remainder of this link. Other channel index numbers indicate that the new assignment shall be entered into the channel table.

Size in Bits	3	5	16		
Content	**CMD**	**MsgId**	**Channel Number 0 - 255**	**Emission Mode**	**Spare**
Binary Value	1 1 0	x x x x x			
Bit Numbers	1 2 3	4 5 6 7 8	9 10 11 12 13 14 15 16	17 18 19 20	21 22 23 24

Size in Bits	3	21
Content	**Data**	**Receive Frequency in 100 Hz Steps**
Binary Value	0 0 0	
Bit Numbers	1 2 3	4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

Size in Bits	3	21
Content	**Repeat**	**Transmit Frequency in 100 Hz Steps**
Binary Value	1 1 1	
Bit Numbers	1 2 3	4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

Legend: CMD – Command; MsgId – Message Identification

Figure C-50.3. Channel Definition and Meet-Me Function

Frequencies shall be specified as a 21-bit values with each step being 100 Hz. See figure C-50.3 for an example format of this message. A 2-bit value 0 for emission mode shall indicate upper side band and a value of 1 shall indicate a value of lower side band. Bits 17-18 refer to the receive frequency, bits 19-20 to the transmit frequency, MIL-STD-188-141B, paragraph A.5.8.3.2.2.

e. The slot assignment feature allows a control station to dynamically assign response slots for stations with which it is linked. In this manner, when a response is required from several stations in an InLink state, orderly responses can be generated. The slot width shall be in Tw. When set to 11 or less, the radio shall respond with the shortest form possible allowing for 5 Tw as timing error. Figure C-50.4 depicts the format of a slot assignment.

Size in Bits	3			5					16															
Content	**CMD**			**MsgId**					**Slot Number**								**Number of TWs in Slot**							
Binary Value	1 1 0			x	x	x	x	x																
Bit Numbers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

Legend: CMD – Command; MsgId – Message Identification; TW – Slot Width Time

Figure C-50.4. Alternative Quick Call-Automatic Link Establishment Slot Assignment

Examples of this usage would be setting up a link to several stations and then periodically polling them with an operator ACK/NAK request or a position report request. Each radio would respond at a specified time following that transmission. This form of time division multiplexing is self-synchronizing to minimize the need for time of day clock synchronization. If more traffic is required on a channel, slot widths can be expanded, MIL-STD-188-141B, paragraph A.5.8.3.2.3.

f. The list content of database (figure C-50.5) shall display the programmable values of a scanning radio such that the receiver can interoperate with that station in the best possible manner. This command requests the contents to be displayed. The Database identifier shall be the ASCII36 character set plus the characters “*” and “_”, MIL-STD-188-141B, paragraph A.5.8.3.2.4.

Size in Bits	3			5					16															
Content	**CMD**			**MsgId**					**Packed ALE Address Indicating Database Identification. This may include the "*" and "_" Characters**															
Binary Value	1 1 0			x	x	x	x	x																
Bit Numbers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

Legend: ALE – Automatic Link Establishment; CMD – command; MsgId – Message Identification

Figure C-50.5. List Content of Database

g. This function requests the time stamp of a database. Its format is identical to that shown in figure C-50.6, MIL-STD-188-141B, paragraph A.5.8.3.2.5.

h. This function (figure C-50.6) sets or displays the time stamp of a database. The first word format of the command is identical to the List Content of Database. The second word contains the time of day that the database is to be active. Only one database shall be active at a time. When the SET bit=1, the command represents the time to assert when the database becomes active. When the SET bit=0, this is a report of the current time set value.

A network control station can program or select preprogrammed channel sets and then causes all mission participants to switch to a new set of channels to operate upon. Other uses would include moving from one area of the world to another that may cause the user to move into a different set of allocated frequencies.

Size in Bits	3	5	16	
Content	**CMD**	**MsgId**	**Packed ALE Address Indicating Database Identification. This may include the "*" and "_" Characters**	
Binary Value	1 1 0	x x x x x		
Bit Numbers	1 2 3	4 5 6 7 8	9 10 11 12 13 14 15 16	17 18 19 20 21 22 23 24

Size in Bits	3	21				
Content	**Data**	**Activation Day**	**Activation Month**	**SET**	**Activation Hour**	**Activation Minute**
Binary Value	0 0 0					
Bit Numbers	1 2 3	4 5 6 7 8	9 10 11 12	13	14 15 16 17 18	19 20 21 22 23 24

Legend: ALE – Automatic Link Establishment; CMD – Command; MsgId – Message Identification

Figure C-50.6. Set Database Activation Time

(MIL-STD-188-141B, paragraph A.5.8.3.6)

i. This function defines a database over-the-air. The first TRW format of the command is identical to the List Content of Database. Subsequent words contain association of existing information into a dataset that the radio may operate against as shown in figure C-50.7.

Size in Bits	3	5	16
Content	**CMD**	**MsgId**	**Packed ALE Address Indicating Database Identification. This may include the "*" and "_" Characters**
Binary Value	1 1 0	x x x x x	
Bit Numbers	1 2 3	4 5 6 7 8	9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

Size in Bits	3	21					
Content	**Data**	**LP Level**	**LLL**	**LP Key Number**	**Spare**	**Number of Channels**	**Spare**
Binary Value	0 0 0						
Bit Numbers	1 2 3	4 5 6	7	8 9 10	11 12 13	14 15 16 17 18	19 20 21 22 23 24

Size in Bits	3	21		
Content	**Repeat**	**Spare**	**Channel Number 1**	**Channel Number 2**
Binary Value	1 1 1			
Bit Numbers	1 2 3	4 5 6 7 8	9 10 11 12 13 14 15 16	17 18 19 20 21 22 23 24

Size in Bits	3	21		
Content	**Data**	**Spare**	**Channel Number 3**	**Channel Number n+3**
Binary Value	0 0 0			
Bit Numbers	1 2 3	4 5 6 7 8	9 10 11 12 13 14 15 16	17 18 19 20 21 22 23 24

Legend: ALE – Automatic Link Establishment; CMD – Command; LP – Link Protection; MsgId – Message Identification

Figure C-50.7. Define Database Content

Word 2 of the message shall consists of:

(1) Three bits of LP Level number. Values range from 0 through 4.

(2) One bit for Lower Level Linking. When set to 1, the radio shall honor lower level link attempts.

(3) Three bits for LP Key number identification. A value of 0 indicates no key assignment. When an LP level greater than 0 exists, this would be an non-operational condition. If more than one type of key is used between LP levels, they must use the same key index. When a radio does not have a key present for a given LP Key, a value of NOKEY shall be used.

(4) Five bits for the number of channels. Immediately following this word shall be (number_of_Channels/2) words containing the channel numbers to use. Earlier commands defining channel numbers or a preprogrammed value define the actual frequencies used.

(5) Six bits for defining the words from a dictionary into the 64 words. The mapping of a dictionary into a database dictionary allows a specific set of words that yield a higher frequency hit rate to the dictionary. A value of 0 indicates using the original programmed dictionary. The mapping of the dictionary is contained in the Trw

that follow the channel association, MIL-STD-188-141B, paragraph A.5.8.3.2.7.

j. This command shall have the same format as the Define Database Content, MIL-STD-188-141B, paragraph A.5.8.3.2.8.

C-50.3 Test Procedures

a. Test Equipment Required

(1) PC with Soundcard

(2) Receiver monitoring 12.000 MHz, USB

(3) Attenuators

(4) UUT plus one additional outstation

(5) Tee Connector

b. Test Configuration. Configure the equipment as shown in figure C-50.8.

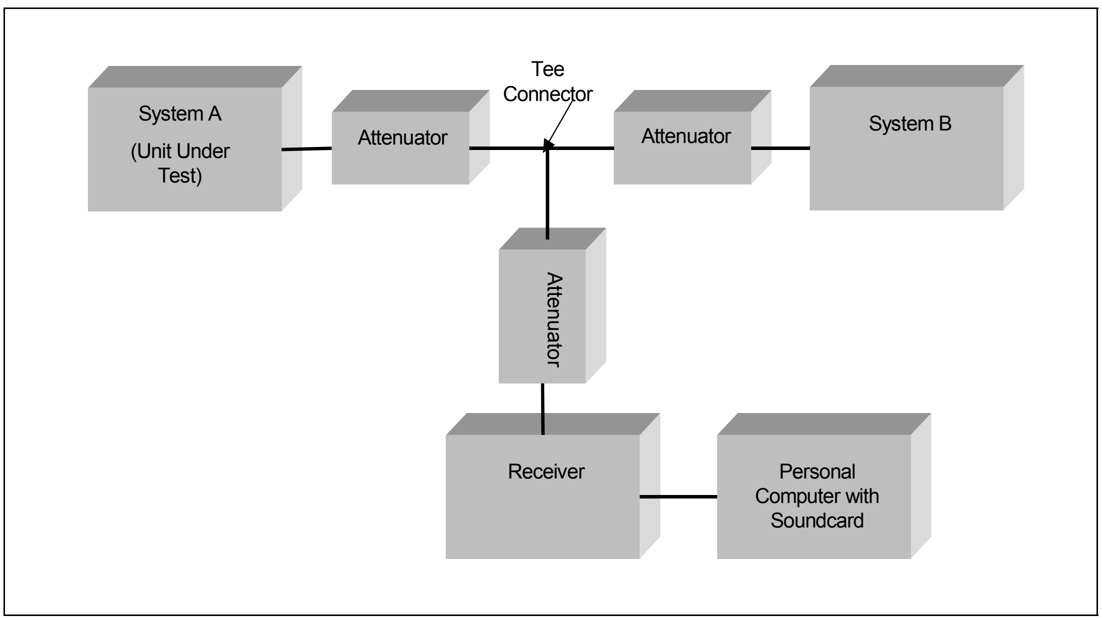

Figure C-50.8. Alternative Quick Call Configuration

c. Test Conduct. Table C-50.5 contains procedures for verifying compliance to standards.

Table C-50.5. Procedures for Verifying Compliance to Orderwire Function Standards

Step	Action	Action/Setting	Result
The following procedure is for reference numbers 233 through 239.			
1	Set up equipment as shown in figure C-50.8.	Establish link between systems A and B.	
2	Place 8 calls/transactions.	Described in table C-50.2.	
3	Capture ALE call sequence audio tones for all 8 calls/transactions in WAV format.	Use PC with soundcard to capture data. Sample at 44.1 kHz, 16 bits, mono.	
4	Use Matlab algorithm from table C-47.1 to decode call with MsgId value 0 "Automatic Message Display (AMD) Dictionary Message."	Use ALE Decode Matrix Form.	
5	Record decoded preamble of the first word.	Expect 110, CMD.	
6	Check space bits.	Bits A9 and A10 on ALE Decode Matrix Form. (expect 00)	
7	Check Look-up 1.	Reference the next 7 bits on the ALE Decode Matrix Form to table C-50.3. Is message correct?	
8	Check the remaining look-up words.	Check results with figure C-50.2. Does radio comply? Are all remaining words sent in message?	
9	Check spaces during AMD unpacking.	See table C-50.4.	

Table C-50.5. Procedures for Verifying Compliance to Orderwire Function Standards (continued)

Step	Action	Action/Setting	Result
10	Decode call with MsgId value 1 "Channel Definition."	Use ALE Decode Matrix Form.	
11	Record preamble of the first word.	Expect 110, CMD.	
12	Record channel number index.	Bits A9 and B4 on ALE Decode Matrix Form (expect 0 to 255).	
13	Record emission mode.	Bits B5 to B8 on ALE Decode Matrix Form.	
14	Record preamble of the next word.	Expect 000, Data.	
15	Record receive frequency.	Bits A4 to B14 on ALE Decode Matrix Form.	
16	Record preamble of the next word.	Expect 111, Repeat.	
17	Record transmit frequency.	Bits A4 to B14 on ALE Decode Matrix Form.	
18	Does call conform?	See figure C-50.3.	
19	Decode call with MsgId value 2 "Slot Assignment."	Use ALE Decode Matrix Form.	
20	Record preamble of the first word.	Expect 110, CMD.	
21	Record slot number.	Bits A9 to B1 on ALE Decode Matrix Form.	
22	Measure and record slot width.	Is measured in triple word? See figure C-50.4.	
23	Decode call with MsgId value 3 "List content of database."	Use ALE Decode Matrix Form.	
24	Record preamble of the first word.	Expect 110, CMD.	
25	Record packed ALE Address.	Bits A9 to B24 on ALE Decode Matrix Form.	
26	Is database identifier in the ASCII 36 character set?	Yes/No	
27	Decode call with MsgId value 4 "List database activation time."	Use ALE Decode Matrix Form.	
28	Record preamble of the first word.	Expect 110, CMD.	
29	Record Packed ALE Address.	Bits A9 to B24 on ALE Decode Matrix Form.	
30	Record preamble of the second word.	Expect 000, Data.	
31	Record Activation Day.	Bits A4 to A8 on ALE Decode Matrix Form.	
32	Record Activation Month.	Bits A9 to A12 on ALE Decode Matrix Form.	
33	Record Set Bit.	Bit B1 on ALE Decode Matrix Form.	
34	Record Activation Hour.	Bits B2 to B6 on ALE Decode Matrix Form.	
35	Record Activation Minute.	Bits B7 to B12 on ALE Decode Matrix Form.	
The following procedure is for reference number 240.			
36	Does call conform?	Yes/No. See figure C-50.6.	
37	Decode call with MsgId value 5 "Set database activation time."	Use ALE Decode Matrix Form.	
38	Record preamble of the first word.	Expect 110, CMD.	
39	Record Packed ALE Address.	Bits A9 to B24 on ALE Decode Matrix Form.	

Table C-50.5. Procedures for Verifying Compliance to Orderwire Function Standards (continued)

Step	Action	Action/Setting	Result
40	Record preamble of the second word.	Expect 000, Data.	
41	Record Activation Day.	Bits A4 to A8 on ALE Decode Matrix Form.	
42	Record Activation Month.	Bits A9 to A12 on ALE Decode Matrix Form.	
43	Record Set Bit.	Bit B1 on ALE Decode Matrix Form.	
44	Record Activation Hour.	Bits B2 to B6 on ALE Decode Matrix Form.	
45	Record Activation Minute.	Bits B7 to B12 on ALE Decode Matrix Form.	
46	Does call conform?	Yes/No. See figure C-50.6.	
47	Decode call with MsgId Value 6 "Define database content."	Use ALE Decode Matrix Form.	
48	Record preamble of the first word.	Expect 110, CMD.	
49	Record Packed ALE Address.	Bits A9 to B24 on ALE Decode Matrix Form.	
50	Record preamble of the second word.	Expect 000, Data.	
51	Record Link Protection (LP) level.	Bits A4 to A8 on ALE Decode Matrix Form.	
52	Record Activation Month.	Bits A4 to A6 on ALE Decode Matrix Form.	
53	Record Lower Level Linking Bit.	Bit A7 on ALE Decode Matrix Form.	
54	Record LP Key Number.	Bits A8 to A10 on ALE Decode Matrix Form.	
55	Record number of channels.	Bits B2 to B6 on ALE Decode Matrix Form.	
56	Record spare bits.	Bits B7 to B12 on ALE Decode Matrix Form.	
57	Record the number of words remaining in the call.	Expect the number of channels divided by 2.	
58	Record preamble of the following words.	Expect Repeat and or Data.	
59	Record the Channel Numbers in the following words.	Bits A9 to B4 and B5 to B12 on the ALE Decode Matrix Form.	
The following procedure is for reference numbers 241 and 242.			
60	Does call conform?	Yes/No. See figure C-50.7.	
61	Decode call with MsgId value 7 "Database content listing."	Use ALE Decode Matrix Form.	
62	Record preamble of the first word.	Expect 110, CMD.	
63	Record Packed ALE Address.	Bits A9 to B24 on ALE Decode Matrix Form.	
64	Record preamble of the second word.	Expect 000, Data.	
65	Record LP level.	Bits A4 to A8 on ALE Decode Matrix Form.	
66	Record Activation Month.	Bits A4 to A6 on ALE Decode Matrix Form.	
67	Record Lower Level Linking bit.	Bit A7 on ALE Decode Matrix Form.	
68	Record LP Key Number.	Bits A8 to A10 on ALE Decode Matrix Form.	

Table C-50.5. Procedures for Verifying Compliance to Orderwire Function Standards (continued)

Step	Action	Action/Setting	Result
69	Record Number of Channels.	Bits B2 to B6 on ALE Decode Matrix Form.	
70	Record spare bits.	Bits B7 to B12 on ALE Decode Matrix Form.	
71	Record the number of words remaining in the call.	Expect the number of channels divided by 2.	
72	Record preamble of the following words.	Expect Repeat and/or Data.	
73	Record the Channel Numbers in the following words.	Bits A9 to B4 and B5 to B12 on the ALE Decode Matrix Form.	
74	Does call conform?	Yes/No. See figure C-50.7.	
Legend: ALE – Automatic Link Establishment; AMD – Automatic Message Display; ASCII – American Standard Code for Information Interchange; CMD – command; LP – Linking Protection; MsgId – Message Identification; PC – Personal Computer; WAV – Wave			

C-50.4 Presentation of Results. The results will be shown in tabular format (table C-50.6) indicating the requirement and measured value or indications of capability.

Table C-50.6. Alternative Quick Call (AQC)-Automatic Link Establishment (ALE) Orderwire Functions Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
233	A.5.8.3.1	The Operator ACK/NAK transaction Command message section is used to poll every station to determine if a site is currently manned.	Requirements of table C-50.1.			
234	A.5.8.3.2	AQC-ALE Control message section.	REQ, ACK, NAK			
235	A.5.8.3.2.1	AMD dictionary message.	Requirements of figure C-28.			
236	A.5.8.3.2.2	The Channel definition provides a system to reprogram the radio with a different frequency or to cause stations in a link to move to a traffic channel.	Frequencies shall be specified as a 21-bit values with each step being 100 hertz.			
237	A.5.8.3.2.3	The slot assignment feature allows a control station to dynamically assign response slots for stations with which it is linked.	The slot width shall be Triple Word. When set to 11 or less, the radio shall respond with the shortest form possible allowing 5 Tw as timing error.			
238	A.5.8.3.2.4	List content of database.	Requirements of figure C-50.1.			
239	A.5.8.3.2.5	List database activation time.	Requirement of figure C-50.2.			

Table C-50.6. Alternative Quick Call (AQC)-Automatic Link Establishment (ALE) Orderwire Functions Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
240	A.5.8.3.2.6	Set database activation time, sets or displays the time stamp of a database.	Requirement of figure C-50.6.			
241	A.5.8.3.2.7	Define database content defines a database over the air.	Requirement of figure C-50.7.			
242	A.5.8.3.2.8	Database content listing.	Requirement of figure C-50.7.			
Legend: ACK – Acknowledgement; ALE – Automatic Link Establishment; AMD – Automatic Message Display; AQC – Alternative Quick Call; MIL-STD – Military Standard; NAK – non-acknowledgement; REQ – request						

C-51 SUBTEST 51, ALTERNATIVE QUICK CALL (AQC)-AUTOMATIC LINK ESTABLISHMENT (ALE) CALLING CYCLE SUBTEST

C-51.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 222.

C-51.2 Criteria

The calling cycle frame is used when the caller is attempting to reach a station that is scanning. Sufficient address words are repeated continuously until the scanning radio has had ample opportunity to stop on the channel. Other receivers, upon hearing an address, may recognize the presence of an ongoing call and skip processing the channel until the handshake is completed.

The calling cycle shall be composed of the target address broadcast for at least the period defined as the call duration for the radio, followed by the target address followed by the caller's (source) address. Data exchange values shall be per the specific type of call being attempted. When the call duration is not evenly divisible by 2 Trw, then an additional full address may be transmitted. When an entire address is not used to complete a fractional portion of the call duration, the caller shall begin the transmission with the second half of the target address using the PART2 preamble. In this case, the Link Protected (LP) word number shall be 1.

When the radio is programmed to automatically derive the call duration, the equation shall be:

Number of Channels * 0.196

Table 1 specifies minimum and maximum number of words used for the scanning cycle section of a call. The total number of words used for calling is four additional words. The unit call time column presents the maximum time to complete a unit call as measured from the first tone transmitted by the caller to the last tone transmitted by the caller in the Acknowledgement frame. Users will see times greater than these due to call setup time, caller tune time, listen before call, and link notification delay; these may add several seconds to the response time seen by a user.

Table C-51.1. Scanning Part Duration Using Automated Calculation

Channels	AQC-ALE Minimum Scan T_{rw}	AQC-ALE Maximum Scan T_{rw}	Call Time in Seconds
1	0	0	4.8
2	1	2	5.6
3	2	2	5.6
4	2	2	5.6
5	3	4	6.4
6	3	4	6.4
7	4	4	6.4
8	4	4	6.4
9	5	6	7.2
10	5	6	7.2
11	6	6	7.2
12	6	6	7.2
13	7	8	8.0
14	7	8	8.0
15	8	8	8.0
16	8	8	8.0
17	9	10	8.8
18	9	10	8.8
19	10	10	8.8
20	10	10	8.8

(MIL-STD-188-141B, paragraph A.5.8.2.1)

C-51.3 Test Procedures

a. Test Equipment Required.

(1) PC with Soundcard

(2) Receiver monitoring 12.000 MHz, USB

(3) Attenuators

(4) Tee Connector

(5) UUT plus one additional outstation

b. Test Configuration. Configure the equipment as shown in figure C-51.1.

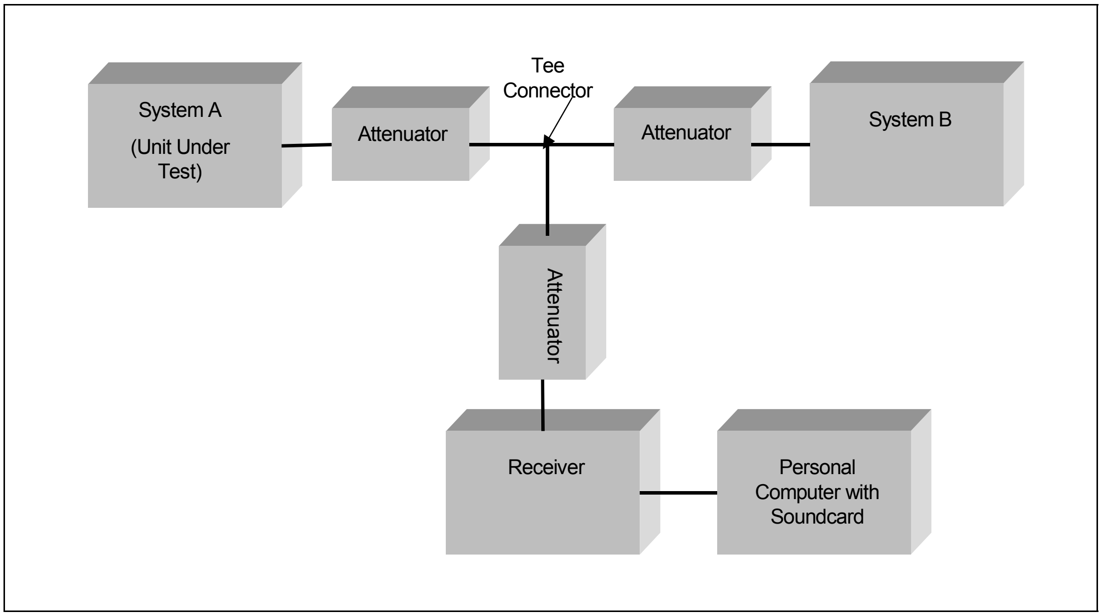

Figure C-51.1. Calling Cycle Subtest Equipment Configuration

c. Test Conduct. Table C-51.2 contains procedures for verifying compliance to standards.

Table C-51.2. Procedures for Timing Calling Cycle

Step	Action	Action/Setting	Results
The following procedure is for reference number 222.			
1	Set up equipment as shown in figure C-51.1.	Program system A with 10 channels in scan list.	
2	Capture ALE call sequence audio tones in WAV format.	Use PC with soundcard. Sample at 44.1 kHz, 16 bits, mono.	
3	Decode all words of the Initial Call using Matlab algorithm from table C-47.1.	See table C-51.1.	
4	Review captured ALE sequence.	Measure and record the time from the first tone of the Initial Call to the last tone of the Initial Call.	
5	Review captured ALE sequence.	Measure and record the time from the first tone of the Initial Call to the last tone of the Acknowledgement. Requirements are that call is less than 7.2 seconds.	
6	Record preambles of first word.	Using ALE Decode Matrix Form. Expect TO or Part2. Note that it is up to the radio designers to have call start with preamble Part2 or To.	

Table C-51.2. Procedures for Timing Calling Cycle (continued)

Step	Action	Action/Setting	Results
7	Record preambles of the remaining words in the Initial Call.	Using ALE Decode Matrix Form.	
8	Record number of words in Initial Call.		
9	Program UUT A.	With 5 channels in scan list.	
10	Capture ALE call sequence audio tones in WAV format.	Use PC with soundcard. Sample at 44.1 kHz, 16 bits, mono.	
11	Decode all words of the Initial Call using Matlab algorithm from table C-47.1 step 17.	See table C-51.1.	
12	Using capture ALE sequence, measure and record.	The time from the first tone of the Initial Call to the last tone of the Initial Call.	
13	Using capture ALE sequence, measure and record.	The time from the first tone of the Initial Call to the last tone of the Acknowledgement. Requirements are that call is less than 6.4 seconds.	
14	Record preambles of first word.	Using ALE Decode Matrix Form. Expect TO or Part2. Note that it is up to the radio designers to have call start with preamble Part2 or To.	
15	Record preambles of the remaining words in the Initial Call.	Using ALE Decode Matrix Form.	
16	Record number of words in Initial Call.		
17	Program UUT A.	With four channels in scan list.	
18	Capture ALE call sequence audio tones in WAV format.	Use PC with soundcard. Sample at 44.1 kHz, 16 bits, mono.	
19	Decode all words of the Initial Call.	See table C-51.1.	
20	Using capture ALE sequence, measure and record.	The time from the first tone of the Initial Call to the last tone of the Initial Call.	
21	Using capture ALE sequence, measure and record.	The time from the first tone of the Initial Call to the last tone of the Acknowledgement. Requirements are that call is less than 5.6 seconds.	

Table C-51.2. Procedures for Timing Calling Cycle (continued)

Step	Action	Action/Setting	Results
22	Record preambles of first word.	Using ALE Decode Matrix Form and Matlab algorithm from table C-47.1 step 17. Expect TO or Part2. Note that it is up to the radio designers to have call start with preamble Part2 or To.	
23	Record preambles of the remaining words in the Initial Call.	Using ALE Decode Matrix Form.	
24	Record number of words in Initial Call.		
Legend: ALE – Automatic Link Establishment; PC – Personal Computer; UUT – Unit Under Test; WAV – Wave			

C-51.4 Presentation of Results. The results will be shown in tabular format (table C-51.3) indicating the requirement and measured value or indications of capability.

Table C-51.3. Calling Cycle Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
222	A.5.8.2.1	The calling cycle shall be composed of the target address broadcast for at least the period defined as the call duration for the radio, followed by the target address followed by the caller's address.	Target address broadcast, target address, caller's address.			
222	A.5.8.2.1	Data exchange values shall be per the specific type of call being attempted.	Per specific type of call			
222	A.5.8.2.1	When the call duration is not evenly divisible by 2 Triple Redundant Words, then an additional full address may be transmitted. When an entire address is not used to complete a fractional portion of the call duration, the caller shall begin the transmission with the second half of the target address using the PART2 preamble. In this case, the Link Protection word number shall be 1.	Not divisible by 2: additional full address transmitted.			
Legend: MIL-STD – Military Standard						

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C-52 SUBTEST 52, ALTERNATIVE QUICK CALL (AQC)-AUTOMATIC LINK ESTABLISHMENT (ALE) DATA EXCHANGE FIELD SUBTEST

C-52.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference number 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, and 221.

C-52.2 Criteria

a. The 4-bit data exchange field shall be encoded as described in table C-52.1 and the following paragraphs. The use of the various encodings DE(1) through (9) shall be as shown in the figures for the Sound, Unit call, StarNet call, AllCall, and AnyCall in the respective subsections of A.5.8.2.

NOTE: A station may use the contents of the data exchange field to further validate the correctness of a given frame.

Table C-52.1. Data Exchange Definitions

	Bit 3	Bit 2	Bit 1	Bit 0	Description
DE(1)	1	1	1	1	No Data Available
DE(2)	x	X	x	x	Number of TOs Left in Calling Cycle Section
DE(3)	x	X	x	x	InLink Resource List Expected
DE(4)	x	X	x	x	Local Noise Index
DE(5)	LQA Variance	0	< LQA Minimum from LQA Mean>		1 bit spare, 3 bits of LQA variance data
DE(6)	x	X	x	x	LQA Measurement Index
DE(7)	x	X	x	x	Number of Tis/Twas left in Sound
DE(8)	Ack This	<# of Command Preambles>			Most Significant Bits of the InLink Transaction Code
DE(9)	I'm InLink	< Transaction Code >			Least significant 4 bits of InLink
Legend: Ack – Acknowledge; DE – Data Exchange; LQA – Link Quality Analysis					

(MIL-STD-188-141B, paragraph A.5.8.1.5)

b. DE(1) shall be sent in the TIS word in the conclusion of a Call frame. All data bits shall be set to 1's, MIL-STD-188-141B, paragraph A.5.8.1.5.1 DE(1) no data available.

c. DE(2) shall be sent in every AQC-ALE word that contains a TO preamble. In a Call frame, the DE(2) field shall indicate the remaining number of TO preambles that remain in the frame. This is an inclusive number and when set to a value of 1 the next address shall be the caller's address using a TIS or TWAS preamble. When the remaining call duration would require a count greater than 15, a count of 15 shall be used.

A value of 0 shall be used in the Response frame and Acknowledgement frame when a single address in required. DE(2) shall count down to 1 whenever multiple addresses are transmitted in an address section, MIL-STD-188-141B, paragraph A.5.8.1.5.2 DE(2) number of TOs left in calling cycle.

d. DE(3) shall be sent in the PART 2 word that follows each TO word. The DE(3) field shall indicate the type of traffic to be conveyed during the InLink state, using the encodings in table C-52.2. Values not specified in the table are reserved and shall not be used until standardized.

Upon receipt of the InLink Resource List in the Call, the called station shall determine whether the station can operate with the desired resource. When responding to the call, the called station shall honor the requested resource whenever possible. If the resource requested is unavailable, the called unit shall respond with an alternate resource that is the best possible alternative resource available to the receiver. This information is provided in the Response frame of a handshake.

By definition, when the calling station enters an InLink state with the called station, the calling station accepted the InLink resource that the called station can provide.

Table C-52.2. InLink Resource List

Value	Meaning	Alternate Resource
0	Clear Voice	15
1	Digital Voice	0
2	High Fidelity Digital (HFD) Voice	1 or 0
3	Reserved	NA
4	Secure Digital Voice	2, 1, 0
5	Secure HFD Voice	4, 2, 1, 0
6	Reserved	NA
7	Reserved	NA
8	ALE Messaging	15
9	PSK Messaging	0 or 15
10	39 Tone Messaging	0 or 15
11	HF Email	9, 8, 0
12	KY-100 Data Security Active	9
13	Reserved	NA
14	Reserved	NA
15	Undeclared Traffic. Usually a mixture.	Always Acceptable
Legend: ALE – Automatic Link Establishment; HF – High Frequency; HFD – High Fidelity Digital; PSK – Phase Shift Keying		

(MIL-STD-188-141B, paragraph A.5.8.1.5.3)

e. DE(4) shall be sent in the PART 2 word that concludes a Call frame and in every PART 2 word in a Sounding frame. The Local Noise Report contains information, which describes the type of local noise at the sender's location. The Local Noise Report provides a broadcast alternative to sounding that permits receiving stations to approximately predict the bilateral link quality for the channel carrying the report. An example application of this technique is networks in which most stations are silent but which need to have a high probability of linking on the first attempt with a base station. A station receiving a Local Noise Report can compare the noise level at the transmitter to its own local noise level, and thereby estimate the bilateral link quality from its own LQA measurement of the received noise report transmission. The report includes a mean and maximum noise power measured on the channel in the past 60 minutes with measurement intervals at least once per minute.

The Local Noise Report shall be formatted as shown in table C-52.3. Units for the Max and Mean fields are dB relative to 0.1 μV 3 kHz noise. The Max noise level shall be the amount of distance from the Mean that the local noise was measured against. When averaging is used, standard rounding rules to the integer shall apply. By comparing the noise levels reported by a distant station on several channels, the station receiving the noise reports can select a channel for linking attempts based upon knowledge of both the propagation characteristics and the interference situation at that destination. For a more detailed local noise report, a station may broadcast the ALE Local Noise Report command in the message section. When deriving the average noise floor, signals that can be recognized shall be excluded from the power measurement.

Table C-52.3. Local Noise Report

Value	Delta Max Noise from Mean	Mean Noise Level
0	0 ≤ Noise < 6 dB	Mean ≤ 6 dB
1	6 ≤ Noise < 12 dB	Mean ≤ 6 dB
2	Noise ≥ 12 dB	Mean ≤ 6 dB
3	0 ≤ Noise < 6 dB	6 < Mean ≤ 15 dB
4	6 ≤ Noise < 12 dB	6 < Mean ≤ 15 dB
5	Noise ≥ 6 dB	6 < Mean ≤ 15 dB
6	0 ≤ Noise < 6 dB	15 < Mean ≤ 40 dB
7	6 ≤ Noise < 12 dB	15 < Mean ≤ 40 dB
8	Noise ≥ 12 dB	15 < Mean ≤ 40 dB
9	0 ≤ Noise < 6 dB	40 < Mean ≤ 60 dB
10	6 ≤ Noise < 12 dB	40 < Mean ≤ 60 dB
11	Noise ≥ 12db	40 < Mean ≤ 60 dB
12	No Definition	60 < Mean ≤ 80 dB
13	No Definition	80 < Mean ≤ 100 dB
14	No Definition	Mean > 100 dB
15	No Data	No Data
Legend: dB – decibels		

(MIL-STD-188-141B, paragraph A.5.8.1.5.4)

f. DE(5) shall be sent in the TIS or TWAS word in the conclusion of AQC-ALE Response and Acknowledgement frames. It shall report the signal quality variation measured on the immediately preceding transmission of the handshake.

Whenever an AQC-ALE or ALE word is received, a signal noise ratio (SNR) sample shall be computed. This measurement can be used to determine the capacity of the channel to handle traffic. Because several types of signaling protocols may be used while in the linked state, it is important that this measurement be applicable to a wide variety of signaling structures. The DE(5) LQA Data Exchange word provides feedback as to the value of the measured signal.

During receipt of a AQC-ALE or ALE signal, an SNR measurement shall be taken at least every Tw (non-redundant word period). Three characteristics shall be collected:

(1) a Mean SNR signal shall be derived.

(2) a Minimum SNR value during the frame shall be recorded.

(3) rapid Change Boolean, when set 1, shall indicate more than 40 percent of the measurements varied greater than ±3 dB from the mean SNR. Items (2) and (3) of the LQA calculation are reported in this data exchange field. This field shall be set to all 1's when the LQA measurement value in DE(6) indicates that no SNR value was taken. Table C-52.4 shall be used to encode the magnitude of lowest value SNR difference from the Mean.

Table C-52.4. Magnitude of Minimum Signal-to-Noise Ratio (SNR) from Mean SNR

Value	Magnitude from SNR Mean
0	difference <= 6 decibels (dB)
1	6 < difference <= 12 dB
2	12 < difference <= 18 dB
3	> 18 dB drop from SNR Mean
Legend: dB – decibels; SNR – Signal-to-Noise Ratio	

(MIL-STD-188-141B, paragraph A.5.8.1.5.5 DE(5) LQA variation)

g. DE(6) shall be sent in the PART 2 word in the conclusion of AQC-ALE Response and Acknowledgement frames. The Link Quality Measurement contains the predicted quality of the channel to handle traffic. This value may be used as a first approximation to setting data rates for data transmission, determining that propagation conditions could carry voice traffic, or directing the station to continue to search for a better channel. (See A.5.8.1.5.5 for a description of the LQA.) This can also be used to determine which channels are more likely to provide sufficient propagation characteristics for the intended InLink state traffic. Table C-52.5 shall be used to encode the measured mean SNR value. An additional column is provided suggesting possible channel usage for the given SNR value.

Table C-52.5. Link Quality Analysis Scores

Value	Measured SNR	Potential Channel Usage
0	SNR ≤ -6	Choose another channel.
1	-6 < SNR ≤ -3	use 50-to 75-bps data
2	-3 < SNR ≤ 0	use 50-to 75-bps data
3	0 < SNR ≤ 3	use 150-bps data
4	3 < SNR ≤ 6	use 300-bps data
5	6 < SNR ≤ 9	use 300-bps data
6	9 < SNR ≤ 12	use 1200 bps data, could carry voice, digital voice, KY-100 data, secure digital voice
7	12 < SNR ≤ 15	use 1200-bps data, could carry voice
8	15 < SNR ≤ 18	use 2400-bps data, could carry voice
9	18 < SNR ≤ 21	use 2400-bps data, could carry good quality voice, HFD Voice, Secure HFD Voice
10	21 < SNR ≤ 24	use 4800-bps data, could carry high quality voice
11	24 < SNR ≤ 27	use 4800-bps data, could carry poor quality voice
12	27 < SNR ≤ 30	Very high data rates can be supported (9600 baud).
13	30 < SNR ≤ 33	
14	SNR > 33	
15	No Measurement Taken	Value in DE(5) shall be ignored.
Legend: bps – bits per second; DE – Data Exchange; HFD – High Fidelity Digital; SNR – Signal-to-Noise Ratio		

(MIL-STD-188-141B, paragraph A.5.8.1.5.6)

h. While transmitting the sounding frame, DE(7) shall be sent in each TIS/TWAS word to identify the remaining number of TIS/TWAS words that will be transmitted in the frame. This is an inclusive number and when set to a value of 1, only one PART2 word remains in the frame.

When the sound duration would require an initial count greater than 15, a count of 15 shall be used until the count can correctly decrement to 14. From this point, DE(7) shall count down to 1, MIL-STD-188-141B, paragraph A.5.8.1.5.7.

i. InLink event transaction definitions are defined by two data exchange words. DE(8) shall be used when the INLINK preamble is used, while DE(9) shall be used for the second half of the address begun with the INLINK preamble. (MIL-STD-188-141B, paragraph A.5.8.1.5.8)

j. Data Bit 3, ACK-THIS, when set to 1, shall indicate that the stations which are linked to the transmitting station are to generate an ACK InLink message in response to this frame. If the address section of an InLink transaction is present, then only the addressed stations in the link are to respond. The responding station InLink event shall return a NAK if any CRC in the received message fails, otherwise the InLink event shall be an ACK. When Data Bit 3 is set to 0, the transmitting station is broadcasting the information and no response by the receiving stations is required, MIL-STD-188-141B, paragraph A.5.8.1.5.8.1.

k. Data Bits 0-2 represent the number of command sections that are present in the frame. A value of 0 indicates no command sections are present, i.e., the frame is complete when the immediately following PART2 address word is received. A value of 1 indicates that 1 command section is present. Up to seven command sections can be transmitted in one InLink event transaction, MIL-STD-188-141B, paragraph A.5.8.1.5.8.2.

l. Data Bit 3, I'mInlink, when set to 1, shall indicate that the transmitting station will continue to be available for InLink transactions. When set to 0, the station is departing the linked state with all associated stations. It shall be the receiver 's decision to return to scan or perform other overhead functions when a station departs from a link state. All InLink event transactions should set this to '1' when the members of the link are to remain in the linked state.

Valid combinations of data bit ACK-THIS and I'm Inlink are defined in table C-52.6.

Table C-52.6. Valid Combinations of ACK-This and I'm InLink

Ack This Value	I'm InLink Value	Description
0	0	Station departing linked state
0	1	Station remaining in linked state
1	0	Not valid. A station cannot leave a link and expect a response
1	1	Acknowledge this transmission

(MIL-STD-188-141B, paragraph A.5.8.1.5.9.1)

m. Data bits 0-2 represent the type of InLink event that is being transmitted. Table C-52.7 shall be used to encode the types of InLink events. The Operator ACK/NAK and AQC-ALE control message sections are described in A.5.8.3.

Table C-52.7. DE(9) InLink Transaction Identifier

Value	Notes	Meaning	Message Section Count
0		Reserved	0
1		MS_141A Section Definition. Each section shall be terminated with a CRC	1 to 7
2		ACK'ng Last Transaction	0
3		NAK'ng Last Transaction	0
4	(1)	Directed Link Terminate	0
5	(1) (2)	Operator ACK/NAK	1
6	(1) (2)	AQC-ALE Control Message	1 to 7
7		Reserved	0
1. Requires that an address section (To,Part2) was received in the frame. 2. Optional Transaction Code.			

(MIL-STD-188-141B, paragraph A.5.8.1.5.9.2)

n. In any frame of a calling handshake or sounding transmission, the transmitting station may emit an optional PSK tone sequence to provide an early measurement of the channel characteristics relative to a PSK-type signaling waveform, MIL-STD-188-141B, paragraph A.5.8.1.6.

o. The optional PSK tone sequence for link quality may be inserted after the last tone associated with any PART2 AQC-ALE word and prior to the first FSK tone of the following AQC-ALE word (if any). The 26.67-msec PSK tone sequence shall be preceded by 8 msec of guard time and followed by 21.33 msec of guard time, for a total duration of 56 msec (seven symbol periods of the 2G ALE FSK waveform), MIL-STD-188-141B, paragraph A.5.8.1.6.1.

p. The PSK tone sequence shall be identical to the 26.67-msec preamble for Burst Waveform 2 (see subtest 47), MIL-STD-188-141B, paragraph A.5.8.1.6.2.

C-52.3 Test Procedures

a. Test Equipment Required.

(1) PC with Soundcard

(2) Receiver monitoring 12.000 MHz, USB

(3) Attenuators

(4) Tee Connector

(5) UUT with one outstation

b. Test Configuration. Configure the equipment as shown in figure C-52.1.

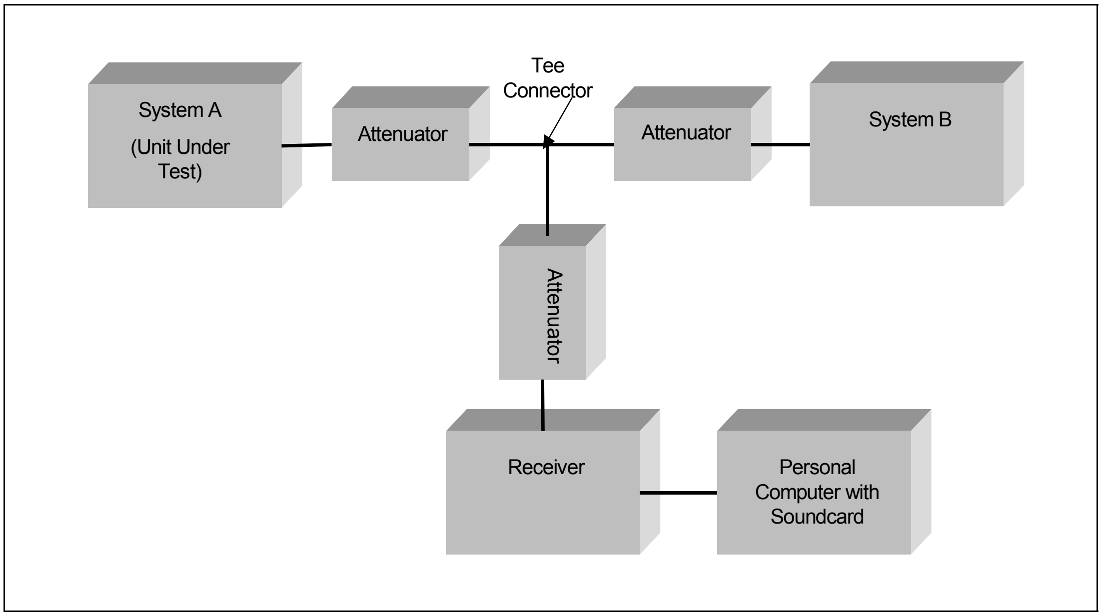

Figure C-52.1. Data Exchange Field Subtest Equipment Configuration

c. Test Conduct. The procedures for this subtest are listed in table C-52.8.

Table C-52.8. Procedures for Verifying Compliance to Data Exchange Field Standards

Step	Action	Action/Setting	Results
The following procedures are for reference numbers 207, and 216 through 221.			
1	Set up equipment as shown in figure C-52.1. Program radios in accordance with tables C-27.1 through C-27.6.	Program system A with Self Address ABC.	
2	Establish link between systems A and B.		
3	Capture ALE call sequence audio tones.	Using the PC with soundcard.	
4	Decode all words of the Initial, Response, and Acknowledgement Calls using the Matlab algorithm from table C-47.1 step 17.		
The following procedure is for reference number 208.			
5	Verify DE bit DE(1).	Locate the word in the Initial Call with preamble TIS. Record bits B9 to B12 on ALE Decode Matrix Form (expect 1111).	

Table C-52.8. Procedures for Verifying Compliance to Data Exchange Field Standards (continued)

Step	Action	Action/Setting	Results
The following procedure is for reference number 209.			
6	Verify DE(2).	Locate the words in the Initial Call with preamble TO. Record bits B9 to B12 on ALE Decode Matrix Form for all words with preamble TO (expect number of TOs that remain in frame unless over 15).	
The following procedure is for reference number 210.			
7	Verify DE(3).	Locate the word in the Initial Call with preamble Part 2 that follows each TO word. Record bits B9 to B12 on ALE Decode Matrix Form. Compare results to table C-52.2.	
The following procedure is for reference number 211.			
8	Verify DE(4).	Locate the word at the end of the Initial Call with preamble Part 2. Record bits B9 to B12 on ALE Decode Matrix Form. Compare results to table C-52.3.	
The following procedure is for reference number 212.			
9	Verify DE(5).	Locate the word in the Response Call with preamble TIS or TWAS. Record bits B9 to B12 on ALE Decode Matrix Form. Compare results to table C-52.4.	
10	Verify DE(5).	Locate the word in the Acknowledgement Call with preamble TIS or TWAS. Record bits B9 to B12 on ALE Decode Matrix Form. Compare results to table C-52.4.	
The following procedure is for reference number 213.			
11	Verify DE(6).	Locate the word in the conclusion of the Response Call with preamble Part 2. Record bits B9 to B12 on ALE Decode Matrix Form. Compare results to table C-52.5.	
12	Verify DE(6).	Locate the word in the conclusion of the Acknowledge Call with preamble Part 2. Record bits B9 to B12 on ALE Decode Matrix Form. Compare results to table C-52.5.	
13	Program system A to make a Sounding Call.		
14	Capture ALE Sounding sequence audio tones in WAV format.		
15	Decode all words.		

Table C-52.8. Procedures for Verifying Compliance to Data Exchange Field Standards (continued)

Step	Action	Action/Setting	Results
16	Verify DE(4).	Locate all the words in the Sounding Call with preamble Part 2. Record bits B9 to B12 on ALE Decode Matrix Form for all these words. Compare results to table C-52.3.	
The following procedure is for reference number 214.			
17	Verify DE(7).	Locate all the words in the Sounding Call with preamble TIS or TWAS. Record bits B9 to B12 on ALE Decode Matrix Form for all these words (expect number of TIS or TWAS that remain in frame unless over 15).	
18	Program UUT A for InLink Call.		
19	Capture ALE Sounding sequence audio tones.	Use PC with soundcard to capture audio tones in WAV format.	
20	Decode all words.	See table C-52.8.	
The following procedure is for reference number 215.			
21	Verify DE(8).	Locate the word in the InLink Call with preamble InLink. Record bits B10 to B12 on ALE Decode Matrix Form. Compare results (MIL-STD-188-141B, paragraph A.5.8.1.5.8, InLink data definition from INLINK).	
22	Verify DE(9).	Locate the word in the InLink Call with preamble Part 2 following word with preamble InLink. Record bits B10 to B12 on ALE Decode Matrix Form. Compare results to table C-52.7.	
23	Verify DE(8) and DE(9).	Compare bit B-9 on words with preamble InLink and Part 2 from steps above to table C-52.6.	
Legend: ALE – Automatic Link Establishment; DE – Data Exchange; Hz – hertz; MIL-STD – Military Standard; PC – Personal Computer; UUT – Unit Under Test			

C-52.4 Presentation of Results. The results will be shown in tabular format (table C-52.9) indicating the requirement and measured value or indications of capability.

Table C-52.9. Results for Alternative Quick Call (AQC)-Automatic Link Establishment (ALE) Data Exchange

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
207	A.5.8.1.5	The 4-bit data exchange (DE) field shall be encoded as described in table A_XXXVIII.	See table C-52.1.			
208	A.5.8.1.5.1	DE(1) shall be sent in the TIS word in the conclusion of a Call frame.	All data bits shall be set to 1s.			
209	A.5.8.1.5.2	DE(2) shall be sent in every AQC-ALE word containing a TO preamble and shall indicate the remaining number of TO preambles in the frame. When a remaining call duration would require a count greater than 15, a count of 15 shall be used.	DE(2)			
210	A.5.8.1.5.3	DE(3) shall be sent in the Part2 word that follows each TO word and shall indicate the type of traffic to be conveyed during the InLink state, using encodings in table AXXXIX.	See table C-52.2.			
211	A.5.8.1.5.4	DE(4) shall be sent in the Part2 word that concludes a Call frame and in every Part2 word in a Sounding frame. The Local Noise Report shall be formatted as shown in figure A.5.8-5.	See table C-52.3.			
212	A.5.8.1.5.5	DE(5) shall be sent in the TIS or TWAS word in the conclusion of AQC-ALE Response and Acknowledgement frames and shall report the signal quality variation measured on the immediately preceding transmission of the handshake.	DE(5)			
212	A.5.8.1.5.5	During receipt of a AQC-ALE or ALE signal, a SNR measurement shall be taken at least every Tw. Three characteristics shall be collected: Mean SNR, Minimum SNR, and Rapid Change Boolean.	Mean SNR, Minimum SNR, and Rapid Change Boolean.			

Table C-52.9. Results for Alternative Quick Call (AQC)-Automatic Link Establishment (ALE) Data Exchange (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
213	A.5.8.1.5.6	DE(6) shall be sent in the Part2 word in the conclusion of AQC-ALE Response and Acknowledgement frames. Table A-XLII shall be used to encode the measured mean SNR value.	See table C-52.5.			
214	A.5.8.1.5.7	In Sounding frame, DE(7) shall be sent in each TIS/TWAS word to identify the remaining number of TWAS/TIS words that will be transmitted in the frame. When the sound duration would require an initial count greater than 15, a count of 15 shall be used until the count can correctly decrement to 14.	DE(7)			
215	A.5.8.1.5.8	DE(8) shall be used when the INLINK preamble is used, while DE(9) shall be used for the second half of the address begun with the INLINK preamble.	DE(8) DE(9)			
216	A.5.8.1.5.8.1	Data Bit 3, ACK-THIS, when set to 1, shall indicate that the stations which are linked to the transmitting station are to generate an ACK InLink message in response to this frame. The responding station InLink event shall return a NAK if any Cyclic Redundancy Check in the received message fails, otherwise the InLink event shall be an ACK.				
217	A.5.8.1.5.8.2	Do Data Bits 0-2 represent the number of command sections that are present in the frame?				
218	A.5.8.1.5.9.1	Data Bit 3, I'mInlink, when set to 1, shall indicate that the transmitting station will continue to be available for InLink transactions. It shall be the receiver's decision to return to scan or perform other overhead functions when a station departs from a link state.				

Table C-52.9. Results for Alternative Quick Call (AQC)-Automatic Link Establishment (ALE) Data Exchange (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
219	A.5.8.1.5.9.2	Table A-XLIV shall be used to encode the typed of InLink events.	See table C-52.7.			
220	A.5.8.1.6.1.	When the optional PSK tone is present, the 26,67 milliseconds (msec) PSK tone sequence shall be preceded by 8 msec of guard time and followed by 21.33 msec of guard time, for a total duration of 56 msec.				
221	A.5.8.1.6.2	The PSK tone sequence shall be identical to the 26.67 msec preamble for Burst Waveform 2.				
Legend: ALE – Automatic Link Establishment; AQC – Automatic Quick Call; DE – Data Exchange; MIL-STD – Military Standard; PSK – Phase Shift Keying; SNR – Signal-to-Noise Ratio						

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C-53 SUBTEST 53, LINKING PROTECTION (LP)

C-53.1 Objective. To determine the extent of compliance to the requirements of MIL-STD-188-141B, reference numbers 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, and 269.

C-53.2 Criteria

a. AQC-ALE linking protection (NT). When operating in LP with AQC-ALE, every 24-bit AQC-ALE word shall be scrambled in accordance with appendix B. The same rules for LP in baseline 2G ALE shall be applied to AQC-ALE with the following exceptions: the word number for all TO AQC-ALE words during the scanning call shall be 0, and the word number for all PART 2 AQC-ALE words during the scanning call shall be 1. The TIS or TWAS word that concludes a scanning call shall use word number 2 and the following PART 2 word shall use word number 3. The AQC-ALE response frame shall use word numbers 0, 1, 2, and 3. A 2-word AQC-ALE acknowledgement shall use word numbers 0 and 1. The Time of Day (TOD) shall be later than that used at the end of the scanning call, MIL-STD-188-141B, paragraph A.5.8.4.

b. LP overview. The LP procedures specified herein shall be implemented as distinct functional entities for control functions and bit randomization functions. (Unless otherwise indicated, distinct hardware for each function is not required.) Figure B-1 shows a conceptual model of the MIL-STD-188-141 data link layer functions, showing the placement within the data link layer at which LP shall be implemented. The linking protection control module (LPCM) shall perform all control functions specified herein and interface to the ALE controller as shown on figure B-2. Scrambler(s) shall perform all cryptographic operations on ALE words, under the control of the LPCM. Use of LP shall neither increase the time to establish a link compared to the non-protected radio, nor degrade the probability of linking below the standard set for non-protected linking in appendix A, table A-II. A means shall be provided to disable the LP functions and operate the radio in the clear unprotected application level (AL-0). Hardware scramblers shall be removable without impairment of the unprotected application level functionality of a radio, MIL-STD-188-141B, paragraph B.4.1.

c. Linking protection application levels (ALs). The ALs of LP are defined herein. The classified application level (AL-4), that offers the highest degree of protection, and the unclassified but sensitive application level (AL-3) use National Security Agency (NSA) controlled algorithms described in classified documents. This standard can only make reference to these documents with very little other descriptive material. All protected radios shall be capable of operation at the unclassified application level (AL-1). A means shall be provided to disable automatic linking at linking protection application levels less secure than the application level in use by the station being called. For example, a station which is operating at unclassified enhanced application level (AL-2) shall be able to disable the receiver from listening for linking attempts at unprotected application level (AL-0) and AL-1. (Design objective (DO): Alert the operator but do not link automatically when a valid call is received from a transmitter with a lower linking protection application level.) This mechanism shall not preclude the operator from manually initiating ALE using a disabled application level. This manual override is required for interoperability, MIL-STD-188-141B, paragraph B.4.1.1.

1. AL-0. Assignment of the AL-0 indicates that no linking protection is being employed. No protection is provided against interfering, unintentional, or malicious linking attempts. All protected HF radios shall be capable of operation in the AL-0 mode, MIL-STD-188-141B, paragraph B.4.1.1.1.

2. AL-1. The AL-1 unclassified application level is mandatory for all protected radio systems, and provides protected interoperability within the U.S. Government. All protected radios shall be capable of operation in the AL-1 mode even if they also provide application levels with greater protection. The AL-1 scrambler shall employ the lattice encryption algorithm as specified in B.5.6, and may be implemented in hardware or software with manufacturer-specified interfaces. This scrambler is for general U.S. Government and commercial use. The AL-1 protection interval (PI) is 60 seconds, which provides slightly lower protection than any of the other available protected modes but allows for relaxed synchronization requirements, MIL-STD-188-141B, paragraph B.4.1.1.2.

3. AL-2. The AL-2 scrambler shall employ the same algorithm as specified for the AL-1 and may be implemented in hardware or software, with manufacturer-specific interfaces. This scrambler is for general U.S. Government and commercial use. The AL-2 PI is 2 seconds, MIL-STD-188-141B, paragraph B.4.1.1.3.

4. AL-3. AL-3 shall use distinct hardware scramblers and shall employ an algorithm and the corresponding interface control document (ICD) developed by the NSA. Systems employing the AL-3 LP shall meet NSA security requirements. The AL-3 PI is a maximum of 2 seconds, MIL-STD-188-141B, paragraph B.4.1.1.4.

5. Classified application level AL-4. AL-4 shall use distinct hardware scramblers and shall employ an algorithm and the corresponding ICD developed by NSA. An AL-4 scrambler may be used to protect classified orderwire traffic. Systems employing classified application level LP shall meet NSA security requirements. The AL-4 PI is a maximum of 1 second, MIL-STD-188-141B, paragraph B.4.1.1.5.

d. TOD. The LPCM requires accurate time and date for use in the LP procedure. The local time base shall not drift more than ±1 second per day when the station is in operation, MIL-STD-188-141B, paragraph B.5.2.2.

e. TOD entry. A means shall be provided for entry of TOD (date and time) via either an operator interface or an electronic fill port or time receiving port (DO: provide both operator interface and electronic port). This interface should also provide for the entry of the uncertainty of the time entered. If time uncertainty is not provided, a default time uncertainty shall be used. Defaults for the various time fill ports may be separately programmable. Default time uncertainty shall be determined by the procuring agency or manufacturer. Default uncertainty of ± 15 seconds is suggested, MIL-STD-188-141B, paragraph B.5.2.2.1.

f. Time exchange protocols. After initialization of TOD, the LPCM shall execute the time protocols of B.5.5 as required, to maintain total time uncertainty less than the PI length of the most secure LP mode it is using. The LPCM shall respond to time requests in accordance with B.5.5.3 unless this function is disabled by the operator, MIL-STD-188-141B, paragraph B.5.2.2.2.

g. Seed format. The LPCM shall maintain randomization information for use by the scrambler(s), and shall provide this information, or "seed," to each scrambler in accordance with the applicable ICD. The 64-bit seed shall contain the frequency, the current PI number, the date, and a word number in the format shown on figure B-3, where the most significant bits of the seed and of each field are on the left. The TOD portion of the seed shall be monotonically non-decreasing. The remaining bits are not so constrained. The date field shall be formatted in accordance with figure B-3. The month field shall contain a 4-bit integer for the current month (1 for January through 12 for December). The day field shall contain a 5-bit integer for the current day of the month (1 through 31). A mechanism shall be provided to accommodate leap years. The PI field shall be formatted in accordance with figure B-3. The coarse time field shall contain an 11-bit integer which counts minutes since midnight (except that temporary discrepancies may occur as discussed in B.5.3). The 6-bit fine time field shall be set to all 1s when time is not known more accurately than within 1 minute (i.e., time quality of six or seven). When a time synchronization protocol (see B.5.5) is employed to obtain more accurate time, the fine time field shall be set to the time obtained using this protocol and incremented as described in B.5.3. The fine time field shall always be a multiple of the PI length, and shall be aligned to PI boundaries (e.g., with a 2-second PI, fine time shall always be even). The word field shall be used to count words within a PI, as specified in B.5.3. The frequency field shall be formatted in accordance with figure B-3. Each 4-bit field shall contain one binary-coded decimal digit of the frequency of the current protected transmission. Regardless of time quality, the fine time field shall be set all 1s for the unclassified application level of LP, MIL-STD-188-141B, paragraph B.5.2.3.

h. Procedure for 2G ALE. The procedure to be employed in protecting transmissions consisting entirely of 24-bit ALE words is presented in B.5.3.1 and B.5.3.2. When a radio is neither transmitting nor receiving, the PI number shall be incremented as follows. When using linking protection level AL-2 and local time quality (see appendix A, A.5.6.4.6) is "5" or better, the fine time field shall be incremented at the end of each PI by the length of the PI, modulo 60. When the fine time field rolls over to "0," the coarse time field shall be incremented, modulo 1440. At midnight, the coarse and fine time fields shall be set to "0," and the date and month fields updated. When using linking protection level AL-1, or when the local time quality (see appendix A, A.5.6.4.6) is “6” or “7,” the fine time field shall contain all “1s,” and the coarse time field shall be incremented once per minute, modulo 1440. At midnight, the coarse time field shall be set to “0”, and the date and month fields updated. Whenever the local time uncertainty is greater than the PI, the system shall:

1. Present an alarm to the operator.
2. Optionally, also attempt resynchronization (if enabled). The first attempt at resynchronization shall use the current fine seed. If this fails, the system shall use a coarse seed for subsequent attempts, MIL-STD-188-141B, paragraph B.5.3.

i. Transmitting station. Each word to be transmitted shall be encrypted by the scrambler using the current seed information. In the course of a transmission, the protocol described below may cause a discrepancy between the TOD fields in the seed and the real time. Such discrepancy shall be allowed to persist until the conclusion of each transmission, whereupon the TOD fields of the seed shall be corrected. The word number field “w” shall be as follows:

1. During the scanning call phase (T_{sc}) of a call, or throughout a sound, the calling stations shall alternate transmission of words encrypted using w = 0 and w = 1. The first word of T_{sc} shall begin with w = 0 or w = 1, as required, such that the last word of T_{sc} is encrypted using w = 1. The TOD used during T_{sc} shall change as required to keep pace with real time, except that TOD shall only change when w = 0. Words encrypted with w = 1 shall use the same TOD as the preceding word.
2. At the beginning of the leading call phase (T_{lc}) of a call (which is the beginning of a single-channel), the first word shall be encrypted using w = 0 and the correct TOD for the time of transmission of that word.
3. All succeeding words of the call shall use succeeding word numbers up to and including $w = w_{max}$. For the word following a word encrypted with $w = w_{max}$, the TOD shall be incremented and w shall be reset to 0.
   (a) W_{max} = 2 for a 1-second PI.
   (b) W_{max} = 5 for a 2-second PI.
   (c) W_{max} = 153 for a 60-second PI.
4. Responses and all succeeding transmissions shall start with w = 0 and the current (corrected) TOD, with these fields incremented as described in paragraph c above for each succeeding word.

Figure B-4 illustrates the permissible TOD with combinations for a transmitting station using a 60-second (w_{max}=153) and a 2-second PI (w_{max} = 5), and the permissible sequences of these combinations. Sounds are protected in the same fashion with T_{rs} in place of T_{lc}, MIL-STD-188-141B, paragraph B.5.3.1.

j. Receiving station. Because of the possibility of acceptable decodes under multiple TOD/word number combinations, receivers shall attempt to decode received words under all allowed combinations (the current and adjacent PIs (future and past), and both w = 0 and w = 1) when attempting to achieve word synchronization with a calling station (six combinations). Stations prepared to accept time requests (see B.5.5.2.2) shall also attempt to decode received words using coarse TOD (fine time = all

1s, correct coarse time only) with both w = 0 and w = 1 (eight combinations total). All valid combinations shall be checked while seeking word sync. After achieving word sync, the number of valid combinations is greatly reduced by the link protection protocol. Figure B-4 illustrates the permissible TOD/w sequences for a receiving station using a 60-second PI and a 2-second PI respectively, after word sync is achieved. Note that unlike the transmitter, the receiving station state machine may be non-deterministic. For example, when in T_{sc} and in state N/1, a received word may yield valid preambles and ASCII when decrypted using all of the valid combinations: N/0, (N + 1)/0, and N/2 (the latter implying that T_{lc} started two words previously), and will therefore, be in three states at once until the ambiguity is resolved by evaluating the decrypted words for compliance with the LP and ALE protocols under the valid successor states to these three states. Stations using a PI of 2 seconds or less shall not accept more than one transmission encrypted using a given TOD, and need not check combinations using that TOD. For example, if a call is decrypted using TOD = N, no TOD before N+1 is valid for the acknowledgement , MIL-STD-188-141B, paragraph B.5.3.2.

k. Data block message (DBM) mode.

1. A DBM data block contains an integral number of 12-bit words, the last of which comprises the least significant 12-bits of a cyclic redundancy check (CRC). These 12-bit words shall be encrypted in pairs, with the first 12-bit word presented to the LPCM by the ALE protocol module as the more significant of the two. When a data block contains an odd number of 12-bit words (i.e., basic DBM data block and extended DBM data blocks with odd N), the final 12-bit word shall not be encrypted, but shall be passed directly to the FEC sublayer.

2. The word number field “w” of the seed shall be incremented only after three pairs of 12-bit words have been encrypted (rather than after every 24-bit word as in normal operation), except that the word number “w” shall be incremented exactly once after the last pair of 12-bit words in a DBM data block is encrypted, whether or not it was the third pair to use that word number. As usual, TOD shall be incremented whenever “w” rolls over to 0, MIL-STD-188-141B, paragraph B.5.3.4.

l. Time protocols. The following shall be employed to synchronize LP time bases. The time service protocols for active time acquisition, both protected (B.5.5.2) and non-protected (B.5.5.3), are mandatory for all implementations of LP, MIL-STD-188-141B, paragraph B.5.5.

m. Time Request call (protected). A station requiring fine time shall request the current value of the network time by transmitting a Time Request call, formatted as follows. (In principle, any station may be asked for the time, but some stations may not be programmed to respond, and others may have poor time quality. Thus, multiple servers may need to be tried before sufficient time quality is achieved.)

TO <time server> CMD Time Is <time> DATA <coarse time>
REP <authenticator> TIS <requester>.

The Time Is command shall be immediately followed by a coarse time word and an authentication word. The authenticator shall be generated by the exclusive-or of the command word and the coarse time word, as specified in appendix A, A.5.6.4.4. The Time Request call transmission shall be protected using the procedure specified in B.5.3.1 and B.5.3.2. When acquiring time synchronization, the coarse seed (fine time field in the seed set to all 1s) current at the requesting station shall be used. When used to reduce the time uncertainty of a station already in time sync, the current fine seed shall be used, MIL-STD-188-141B, paragraph B.5.5.2.1.

n. Time Service response (protected). A station which receives and accepts a Time Request call shall respond with a Time Service response formatted as follows:

TO <requester> CMD Time Is <time> DATA <coarse time>
REP <authenticator> TWAS <time server>.

The Time Is command shall be immediately followed by a coarse time word and an authentication word. The authenticator shall be generated by the three-way exclusive-or of the command word and the coarse time word from this transmission and the authentication word (including the REP preamble) from the requester, as specified in appendix A, A.5.6.4.5. The entire Time Service response shall be protected as specified in B.5.3.1 and B.5.3.2 using the time server's current coarse seed if the request used a coarse seed, or the current fine seed otherwise. The seed used in protecting a Time Service response may differ from that used in the request that caused the response. A time server shall respond only to the first Time Request call using each fine or coarse seed; i.e., one coarse request per minute and one fine request per fine PI. Acceptance of time request may be disabled by the operator. Stations prepared to accept coarse Time Request commands shall decrypt the initial words of incoming calls under eight (vs. six) possible seeds: w = 0 and w = 1 with the current coarse TOD, and with the current fine TOD ±1 PI. (Note that only one coarse TOD is checked vs. three fine TODs), MIL-STD-188-141B, paragraph B.5.5.2.2.

o. Time Server request (protected). A time server may request authenticated time from the original requestor by returning a Time Server request, which is identical to the Time Service response as given above except that the TWAS termination is replaced by TIS. The original requester shall then respond with a Time Service response, as above, with an authenticator generated by the three-way exclusive-or of the command word and the coarse time word from its Time Service response and the authentication word (including the REP preamble) from the Time Server request, as specified in appendix A, A.5.6.4.5., MIL-STD-188-141B, paragraph B.5.5.2.3.

p. Authentication and adjustment (protected). A station awaiting a Time Service response shall attempt to decrypt received words under the appropriate seeds. If the request used a coarse seed, the waiting station shall try the coarse seeds used to encrypt its request, with w = 0 and w = 1, and those corresponding to 1 minute later. If the request used a fine seed, the waiting station shall try the usual six seeds: w = 0 and w = 1, and those corresponding to 1 minute later. If the request used a fine seed, the waiting station shall try the usual six seeds: w = 0 and w = 1 with the current fine TOD ±1 PI. Upon successful decryption of a Time Service response, the requesting station shall exclusive-or the received command and coarse time words with the authentication word it sent in its request. If the 21 least significant bits of the result match the corresponding 21 bits of the received authentication word, the internal time shall be adjusted using the time received in the Time Is command and coarse time word, and the time uncertainty shall be set in accordance with appendix A, A.5.6.4.6., MIL-STD-188-141B, paragraph B.5.5.2.4.

q. Time Request call (non-protected). A station requiring time shall request the current value of the network time by transmitting a non-protected Time Request call, formatted as follows:

TO <time server> CMD Time Request DATA <coarse time>
REP <random #> TIS <requestor>.

The Time Request command shall be immediately followed by a coarse time word, followed by an authentication word containing a 21-bit number, generated by the requesting station in such a fashion that future numbers are not predictable from recently used numbers from any net member. Encrypting a function of a radio-unique quantity and a sequence number that is incremented with each use (and is retained while the radio is powered off) may meet this requirement, MIL-STD-188-141B, paragraph B.5.5.3.1.

r. Time Service response (non-protected). A station that receives and accepts a non-protected Time Request call shall respond with a non-protected Time Service response formatted as follows:

TO <requester> CMD Time Is <time> DATA <coarse time>
REP <authenticator> TWAS <time server>.

The Time Is command shall be immediately followed by a coarse time word and an authentication word. The 21 bit authenticator shall be generated by encrypting the 24-bit result of the three-way exclusive-or of the command word and the coarse time word from this transmission and the entire random number word (including the REP preamble) from the requester, as specified in appendix A, A.5.6.4.5. The encryption shall employ the AL-1 and AL-2 algorithm and a seed containing the time sent and w = all 1s. The least significant 21 bits of this encryption shall be used as the authenticator. A time server shall respond only to the first error-free non-protected Time Request call received each minute (according to its internal time). Acceptance of non-protected time requests may be disabled by the operator, MIL-STD-188-141B, paragraph B.5.5.3.2.

s. Authentication and adjustment (non-protected mode). Upon receipt of a non-protected Time Service response, the requesting station shall exclusive-or the received coarse time word with the received Time Is command word. Then exclusive-or the result with the entire random number word it sent in its Time Request call, and encrypt this result using w = all 1s and the coarse time contained in the Time Service response. If the 21 least significant bits of the result match the corresponding 21 bits of the received authentication word, the internal time shall be adjusted using the received coarse and fine time, and the time uncertainty shall be set in accordance with appendix A, A.5.6.4.6, MIL-STD-188-141B, paragraph B.5.5.3.3.

t. Passive time acquisition (optional). As an alternative to the active time acquisition protocols specified above, stations may attempt to determine the correct network time passively by monitoring protected transmissions. Regardless of the technique used to otherwise accept or reject time so acquired, passive time acquisition shall include the following constraints:

1. Local time may only be adjusted to times within the local window of uncertainty. Received transmissions using times outside of the local uncertainty window shall be ignored.
2. Local time quality shall be adjusted only after receipt of transmissions from at least two stations, both of which include time quality values and whose times are consistent with each other within the windows implied by those time qualities.

A passive time acquisition mechanism may also be used to maintain network synchronization once achieved. Passive time acquisition is optional, and if provided, the operator shall be able to disable it, MIL-STD-188-141B, paragraph B.5.5.4.

u. Time broadcast. To maintain network synchronization, stations shall be capable of broadcasting unsolicited Time Is commands to the network, periodically or upon request by the operator:

TO <net> CMD Time Is <time> DATA <coarse time>
REP <authenticator> TWAS <time server>.

The Time Is command shall be immediately followed by a coarse time word and an authentication word. The authenticator shall be generated by the exclusive-or of the command word and the coarse time word from this transmission as specified in appendix A, A.5.6.4.4. If the broadcast is made without LP (i.e., in the clear), the authenticator must be encrypted as described in appendix A, A.5.6.4.5 to provide any authentication. The use of an authenticator that does not depend on a challenge from a requesting station provides no protection against playback of such broadcasts. A station receiving such broadcasts must verify that the time and the time uncertainty that the broadcasts contain are consistent with the local time and uncertainty before such received time is at all useful, MIL-STD-188-141B, paragraph B.5.5.5.

v. Encryption using the Lattice Algorithm. A schematic representation of the algorithm is shown in figure B-5. The algorithm operates on each of the 3 bytes of the 24-bit word individually. At each step, here termed one “round” of processing, each byte is exclusive-ored with one or both of the other data bytes, a byte of key, and a byte of seed, and the result is then translated using the 256x8 bit substitution table ("S-box") listed in table B-I. Eight rounds shall be performed. Mathematically, the encryption algorithm works as follows:

1. Let f(•) be an invertible function mapping {0..255} -> {0..255}.

2. Let V be a vector of key variable bytes and S be a vector of TOD/frequency "seed" bytes. Starting with the first byte in each of V and S, perform eight "rounds" of the sequence in 4 below, using the next byte from V and S (modulo their lengths) each time a reference to V[ ] and S[ ] is made.

3. Let A be the most significant of the three-byte input to each round of encryption, B be the middle byte, and C be the least significant byte, and A', B', and C' be the corresponding output bytes of each round.

4. Then for each round:

$$A' = f(A + B + V[\ ] + S[\ ])$$
$$C' = f(C + B + V[\ ] + S[\ ])$$
$$B' = f(A' + B + C' + V[\ ] + S[\ ])$$

The 24-bit output of the encryption algorithm consists of, in order of decreasing significance, the bytes A', B', and C' resulting from the eighth round of encryption, MIL-STD-188-141B, paragraph B.5.6.1.

C-53.3 Test Procedures

a. Test Equipment Required

(1) PC with Soundcard

(2) Attenuators

(3) Receiver monitoring 12.000 MHz, USB

(4) UUT plus one additional outstation

(5) Tee Connector

b. Test Configuration. Configure the equipment as shown in figure C-53.1.

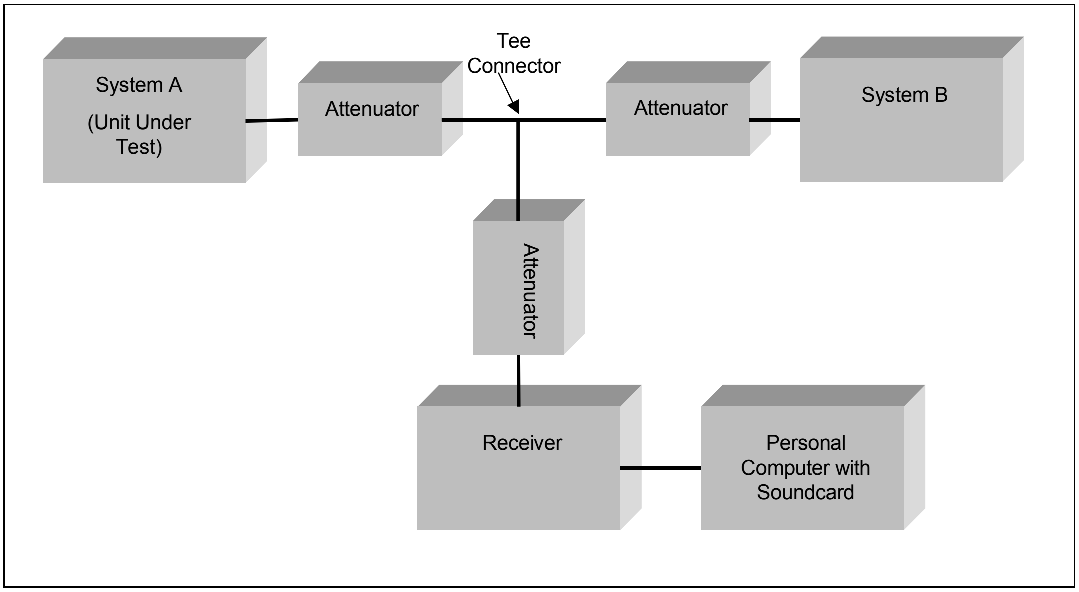

Figure C-53.1. Equipment Configuration for Linking Protection Subtest

c. Test Conduct. Tables C-53.1 and C-53.2 contain procedures for verifying compliance to standards using similar equipment (i.e., System A and B radios from same manufacturer). Tables C-53.3 and C-53.4 contain procedures for verifying compliance to standards using dissimilar equipment (i.e., System A and B radios from different manufacturers).

Table C-53.1. Procedures for Linking Protection AL1 Using Similar Equipment

Step	Action	Settings/Action	Result
1	Set up equipment as shown in figure C-53.1. Program radios in accordance with tables C-27.1 through C-27.6.	See figure C-53.1. Systems A and B radios should be from the same manufacturer.	
2	Configure the PC to record audio files in WAV format.	All WAV files must be sampled at 44.1 kHz, 16 bits, mono.	
The following procedure is for reference numbers 244, 245, 246, 247, and 269.			
3	Initialize the systems for operation in AL0 mode. Use preprogrammed channel information from subtest 27.		
4	Place call. System A (callsign: A01) places individual call (AL0) to system B (callsign: B01). Radios should be scanning channels 1 through 10.	Use PC to record call in WAV format.	
5	Observe systems A and B and record the result of the linking attempt.	Use wave editor software to review the WAV file captured in the previous step. Use this software to measure the length of the call in seconds.	
6	Initialize the systems for operation in AL1 mode. Use preprogrammed channel information from subtest 27.	Enter the equivalent of the following 56-bit key into both radios: 1000000000100000000000000000000000 0000000000000000000000	
7	Ensure that both radios have their “link in lower level” function disabled.		
The following procedure is for reference number 252.			
8	Program correct local date and time into System A. Program System B 2 minutes ahead of System A.	Record the time uncertainty from systems A and B.	
9	Place call. System A (callsign: A01) places individual call (AL1) to System B (callsign: B01). Radios should be scanning channels 1 through 10.	Use PC to record call in WAV format.	
10	Observe systems A and B and record the result of the linking attempt. Expected: No Link	Use wave editor software to review the WAV file captured in the previous step. Use this software to measure the length of the call in seconds.	
11	Program correct local date and time into system A. Program system B 15 seconds ahead of system A.		
12	Place call.	System A (callsign: A01) places individual call (AL1) to system B (callsign: B01). Radios should be scanning channels 1 through 10.	
13	Observe systems A and B and record the result of the linking attempt.	Expected: Successful link	

Table C-53.1. Procedures for Linking Protection AL1 Using Similar Equipment (continued)

Step	Action	Settings/Action	Result
The following procedure is for reference number 256.			
14	Configure system A to send the given AMD message to system B.	Message: TEST2	
15	Place call.	System A (callsign: A01) places AMD call (AL1) to system B (callsign: B01).	
16	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name.	
17	Use ALEOOWPP software to decode the WAV file captured in the previous step.	ALEOOWPP software and instructions are available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	
18	Review decoded AMD call.	Use JITC LP Decode Software to decode the link protected call. This software is available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	
19	Program new key into system B. Do not reprogram system A.	Enter the equivalent of the following 56-bit key into system B: 10100000000000000000000000000000 000000000000000000000000	
20	Place call.	System A (callsign: A01) places individual call (AL1) to system B (callsign: B01). Radios should be scanning channels 1 through 10.	
21	Observe Systems A and B and record the result of the linking attempt.	Expected: No link	
22	Program new key into system A.	Enter the equivalent of the following 56-bit key into system A: 10100000000000000000000000000000 000000000000000000000000	
23	Place system A in AL0. System B should remain in AL1.		
24	Place call.	System A (callsign: A01) places individual call (AL0) to system B (callsign: B01). Radios should be scanning channels 1 through 10.	
25	Observe Systems A and B and record the result of the linking attempt.	Expected: No link	
26	Enable the “link in lower level” function for system B.		
27	Place call.	System A (callsign: A01) places individual call (AL0) to system B (callsign: B01). Radios should be scanning channels 1 through 10.	
28	Observe Systems A and B and record the result of the linking attempt.	Expected: Successful link	

Table C-53.1. Procedures for Linking Protection AL1 Using Similar Equipment (continued)

Step	Action	Settings/Action	Result
The following procedure is for reference number 258.			
29	Configure Systems A and B for operation in DTM mode.	Establish link using AL1.	
30	Send DTM message from system A to system B.	Message: AL1 TEST MESSAGE.	
31	Observe message received by system B.	Record message.	
Legend: AL – Application Level; AMD – Automatic Message Display; DTM – Data Text Message; JITC – Joint Interoperability Test Command; kHz – kilohertz; LP – Linking Protection; PC – Personal Computer; WAV – Wave			

Table C-53.2. Procedures for AL2, AL3, and Time Exchange Using Similar Equipment

Step	Action	Settings/Action	Result
1	Set up equipment.	See figure C-53.1. Systems A and B should be from the same manufacturer.	
2	Configure the PC to record audio files in WAV format.	All WAV files must be sampled at 44.1 kHz, 16 bits, mono.	
3	Initialize the systems for operation in AL1 mode. Use preprogrammed channel information from subtest 27.		
4	Program correct local date and time into system A. Program system B 15 seconds ahead of system A.		
The following procedure is for reference numbers 253, 262, 263, and 268.			
5	Program system A to be the time server for the network.	System A should periodically broadcast the time on all channels in its scan group. Observe system A and record observations.	
6	Observe the action of system B upon receiving a time broadcast from system A.	System B should synchronize its time with system A.	
7	Program system B to also be a time server.	System B should periodically broadcast the time on all channels in its scan group. Observe Systems A and B. Record observations.	
8	At the audio out, use the PC to record the complete set of tones of the time broadcast from system A.	Record file name.	
9	Use ALEOOWPP software to decode the WAV file captured in the previous step.	ALEOOWPP software is available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	
10	Review decoded time broadcast.	Use JITC LP Decode Software to decode the link protected call. This software is available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm. Record actual results.	

Table C-53.2. Procedures for AL2, AL3, and Time Exchange Using Similar Equipment (continued)

Step	Action	Settings/Action	Result
11	Reprogram system A so that it is no longer a time server.		
	The following procedure is for reference number 255.		
12	Leave radios in scan mode and check every hour to measure the time it takes for both radios to lose confidence in the network time and alert the operator that they are out of sync.	Record results.	
	The following procedure is for reference numbers 264 and 265.		
13	Place both radios in AL0.		
14	Program system B (callsign: B01) to request the time from system A (callsign A01).		
15	At the audio out, use the PC to record the complete set of tones of the time exchange.	Record file name.	
16	Use ALEOOWPP software to decode the WAV file captured in the previous step.	ALEOOWPP software is available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	
17	Review decoded time exchange.	Expected decode: TO A01 CMD Time Request DATA <coarse time> REP <random #> TIS B01 TO B01 CMD Time Is <time> DATA <coarse time> REP <authenticator> TWAS A01 Record actual results.	
	The following procedure is for reference numbers 260 and 261.		
18	Place both radios in AL1.		
19	Program system A to request the time from system B.		
20	Observe action of Systems A and B.	Record observations.	
21	At the audio out, use the PC to record the complete set of tones of the time exchange.	Record file name.	
22	Use ALEOOWPP software to decode the WAV file captured in the previous step.	ALEOOWPP software is available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	
23	Review decoded time exchange.	Use JITC LP Decode Software to decode the link protected call. This software is available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm. Record actual results.	
	The following procedure is for reference number 248.		
24	Place Systems A and B in AL2 (if available).		

Table C-53.2. Procedures for AL2, AL3, and Time Exchange Using Similar Equipment (continued)

Step	Action	Settings/Action	Result
25	Place call.	System A (callsign: A01) places individual call (AL2) to system B (callsign: B01). Radios should be scanning channels 1 through 10.	
26	Observe Systems A and B and record the result of the linking attempt.	Radios should link. If link is not established, initiate an unprotected time broadcast from system A, and retry call.	
The following procedure is for reference number 249.			
27	Place Systems A and B in AL3 (if available).		
28	Place call.	System A (callsign: A01) places individual call (AL3) to system B (callsign: B01). Radios should be scanning channels 1 through 10.	
29	Observe Systems A and B and record the result of the linking attempt.	Radios should link. If link is not established, initiate an unprotected time broadcast from system A, and retry call.	
The following procedure is for reference number 251.			
30	Check the accuracy of the UUT's internal clock over a 24-hour period.	Compare accuracy to a known time standard such as WWV. Record time difference in seconds.	Start: End:
The following procedure is for reference number 267.			
31	Place Systems A and B in AL1.	Program system B's time 15 seconds ahead of system A.	
32	Place an individual call from system A to system B.	Observe time difference between Systems A and B to determine if UUT is capable of passive time acquisition.	
Legend: AL – Application Level; JTC – Joint Interoperability Test Command; kHz – kilohertz; LP – Linking Protection; PC – Personal Computer; UUT – Unit Under Test; WAV – Wave			

Table C-53.3. Procedures for Linking Protection AL1 Using Dissimilar Equipment

Step	Action	Settings/Action	Result
1	Set up equipment.	See figure C-53.1. Systems A and B should be made by different manufacturers.	
2	Configure the PC to record audio files in WAV format.	All WAV files must be sampled at 44.1 kHz, 16 bits, mono.	
The following procedure is for reference numbers 244, 245, 246, 247, and 269.			
3	Initialize the systems for operation in AL0 mode. Use preprogrammed channel information from subtest 27.		
4	Place call.	System A (callsign: A01) places individual call (AL0) to system B (callsign: B01). Radios should be scanning channels 1 through 10.	

Table C-53.3. Procedures for Linking Protection AL1 Using Dissimilar Equipment (continued)

Step	Action	Settings/Action	Result
5	Observe systems A and B and record the result of the linking attempt.	Expected: Successful link	
6	Initialize the systems for operation in AL1 mode. Use preprogrammed channel information from subtest 27.	Enter the equivalent of the following 56-bit key into both radios: 1000000000100000000000000000000000000000000000000000000	
7	Ensure that both radios have their "link in lower level" function disabled.		
	The following procedure is for reference number 252.		
8	Program correct local date and time into system A. Program system B 2 minutes ahead of system A.		
9	Place call.	System A (callsign: A01) places individual call (AL1) to system B (callsign: B01). Radios should be scanning channels 1 through 10.	
10	Observe Systems A and B and record the result of the linking attempt.	Expected: No link	
11	Program correct local date and time into system A. Program system B 15 seconds ahead of system A.		
12	Place call.	System A (callsign: A01) places individual call (AL1) to system B (callsign: B01). Radios should be scanning channels 1 through 10.	
13	Observe Systems A and B and record the result of the linking attempt.	Expected: Successful link	
	The following procedure is for reference number 256.		
14	Configure system A to send the given AMD message to system B.	Message: TEST3	
15	Place call.	System A (callsign: A01) places AMD call (AL1) to system B (callsign: B01).	
16	At the audio out, use the PC to record the complete set of tones in WAV format.	Record file name.	
17	Use ALEOOWPP software to decode the WAV file captured in the previous step.	ALEOOWPP software is available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm.	
18	Review decoded AMD call.	Use JITC LP Decode Software to decode the link protected call. This software is available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm. Record actual results.	

Table C-53.3. Procedures for Linking Protection AL1 Using Dissimilar Equipment (continued)

Step	Action	Settings/Action	Result
19	Program new key into system B. Do not reprogram system A.	Enter the equivalent of the following 56-bit key into system B: 101000000000000000000000000000000 00000000000000000000000	
20	Place call.	System A (callsign: A01) places individual call (AL1) to system B (callsign: B01). Radios should be scanning channels 1 through 10.	
21	Observe Systems A and B and record the result of the linking attempt.	Expected: No link	
22	Program new key into system A.	Enter the equivalent of the following 56-bit key into system A: 101000000000000000000000000000000 00000000000000000000000	
23	Place system A in AL0. System B should remain in AL1.		
24	Place call.	System A (callsign: A01) places individual call (AL0) to system B (callsign: B01). Radios should be scanning channels 1 through 10.	
25	Observe Systems A and B and record the result of the linking attempt.	Expected: No link	
	The following procedure is for reference number 245.		
26	Manually initiate an ALE call from system B to system A using AL0.	Observe Systems A and B and record the result of the linking attempt. Expected: Link	
27	Enable the "link in lower level" function for system B.		
28	Place call.	System A (callsign: A01) places individual call (AL0) to system B (callsign: B01). Radios should be scanning channels 1 through 10.	
29	Observe Systems A and B and record the result of the linking attempt.	Expected: Successful link	
	The following procedure is for reference number 258.		
30	Configure Systems A and B for operation in DTM mode.	Establish link using AL1.	
31	Send DTM message from system A to system B.	Message: AL1 TEST MESSAGE.	
32	Observe message received by system B.	Record message.	

Legend: AL – Application Level; AMD – Automatic Message Display; DTM – Data Text Message; kHz – kilohertz; LP – Linking Protection; PC – Personal Computer; WAV – Wave

Table C-53.4. Procedures for AL2, AL3, and Time Exchange Using Dissimilar Equipment

Step	Action	Settings/Action	Result
1	Set up equipment.	See figure C-53.1. Systems A and B should be from different manufacturers.	
2	Configure the personal computer to record audio files in WAV format.	All WAV files must be sampled at 44.1 kHz, 16 bits, mono.	
3	Initialize the systems for operation in AL1 mode. Use preprogrammed channel information from subtest 27.		
4	Program correct local date and time into system A. Program system B 15 seconds ahead of system A.		
The following procedure is for reference numbers 253, 262, 263, and 268.			
5	Program system A to be the time server for the network.	System A should periodically broadcast the time on all channels in its scan group. Observe system A and record observations.	
6	Observe the action of system B upon receiving a time broadcast from system A.	System B should synchronize its time with system A.	
7	Program system B to also be a time server.	System B should periodically broadcast the time on all channels in its scan group. Observe Systems A and B. Record observations.	
8	At the audio out, use the PC to record the complete set of tones of the time broadcast from system A.	Record file name.	
9	Use ALEOOWPP software to decode the WAV file captured in the previous step.	ALEOOWPP software is available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	
10	Review decoded time broadcast.	Use JITC LP Decode Software to decode the link protected call. This software is available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm. Record actual results.	
11	Reprogram system A so that it is no longer a time server.		
The following procedure is for reference number 255.			
12	Leave radios in scan mode and check every hour to measure the time it takes for both radios to lose confidence in the network time and alert the operator that they are out of sync.	Record results.	
The following procedure is for reference numbers 264 and 265.			
13	Place both radios in AL0.		
14	Program system B (callsign: B01) to request the time from system A (callsign A01).		

Table C-53.4. Procedures for AL2, AL3, and Time Exchange Using Dissimilar Equipment (continued)

Step	Action	Settings/Action	Result
15	At the audio out, use the PC to record the complete set of tones of the time exchange.	Record file name.	
16	Use ALEOOWPP software to decode the WAV file captured in the previous step.	ALEOOWPP software is available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	
17	Review decoded time exchange.	Expected decode: TO A01 CMD Time Request DATA <coarse time> REP <random #> TIS B01 TO B01 CMD Time Is <time> DATA <coarse time> REP <authenticator> TWAS A01 Record actual results.	
The following procedure is for reference numbers 260 and 261.			
18	Place both radios in AL1.		
19	Program system A to request the time from system B.		
20	Observe action of Systems A and B.	Record observations.	
21	At the audio out, use the PC to record the complete set of tones of the time exchange.	Record file name.	
22	Use ALEOOWPP software to decode the WAV file captured in the previous step.	ALEOOWPP software is available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	
23	Review decoded time exchange.	Use JITC LP Decode Software to decode the link protected call. This software is available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm. Record actual results.	
The following procedure is for reference number 248.			
24	Place Systems A and B in AL2 (if available).		
25	Place call.	System A (callsign: A01) places individual call (AL2) to system B (callsign: B01). Radios should be scanning channels 1 through 10.	
26	Observe Systems A and B and record the result of the linking attempt.	Radios should link. If link is not established, initiate an unprotected time broadcast from system A, and retry call.	
The following procedure is for reference number 249.			
27	Place Systems A and B in AL3 (if available).		
28	Place call.	System A (callsign: A01) places individual call (AL3) to system B (callsign: B01). Radios should be scanning channels 1 through 10.	

Table C-53.4. Procedures for AL2, AL3, and Time Exchange Using Dissimilar Equipment (continued)

Step	Action	Settings/Action	Result
29	Observe Systems A and B and record the result of the linking attempt.	Radios should link. If link is not established, initiate an unprotected time broadcast from system A, and retry call.	
The following procedure is for reference number 251.			
30	Check the accuracy of the UUT's internal clock over a 24-hour period.	Compare accuracy to a known time standard such as WWV. Record time difference in seconds.	Start: End:
The following procedure is for reference number 267.			
31	Place Systems A and B in AL1.	Program system B's time 15 seconds ahead of system A.	
32	Place an individual call from system A to system B.	Observe time difference between Systems A and B to determine if UUT is capable of passive time acquisition.	
Legend: AL – Application Level; JITC – Joint Interoperability Test Command; kHz – kilohertz; LP – Linking Protection; PC – Personal Computer; UUT – Unit Under Test; WAV – Wave			

C-53.4 Presentation of Results. The results will be shown in tabular format (table C-53.5) indicating the requirement and measured value or indications of capability for similar and dissimilar equipment.

Table C-53.5. Linking Protection Results

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
243	A.5.8.4	AQC-ALE linking protection (NT). When operating in LP with AQC-ALE, every 24-bit AQC-ALE word shall be scrambled in accordance with appendix B. The same rules for LP in baseline 2G ALE shall be applied to AQC-ALE with the following exceptions: The word number for all TO AQC-ALE words during the scanning call shall be 0, and the word number for all PART 2 AQC-ALE words during the scanning call shall be 1. The TIS or TWAS word that concludes a scanning call shall use word number 2 and the following PART 2 word shall use word number 3. The AQC-ALE response frame shall use word numbers 0, 1, 2, and 3. A 2-word AQC-ALE acknowledgement shall use word numbers 0 and 1. The TOD shall be later than that used at the end of the scanning call.	Not tested, procedures under development			

Table C-53.5. Linking Protection Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
244	B.4.1	LP overview. The LP procedures specified herein shall be implemented as distinct functional entities for control functions and bit randomization functions. (Unless otherwise indicated, distinct hardware for each function is not required.) Figure B-1 shows a conceptual model of the MIL-STD-188-141 data link layer functions, showing the placement within the data link layer at which LP shall be implemented. The linking protection control module (LPCM) shall perform all control functions specified herein and interface to the ALE controller as shown on figure B-2. Scrambler(s) shall perform all cryptographic operations on ALE words, under the control of the LPCM. Use of LP shall neither increase the time to establish a link compared to the non-protected radio, nor degrade the probability of linking below the standard set for non-protected linking in appendix A, table A-II. A means shall be provided to disable the LP functions and operate the radio in the clear unprotected application level (AL-0). Hardware scramblers shall be removable without impairment of the unprotected application level functionality of a radio.	AL-0 LP shall not increase time to establish a link. (Probability of linking results from subtest 46.)	Similar: Dissimilar:		

Table C-53.5. Linking Protection Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
245	B.4.1.1	Linking protection application levels. The application levels of LP are defined herein. The classified application level (AL-4), which offers the highest degree of protection, and the unclassified-but-sensitive application level (AL-3) use National Security Agency (NSA) controlled algorithms described in classified documents. This standard can only make reference to these documents with very little other descriptive material. All protected radios shall be capable of operation at the unclassified application level (AL-1). A means shall be provided to disable automatic linking at linking protection application levels less secure than the application level in use by the station being called. For example, a station which is operating at unclassified enhanced application level (AL-2) shall be able to disable the receiver from listening for linking attempts at unprotected application level (AL-0) and AL-1. (Design objective (DO): Alert the operator but do not link automatically when a valid call is received from a transmitter with a lower linking protection application level.) This mechanism shall not preclude the operator from manually initiating ALE using a disabled application level. This manual override is required for interoperability.	AL-1 Disable "link in lower levels". Manually initiate ALE using disabled AL.	Similar: Dissimilar:		
246	B.4.1.1.1	AL-0. Assignment of the AL-0 indicates that no linking protection is being employed. No protection is provided against interfering, unintentional, or malicious linking attempts. All protected HF radios shall be capable of operation in the AL-0 mode.	AL-0	Similar: Dissimilar:		

Table C-53.5. Linking Protection Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
247	B.4.1.1.2	AL-1. The AL-1 unclassified application level is mandatory for all protected radio systems, and therefore, provides protected interoperability within the U.S. Government. All protected radios shall be capable of operation in the AL-1 mode even if they also provide application levels with greater protection. The AL-1 scrambler shall employ the lattice encryption algorithm as specified in B.5.6, and may be implemented in hardware or software with manufacturer-specified interfaces. This scrambler is for general U.S. Government and commercial use. The AL-1 protection interval (PI) is 60 seconds, which provides slightly lower protection than any of the other available protected modes but allows for relaxed synchronization requirements.	AL-1 PI = 60 Seconds Call decodes using JITC LP Decode Software.	Similar: Dissimilar:		
248	B.4.1.1.3	AL-2. The AL-2 scrambler shall employ the same algorithm as specified for the AL-1, and may be implemented in hardware or software, with manufacturer-specific interfaces. This scrambler is for general U.S. Government and commercial use. The AL-2 PI is 2 seconds.	PI = 2 sec Call decodes using JITC LP Decode Software.	Similar: Dissimilar:		
249	B.4.1.1.4	AL-3. AL-3 shall use distinct hardware scramblers and shall employ an algorithm and the corresponding interface control document (ICD) developed by the NSA. Systems employing the AL-3 LP shall meet NSA security requirements. The AL-3 PI is a maximum of 2 seconds.	PI = 2 Seconds Scrambler algorithm not tested, procedure under development	Similar: Dissimilar:		
250	B.4.1.1.5	Classified application level AL-4. AL-4 shall use distinct hardware scramblers and shall employ an algorithm and the corresponding ICD developed by NSA. An AL-4 scrambler may be used to protect classified orderwire traffic. Systems employing classified application level LP shall meet NSA security requirements. The AL-4 PI is a maximum of 1 second.	Not tested, procedures under development			

Table C-53.5. Linking Protection Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
251	B.5.2.2	TOD. The LPCM requires accurate time and date for use in the LP procedure. The local time base shall not drift more than ±1 second per day when the station is in operation.	±1 Second	Similar: Dissimilar:		
252	B.5.2.2.1	TOD entry. A means shall be provided for entry of TOD (date and time) via either an operator interface or an electronic fill port or time receiving port (DO: provide both operator interface and electronic port). This interface should also provide for the entry of the uncertainty of the time entered. If time uncertainty is not provided, a default time uncertainty shall be used. Defaults for the various time fill ports may be separately programmable. Default time uncertainty shall be determined by the procuring agency or manufacturer. Default uncertainty of ± 15 seconds is suggested.	Enter TOD Time Uncertainty	Similar: Dissimilar:		
253	B.5.2.2.2	Time exchange protocols. After initialization of TOD, the LPCM shall execute the time protocols of B.5.5 as required, to maintain total time uncertainty less than the PI length of the most secure LP mode it is using. The LPCM shall respond to time requests in accordance with B.5.5.3 unless this function is disabled by the operator.	Execute time protocols. Respond to Time Request .	Similar: Dissimilar:		

Table C-53.5. Linking Protection Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
254	B.5.2.3	Seed format. The LPCM shall maintain randomization information for use by the scrambler(s), and shall provide this information, or "seed," to each scrambler in accordance with the applicable ICD. The 64-bit seed shall contain the frequency, the current PI number, the date, and a word number in the format shown on figure B-3, where the most significant bits of the seed and of each field are on the left. The TOD portion of the seed shall be monotonically non-decreasing. The remaining bits are not so constrained. The date field shall be formatted in accordance with figure B-3. The month field shall contain a 4-bit integer for the current month (1 for January through 12 for December). The day field shall contain a 5-bit integer for the current day of the month (1 through 31). A mechanism shall be provided to accommodate leap years. The PI field shall be formatted in accordance with figure B-3. The coarse time field shall contain an 11-bit integer which counts minutes since midnight (except that temporary discrepancies may occur as discussed in B.5.3). The 6-bit fine time field shall be set to all 1s when time is not known more accurately than within 1 minute (i.e., time quality of six or seven). When a time synchronization protocol (see B.5.5) is employed to obtain more accurate time, the fine time field shall be set to the time obtained using this protocol and incremented as described in B.5.3. The fine time field shall always be a multiple of the PI length, and shall be aligned to PI boundaries (e.g., with a 2-second PI, fine time shall always be even). The word field shall be used to count words within a PI, as specified in B.5.3. The frequency field shall be formatted in accordance with figure B-3.	Call decodes using JITC LP Decode Software.			

Table C-53.5. Linking Protection Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
255	B.5.3	Procedure for 2G ALE. The procedure to be employed in protecting transmissions consisting entirely of 24-bit ALE words is presented in B.5.3.1 and B.5.3.2. When a radio is neither transmitting nor receiving, the PI number shall be incremented as follows. When using linking protection level AL-2 and local time quality (see appendix A, A.5.6.4.6) is "5" or better, the fine time field shall be incremented at the end of each PI by the length of the PI, modulo 60. When the fine time field rolls over to "0," the coarse time field shall be incremented, modulo 1440. At midnight, the coarse and fine time fields shall be set to "0," and the date and month fields updated. When using linking protection level AL-1, or when the local time quality (see appendix A, A.5.6.4.6) is "6" or "7," the fine time field shall contain all "1s," and the coarse time field shall be incremented once per minute, modulo 1440. At midnight, the coarse time field shall be set to "0", and the date and month fields updated. Whenever the local time uncertainty is greater than the PI, the system shall: a. Present an alarm to the operator. b. Optionally, also attempt resynchronization (if enabled). The first attempt at resynchronization shall use the current fine seed. If this fails, the system shall use a coarse seed for subsequent attempts.	PI number Alarm operator when time uncertainty is greater than PI.	Similar: Dissimilar:		

Table C-53.5. Linking Protection Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
256	B.5.3.1	Transmitting station. Each word to be transmitted shall be encrypted by the scrambler using the current seed information. In the course of a transmission, the protocol described below may cause a discrepancy between the TOD fields in the seed and the real time. Such discrepancy shall be allowed to persist until the conclusion of each transmission, whereupon the TOD fields of the seed shall be corrected. The word number field "w" shall be as follows: a. During the scanning call phase (T_{sc}) of a call, or throughout a sound, the calling stations shall alternate transmission of words encrypted using w = 0 and w = 1. The first word of T_{sc} shall begin with w = 0 or w = 1, as required, such that the last word of T_{sc} is encrypted using w = 1. The TOD used during T_{sc} shall change as required to keep pace with real time, except that TOD shall only change when w = 0. Words encrypted with w = 1 shall use the same TOD as the preceding word. b. At the beginning of the leading call phase (T_{lc}) of a call (which is the beginning of a single-channel), the first word shall be encrypted using w = 0 and the correct TOD for the time of transmission of that word. c. All succeeding words of the call shall use succeeding word numbers up to and including $w = w_{max}$. For the word following a word encrypted with $w = w_{max}$, the TOD shall be incremented and w shall be reset to 0. (1) W_{max} = 2 for a 1-second PI. (2) W_{max} = 5 for a 2-second PI. (3) W_{max} = 153 for a 60-second PI. d. Responses and all succeeding transmissions shall start with w = 0 and the current (corrected) TOD, with these fields incremented as described in paragraph c above for each succeeding word.	Call decodes using JITC LP Decode Software.	Similar:		
				Dissimilar:		

Table C-53.5. Linking Protection Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
257	B.5.3.2	Receiving station. Because of the possibility of acceptable decodes under multiple TOD/word number combinations, receivers shall attempt to decode received words under all allowed combinations (the current and adjacent PIs (future and past), and both w = 0 and w = 1) when attempting to achieve word synchronization with a calling station (six combinations). Stations prepared to accept time requests (see B.5.5.2.2) shall also attempt to decode received words using coarse TOD (fine time = all 1s, correct coarse time only) with both w = 0 and w = 1 (eight combinations total). All valid combinations shall be checked while seeking word sync. After achieving word sync, the number of valid combinations is greatly reduced by the link protection protocol. Figure B-4 illustrates the permissible TOD/w sequences for a receiving station using a 60-second PI and a 2-second PI respectively, after word sync is achieved. Note that unlike the transmitter, the receiving station state machine may be non-deterministic. For example, when in T_{sc} and in state N/1, a received word may yield valid preambles and ASCII when decrypted using all of the valid combinations: N/0, (N + 1)/0, and N/2 (the latter implying that T_{lc} started two words previously), and will therefore be in three states at once until the ambiguity is resolved by evaluating the decrypted words for compliance with the LP and ALE protocols under the valid successor states to these three states. Stations using a PI of 2 seconds or less shall not accept more than one transmission encrypted using a given TOD, and need not check combinations using that TOD. For example, if a call is decrypted using TOD = N, no TOD before N+1 is valid for the acknowledgement.	Not tested (internal function of UUT)			

Table C-53.5. Linking Protection Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
258	B.5.3.4	Data block message (DBM) mode. a. A DBM data block contains an integral number of 12-bit words, the last of which comprises the least significant 12 bits of a cyclic redundancy check (CRC). These 12-bit words shall be encrypted in pairs, with the first 12-bit word presented to the LPCM by the ALE protocol module as the more significant of the two. When a data block contains an odd number of 12-bit words (i.e., basic DBM data block and extended DBM data blocks with odd N), the final 12-bit word shall not be encrypted, but shall be passed directly to the FEC sublayer. b. The word number field "w" of the seed shall be incremented only after three pairs of 12-bit words have been encrypted (rather than after every 24-bit word as in normal operation), except that the word number "w" shall be incremented exactly once after the last pair of 12-bit words in a DBM data block is encrypted, whether or not it was the third pair to use that word number. As usual, TOD shall be incremented whenever "w" rolls over to 0.	Send and Receive DBM Message: AL1 TEST MESSAGE Test procedures under develop-ment.	Similar: Dissimilar:		

Table C-53.5. Linking Protection Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
260	B.5.5.2.1	Time Request call (protected). A station requiring fine time shall request the current value of the network time by transmitting a Time Request call, formatted as follows. (In principle, any station may be asked for the time, but some stations may not be programmed to respond, and others may have poor time quality. Thus, multiple servers may need to be tried before sufficient time quality is achieved.) TO <time server> CMD Time Is <time> DATA <coarse time> REP <authenticator> TIS <requester>. The Time Is command shall be immediately followed by a coarse time word and an authentication word. The authenticator shall be generated by the exclusive-or of the command word and the coarse time word, as specified in appendix A, A.5.6.4.4. The Time Request call transmission shall be protected using the procedure specified in B.5.3.1 and B.5.3.2. When acquiring time synchronization, the coarse seed (fine time field in the seed set to all 1s) current at the requesting station shall be used. When used to reduce the time uncertainty of a station already in time sync, the current fine seed shall be used.	Time request call in accordance with reference number 260.	Similar: Dissimilar:		

Table C-53.5. Linking Protection Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
261	B.5.5.2.2	Time Service response (protected). A station which receives and accepts a Time Request call shall respond with a Time Service response formatted as follows: TO <requester> CMD Time Is <time> DATA <coarse time> REP <authenticator> TWAS <time server>. The Time Is command shall be immediately followed by a coarse time word and an authentication word. The authenticator shall be generated by the three-way exclusive-or of the command word and the coarse time word from this transmission and the authentication word (including the REP preamble) from the requester, as specified in appendix A, A.5.6.4.5. The entire Time Service response shall be protected as specified in B.5.3.1 and B.5.3.2 using the time server's current coarse seed if the request used a coarse seed, or the current fine seed otherwise. The seed used in protecting a Time Service response may differ from that used in the request that caused the response. A time server shall respond only to the first Time Request call using each fine or coarse seed; i.e., one coarse request per minute and one fine request per fine PI. Acceptance of time request may be disabled by the operator. Stations prepared to accept coarse Time Request commands shall decrypt the initial words of incoming calls under eight (vs. six) possible seeds: w = 0 and w = 1 with the current coarse TOD, and with the current fine TOD ±1 PI. (Note that only one coarse TOD is checked vs. three fine TODs.)	Respond to time request in accord-ance with reference number 261.	Similar: Dissimilar:		

Table C-53.5. Linking Protection Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
262	B.5.5.2.3	Time Server request (protected). A time server may request authenticated time from the original requestor by returning a Time Server request, which is identical to the Time Service response as given above except that the TWAS termination is replaced by TIS. The original requester shall then respond with a Time Service response, as above, with an authenticator generated by the three-way exclusive-or of the command word and the coarse time word from its Time Service response and the authentication word (including the REP preamble) from the Time Server request, as specified in appendix A, A.5.6.4.5.	Time Service response.	Similar: Dissimilar:		
263	B.5.5.2.4	Authentication and adjustment (protected). A station awaiting a Time Service response shall attempt to decrypt received words under the appropriate seeds. If the request used a coarse seed, the waiting station shall try the coarse seeds used to encrypt its request, with w = 0 and w = 1, and those corresponding to 1 minute later. If the request used a fine seed, the waiting station shall try the usual six seeds: w = 0 and w = 1, and those corresponding to 1 minute later. If the request used a fine seed, the waiting station shall try the usual six seeds: w = 0 and w = 1 with the current fine TOD ±1 PI. Upon successful decryption of a Time Service response, the requesting station shall exclusive-or the received command and coarse time words with the authentication word it sent in its request. If the 21 least significant bits of the result match the corresponding 21 bits of the received authentication word, the internal time shall be adjusted using the time received in the Time Is command and coarse time word, and the time uncertainty shall be set in accordance with appendix A, A.5.6.4.6.	Internal time adjusted	Similar: Dissimilar:		

Table C-53.5. Linking Protection Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
264	B.5.5.3.1	Time Request call (non-protected). A station requiring time shall request the current value of the network time by transmitting a non-protected Time Request call, formatted as follows: TO <time server> CMD Time Request DATA <coarse time> REP <random #> TIS <requestor>. The Time Request command shall be immediately followed by a coarse time word, followed by an authentication word containing a 21-bit number, generated by the requesting station in such a fashion that future numbers are not predictable from recently used numbers from any net member. Encrypting a function of a radio-unique quantity and a sequence number that is incremented with each use (and is retained while the radio is powered off) may meet this requirement.	TO <time server> CMD Time Request DATA <coarse time> REP <random #> TIS <requestor>.	Similar: Dissimilar:		

Table C-53.5. Linking Protection Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
265	B.5.5.3.2	Time Service response (non-protected). A station that receives and accepts a non-protected Time Request call shall respond with a non-protected Time Service response formatted as follows: TO <requester> CMD Time Is <time> DATA <coarse time> REP <authenticator> TWAS <time server>. The Time Is command shall be immediately followed by a coarse time word and an authentication word. The 21-bit authenticator shall be generated by encrypting the 24-bit result of the three-way exclusive-or of the command word and the coarse time word from this transmission and the entire random number word (including the REP preamble) from the requester, as specified in appendix A, A.5.6.4.5. The encryption shall employ the AL-1 and AL-2 algorithm and a seed containing the time sent and w = all 1s. The least-significant 21 bits of this encryption shall be used as the authenticator. A time server shall respond only to the first error-free non-protected Time Request call received each minute (according to its internal time). Acceptance of non-protected time requests may be disabled by the operator.	TO <requester> CMD Time Is <time> DATA <coarse time> REP <authenticator> TWAS <time server>.	Similar: Dissimilar:		

Table C-53.5. Linking Protection Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
266	B.5.5.3.3	Authentication and adjustment (non-protected mode). Upon receipt of a non-protected Time Service response, the requesting station shall exclusive-or the received coarse time word with the received Time Is command word. Then exclusive-or the result with the entire random number word it sent in its Time Request call, and encrypt this result using w = all 1s and the coarse time contained in the Time Service response. If the 21 least significant bits of the result match the corresponding 21 bits of the received authentication word, the internal time shall be adjusted using the received coarse and fine time, and the time uncertainty shall be set in accordance with appendix A, A.5.6.4.6.	Not tested, internal function of UUT.			

Table C-53.5. Linking Protection Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
267	B.5.5.4	Passive time acquisition (optional). As an alternative to the active time acquisition protocols specified above, stations may attempt to determine the correct network time passively by monitoring protected transmissions. Regardless of the technique used to otherwise accept or reject time so acquired, passive time acquisition shall include the following constraints: a. Local time may only be adjusted to times within the local window of uncertainty. Received transmissions using times outside of the local uncertainty window shall be ignored. b. Local time quality shall be adjusted only after receipt of transmissions from at least two stations, both of which include time quality values, and whose times are consistent with each other within the windows implied by those time qualities. A passive time acquisition mechanism may also be used to maintain network synchronization once achieved. Passive time acquisition is optional, and if provided, the operator shall be able to disable it.	Disable passive time acquisition.	Similar: Dissimilar:		

Table C-53.5. Linking Protection Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
268	B.5.5.5	Time broadcast. To maintain network synchronization, stations shall be capable of broadcasting unsolicited Time Is commands to the network, periodically or upon request by the operator: TO <net> CMD Time Is <time> DATA <coarse time> REP <authenticator> TWAS <time server>. The Time Is command shall be immediately followed by a coarse time word and an authentication word. The authenticator shall be generated by the exclusive-or of the command word and the coarse time word from this transmission as specified in appendix A, A.5.6.4.4. If the broadcast is made without LP (i.e., in the clear), the authenticator must be encrypted as described in appendix A, A.5.6.4.5 to provide any authentication. The use of an authenticator that does not depend on a challenge from a requesting station provides no protection against playback of such broadcasts. A station receiving such broadcasts must verify that the time and the time uncertainty that the broadcasts contain are consistent with the local time and uncertainty before such received time is at all useful.	Broadcast "Time Is" commands	Similar: Dissimilar:		

Table C-53.5. Linking Protection Results (continued)

Reference Number	MIL-STD-188-141B, paragraph	Requirement	Result		Finding	
			Required Value	Observed Value	Met	Not Met
269	B.5.6.1	Encryption using the Lattice Algorithm. A schematic representation of the algorithm is shown in figure B-5. The algorithm operates on each of the 3 bytes of the 24-bit word individually. At each step, here termed one "round" of processing, each byte is exclusive-ored with one or both of the other data bytes, a byte of key, and a byte of seed, and the result is then translated using the 256x8 bit substitution table ("S-box") listed in table B-I. Eight rounds shall be performed. Mathematically, the encryption algorithm works as follows: 1. Let f(•) be an invertible function mapping {0..255} -> {0..255}. 2. Let V be a vector of key variable bytes and S be a vector of TOD/frequency "seed" bytes. Starting with the first byte in each of V and S, perform eight "rounds" of the sequence in 4 below, using the next byte from V and S (modulo their lengths) each time a reference to V[ ] and S[ ] is made. 3. Let A be the most significant of the three-byte input to each round of encryption, B be the middle byte, and C be the least significant byte, and A', B', and C' be the corresponding output bytes of each round. 4. Then for each round, A' = f(A + B + V[ ] + S[ ]) C' = f(C + B + V[ ] + S[ ]) B' = f(A' + B + C' + V[ ] + S[ ]) The 24-bit output of the encryption algorithm consists of, in order of decreasing significance, the bytes A', B', and C' resulting from the eighth round of encryption.	Successful decode using the JITC LP Decode software.			

Legend: AL – Application Level; ALE – Automatic Link Establishment; ASCII – American Standard Code for Information Interchange; CRC – Cyclic Redundancy Check; DBM – Data Block Message; DO – Design Objective; HF – High Frequency; ICD – Interface Control Document; JITC – Joint Interoperability Test Command; LP – Linking Protection; LPCM – Linking Protection Control Module; MIL-STD – Military Standard; NSA – National Security Agency; NT – Not Tested; PI – Protection Level; TOD – Time of Day; UUT – Unit Under Test

APPENDIX D

DATA COLLECTION FORMS

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MIL-STD-188-141B CONFORMANCE TEST Forms Control	CONTROL NUMBER:
	DATE: (DD/MM/YY)

Form Number	Serial Number	Equipment Nomenclature	Call Sign	Remarks

DATA ENTRY TECHNICIAN:	TEST DIRECTOR:
SIGNATURE:	SIGNATURE:

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MIL-STD-188-141B CONFORMANCE TEST Equipment Configuration Diagram Form	CONTROL NUMBER:
	DATE: (DD/MM/YY)

TEST TECHNICIAN:	
DATA ENTRY TECHNICIAN:	TEST DIRECTOR:

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<table>
<tr><td colspan="2">MIL-STD-188-141B
CONFORMANCE TEST
Event Log Form</td><td>CONTROL NUMBER:

DATE:
(DD/MM/YY)</td></tr>
</table>

Time (Local)	Initials	Event

TEST TECHNICIAN:	
DATA ENTRY TECHNICIAN:	TEST DIRECTOR:

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MIL-STD-188-141B CONFORMANCE TEST PLAN FORM		CONTROL NUMBER:
		DATE: (DD/MM/YY)
Equipment:	Serial Number:	
Description:		
Remarks		
TEST TECHNICIAN:		
DATA ENTRY TECHNICIAN:	TEST DIRECTOR:	

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MIL-STD-188-141B CONFORMANCE TEST Additional Remarks Form	CONTROL NUMBER:
	DATE: (DD/MM/YY)

Remarks	
TEST TECHNICIAN:	
DATA ENTRY TECHNICIAN:	TEST DIRECTOR:

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MIL-STD-188-141B CONFORMANCE TEST Electrical Characteristics of Digital Interfaces				Control Number:
DATE: __/__/__ TIME: _______ (MM / DD / YY) (LOCAL)				
Data Collection Method: ☐ Manual ☐ Automatic				
Unbalanced Interface				
Binary State	V_o	V_t	I_s	I_x
ZERO				
ONE				
Balanced Interface				
Binary State	V_o | V_{os} | V_{ob}	V_t | V_{os}	I_{sa} | I_{sb}	I_{xa} | I_{xb}
ZERO				
ONE				
Remarks				
Authentication				
Data Collector Name:			Signature:	
Data Entry Name:			Signature:	
Data Verification Name:			Signature:	

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MIL-STD-188-141B CONFORMANCE TEST Phase Stability	Control Number:

DATE: __/__/__ TIME: _______
(MM / DD / YY) (LOCAL)

Data Collection Method: ☐ **Manual** ☐ **Automatic**

Number	Pass	Fail	Number	Pass	Fail	Number	Pass	Fail
1			**21**			**41**		
2			**22**			**42**		
3			**23**			**43**		
4			**24**			**44**		
5			**25**			**45**		
6			**26**			**46**		
7			**27**			**47**		
8			**28**			**48**		
9			**29**			**49**		
10			**30**			**50**		
11			**31**			**51**		
12			**32**			**52**		
13			**33**			**53**		
14			**34**			**54**		
15			**35**			**55**		
16			**36**			**56**		
17			**37**			**57**		
18			**38**			**58**		
19			**39**			**59**		
20			**40**			**60**		

Remarks

Authentication	
Data Collector Name:	**Signature:**
Data Entry Name:	**Signature:**
Data Verification Name:	**Signature:**

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MIL-STD-188-141B CONFORMANCE TEST Phase Stability							Control Number:	
DATE: __/__/__ TIME: _______ (MM / DD / YY) (LOCAL)								
Data Collection Method: ☐ Manual ☐ Automatic								
Number	**Pass**	**Fail**	**Number**	**Pass**	**Fail**	**Number**	**Pass**	**Fail**
61			81			101		
62			82			102		
63			83			103		
64			84			104		
65			85			105		
66			86			106		
67			87			107		
68			88			108		
69			89			109		
70			90			110		
71			91			111		
72			92			112		
73			93			113		
74			94			114		
75			95			115		
76			96			116		
77			97			117		
78			98			118		
79			99			119		
80			100			120		
Remarks								
Authentication								
Data Collector Name:				Signature:				
Data Entry Name:				Signature:				
Data Verification Name:				Signature:				

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MIL-STD-188-141B CONFORMANCE TEST Phase Stability							Control Number:	
DATE: __/__/__ TIME: _______ (MM / DD / YY) (LOCAL)								
Data Collection Method: ☐ Manual ☐ Automatic								
Number	Pass	Fail	Number	Pass	Fail	Number	Pass	Fail
121			141			161		
122			142			162		
123			143			163		
124			144			164		
125			145			165		
126			146			166		
127			147			167		
128			148			168		
129			149			169		
130			150			170		
131			151			171		
132			152			172		
133			153			173		
134			154			174		
135			155			175		
136			156			176		
137			157			177		
138			158			178		
139			159			179		
140			160			180		
Remarks								
Authentication								
Data Collector Name:				Signature:				
Data Entry Name:				Signature:				
Data Verification Name:				Signature:				

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MIL-STD-188-141B CONFORMANCE TEST Phase Stability	Control Number:

DATE: __/__/__ TIME: _______
(MM / DD / YY) (LOCAL)

Data Collection Method: ☐ **Manual** ☐ **Automatic**

Number	Pass	Fail	Number	Pass	Fail	Number	Pass	Fail
181			**201**			**221**		
182			**202**			**222**		
183			**203**			**223**		
184			**204**			**224**		
185			**205**			**225**		
186			**206**			**226**		
187			**207**			**227**		
188			**208**			**228**		
189			**209**			**229**		
190			**210**			**230**		
191			**211**			**231**		
192			**212**			**232**		
193			**213**			**233**		
194			**214**			**234**		
195			**215**			**235**		
196			**216**			**236**		
197			**217**			**237**		
198			**218**			**238**		
199			**219**			**239**		
200			**220**			**240**		

Remarks

Authentication	
Data Collector Name:	**Signature:**
Data Entry Name:	**Signature:**
Data Verification Name:	**Signature:**

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MIL-STD-188-141B CONFORMANCE TEST Phase Stability	Control Number:

DATE: __/__/__ TIME: _______
(MM / DD / YY) (LOCAL)

Data Collection Method: ☐ Manual ☐ Automatic

Number	Pass	Fail	Number	Pass	Fail	Number	Pass	Fail
241			261			281		
242			262			282		
243			263			283		
244			264			284		
245			265			285		
246			266			286		
247			267			287		
248			268			288		
249			269			289		
250			270			290		
251			271			291		
252			272			292		
253			273			293		
254			274			294		
255			275			295		
256			276			296		
257			277			297		
258			278			298		
259			279			299		
260			280					

Remarks

Authentication	
Data Collector Name:	Signature:
Data Entry Name:	Signature:
Data Verification Name:	Signature:

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MIL-STD-188-141B CONFORMANCE TEST Receiver RF Characteristics	Control Number:
DATE: __/__/__ TIME: _______ (MM / DD / YY) (LOCAL)	
Data Collection Method: ☐ Manual ☐ Automatic	

Image Rejection

Signal Generator 1 Frequency	Signal Generator 2 Frequency	Signal Generator 1 Radio Frequency Output (dBm)	Signal Generator 2 Radio Frequency Output (dBm)	Rejection Level (dB)

Intermediate Frequency Rejection

Signal Generator 1 Frequency	Signal Generator 2 Frequency	Signal Generator 1 Radio Frequency Output (dBm)	Signal Generator 2 Radio Frequency Output (dBm)	Rejection Level (dB)

Adjacent Channel Rejection

Signal Generator 1 Frequency	Signal Generator 2 Frequency	Signal Generator 1 Radio Frequency Output (dBm)	Signal Generator 2 Radio Frequency Output (dBm)	Rejection Level (dB)

Remarks

Authentication

Data Collector Name:	Signature:
Data Entry Name:	Signature:
Data Verification Name:	Signature:

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MIL-STD-188-141B CONFORMANCE TEST Receiver RF Characteristics							Control Number:
DATE: __/__/__ TIME: _______ (MM / DD / YY) (LOCAL)							
Data Collection Method: ☐ Manual ☐ Automatic							
Receiver Frequency (MHz)	Noise Level w/o Input	+ 10 dBm	RF Out Level (dBm)	Receiver Frequency (MHz)	Noise Level w/o Input	+ 10 dBm	RF Out Level (dBm)
2.0000				2.5555			
2.1111				2.6666			
2.2222				2.7777			
2.3333				2.8888			
2.4444				2.9999			
3.				17.			
4.				18.			
5.				19.			
6.				20.			
7.				21.			
8.				22.			
9.				23.			
10.				24.			
11.				25.			
12.				26.			
13.				27.			
14.				28.			
15.				29.			
16.							
Remarks							
Authentication							
Data Collector Name:				Signature:			
Data Entry Name:				Signature:			
Data Verification Name:				Signature:			

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MIL-STD-188-141B CONFORMANCE TEST Desensitization Dynamic Range					Control Number:
DATE: __/__/__ TIME: _______ (MM / DD / YY) (LOCAL)					
Data Collection Method: ☐ Manual ☐ Automatic					
Interfering Signal					
USB (+5%)			LSB (+5%)		
RF Level	SINAD (dBm)	AGC Voltage	RF Level	SINAD (dBm)	AGC Voltage
USB (-5%)			LSB (-5%)		
RF Level	SINAD (dBm)	AGC Voltage	RF Level	SINAD (dBm)	AGC Voltage
Remarks					
Authentication					
Data Collector Name:			Signature:		
Data Entry Name:			Signature:		
Data Verification Name:			Signature:		

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MIL-STD-188-141B CONFORMANCE TEST Receiver Sensitivity							Control Number:
DATE: __/__/__ TIME: _______ (MM / DD / YY) (LOCAL)							
Data Collection Method: ☐ Manual ☐ Automatic							
Receiver Frequency (MHz)	Noise Level w/o Input	+ 10 dBm	RF Out Level (dBm)	Receiver Frequency (MHz)	Noise Level w/o Input	+ 10 dBm	RF Out Level (dBm)
2.0000				2.5555			
2.1111				2.6666			
2.2222				2.7777			
2.3333				2.8888			
2.4444				2.9999			
3.				17.			
4.				18.			
5.				19.			
6.				20.			
7.				21.			
8.				22.			
9.				23.			
10.				24.			
11.				25.			
12.				26.			
13.				27.			
14.				28.			
15.				29.			
16.							
Remarks							
Authentication							
Data Collector Name:				Signature:			
Data Entry Name:				Signature:			
Data Verification Name:				Signature:			

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MIL-STD-188-141B CONFORMANCE TEST Receiver Linearity			Control Number:
DATE: __/__/__ TIME: _______ (MM / DD / YY) (LOCAL)			
Data Collection Method: □ Manual □ Automatic			
Pretest Determinations			
Test Frequency:		Noise Frequency:	
10 dB SINAD			
RF Signal Generator Output Level:		Audio Output Level:	
Receiver Linearity			
RF Output Level	**Audio Output Level**	**RF Output Level**	**Audio Output Level**
Remarks			
Authentication			
Data Collector Name:		Signature:	
Data Entry Name:		Signature:	
Data Verification Name:		Signature:	

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MIL-STD-188-141B CONFORMANCE TEST Input Impedance					Control Number:
DATE: __/__/__ TIME: _______ (MM / DD / YY) (LOCAL)					
Data Collection Method: ☐ Manual ☐ Automatic					
INPUT IMPEDANCE					
Frequency (MHz)	Phase Angle	Magnitude	Frequency (MHz)	Phase Angle	Magnitude
1.5			17.0		
2.0			18.0		
3.0			19.0		
4.0			20.0		
5.0			21.0		
6.0			22.0		
7.0			23.0		
8.0			24.0		
9.0			25.0		
10.0			26.0		
11.0			27.0		
12.0			28.0		
13.0			29.0		
14.0			29.999		
15.0					
16.0					
Remarks					
Authentication					
Data Collector Name:			Signature:		
Data Entry Name:			Signature:		
Data Verification Name:			Signature:		

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MIL-STD-188-141B CONFORMANCE TEST Memory	Control Number:
DATE: __/__/__ TIME: _______ (MM / DD / YY) (LOCAL)	
Data Collection Method: ☐ Manual ☐ Automatic	
Page __ of __ pages	

Self Address & Net Memory				
Index	Self Address	Net Address	Tswt (SN)	Valid Channels

Authentication	
Data Collector Name:	Signature:
Data Entry Name:	Signature:
Data Verification Name:	Signature:

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MIL-STD-188-141B CONFORMANCE TEST Memory	Control Number:
DATE: __/__/__ TIME: _______ (MM / DD / YY) (LOCAL)	
Data Collection Method: ☐ Manual ☐ Automatic	
Page __ of __ pages	

Net Address or Other Address Memory						
Other Address	Net Address or Other Individual Address and Slots				Valid Channel	Wait for Reply (T)
	Slot 1	Slot 2	Slot 3	Slot 4		

Authentication	
Data Collector Name:	Signature:
Data Entry Name:	Signature:
Data Verification Name:	Signature:

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MIL-STD-188-141B CONFORMANCE TEST Link Establishment	Control Number:
DATE: __/__/__ TIME: _______ (MM / DD / YY) (LOCAL)	
Data Collection Method: ☐ Manual ☐ Automatic	

Probability of Linking

Gaussian Noise Channel — Scan Rate ____

SNR	Number of Attempts	Number of Successful Attempts	Probability of Linking (%)	Average Link Establishment Time
- 2.5				
- 1.5				
- 0.5				
0.0				

CCIR Good Channel — Scan Rate ____

SNR	Number of Attempts	Number of Successful Attempts	Probability of Linking (%)	Average Link Establishment Time
+ 0.5				
+ 2.5				
+ 5.5				
+ 8.5				

Remarks

Authentication

Data Collector Name:	Signature:
Data Entry Name:	Signature:
Data Verification Name:	Signature:

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MIL-STD-188-141B CONFORMANCE TEST Link Establishment	Control Number:
DATE: __/__/__ TIME: _______ (MM / DD / YY) (LOCAL)	
Data Collection Method: ☐ Manual ☐ Automatic	

Probability of Linking

CCIR Poor Channel — Scan Rate ____

SNR	Number of Attempts	Number of Successful Attempts	Probability of Linking (%)	Average Link Establishment Time
+ 1.0				
+ 3.0				
+ 6.0				
+ 11.0				

Remarks

Authentication

Data Collector Name:	Signature:
Data Entry Name:	Signature:
Data Verification Name:	Signature:

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MIL-STD-188-141B CONFORMANCE TEST Link Establishment	Control Number:
DATE: __/__/__ TIME: _______ (MM / DD / YY) (LOCAL)	
Data Collection Method: ☐ Manual ☐ Automatic	

ALE Score Sheet

Gaussian Noise ☐ CCIR Good ☐ CCIR Poor ☐ SNR ____ Probability of Linking ____%

Attempt	Success	Attempt	Success	Attempt	Success	Attempt	Success
1		26		51		76	
2		27		52		77	
3		28		53		78	
4		29		54		79	
5		30		55		80	
6		31		56		81	
7		32		57		82	
8		33		58		83	
9		34		59		84	
10		35		60		85	
11		36		61		86	
12		37		62		87	
13		38		63		88	
14		39		64		89	
15		40		65		90	
16		41		66		91	
17		42		67		92	
18		43		68		93	
19		44		69		94	
20		45		70		95	
21		46		71		96	
22		47		72		97	
23		48		73		98	
24		49		74		99	
25		50		75		100	

Authentication

Data Collector Name:	Signature:
Data Entry Name:	Signature:
Data Verification Name:	Signature:

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MIL-STD-188-141B CONFORMANCE TEST Link Establishment			Control Number:
DATE: __/__/__ TIME: ________ (MM / DD / YY) (LOCAL)			
Data Collection Method: ☐ Manual ☐ Automatic			
Link Establishment Timing			
Number	**Gaussian Noise**	**CCIR Good**	**CCIR Poor**
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
Remarks			
Authentication			
Data Collector Name:		Signature:	
Data Entry Name:		Signature:	
Data Verification Name:		Signature:	

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MIL-STD-188-141B CONFORMANCE TEST LQA Operation	Control Number:
DATE: __/__/__ TIME: _______ (MM / DD / YY) (LOCAL)	
Data Collection Method: ☐ Manual ☐ Automatic	

LQA OPERATION					
PROGRAMMED INPUT			OBSERVED OUTPUT		
ALE		SIMULATOR	SYSTEM B LQA INFORMATION		
Channel	Level	Channel	TEST #1	TEST #2	TEST #3
01		01			
02		02			
03		03			
04		04			
05		05			
06		06			
07		07			
08		08			
09		09			
10		10			

Remarks
BEST CHANNEL SELECTED BY ALE ____ LQA VALUE ____
BEST CHANNEL PROGRAMMED _____ LEVEL ____

Authentication	
Data Collector Name:	Signature:
Data Entry Name:	Signature:
Data Verification Name:	Signature:

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MIL-STD-188-141B CONFORMANCE TEST Signal Structure	Control Number:
DATE: __/__/__ TIME: _______ (MM / DD / YY) (LOCAL)	

Data Collection Method: ☐ Manual ☐ Automatic

Word Format Verification: ☐ Yes ☐ No

Word Structure Verification: ☐ Yes ☐ No

Word Type/Preamble Verification: ☐ Yes ☐ No

THRU word: ☐ Yes ☐ No
TO word: ☐ Yes ☐ No
COMMAND word: ☐ Yes ☐ No
FROM word: ☐ Yes ☐ No
THIS IS word: ☐ Yes ☐ No
THIS WAS word: ☐ Yes ☐ No
DATA word: ☐ Yes ☐ No
REPEAT word: ☐ Yes ☐ No

ASCII Character Verification:

Basic 38 ASCII subset: ☐ Yes ☐ No
Expanded 64 ASCII subset: ☐ Yes ☐ No
Full 128 ASCII set (DTM only): ☐ Yes ☐ No

Remarks

Authentication	
Data Collector Name:	Signature:
Data Entry Name:	Signature:
Data Verification Name:	Signature:

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MIL-STD-188-141B CONFORMANCE TEST Occupancy Detection	Control Number:

DATE: ____/____/____ (MM/DD/YY) **TIME:**________________ (LOCAL)

TEST MODE: ALE_____ SSB VOICE_____ SERIAL TONE MODEM_____ STANAG 4539_____ STANAG 4285_____

Attempt	Result	Attempt	Result	Attempt	Result	Attempt	Result
1		26		51		76	
2		27		52		77	
3		28		53		78	
4		29		54		79	
5		30		55		80	
6		31		56		81	
7		32		57		82	
8		33		58		83	
9		34		59		84	
10		35		60		85	
11		36		61		86	
12		37		62		87	
13		38		63		88	
14		39		64		89	
15		40		65		90	
16		41		66		91	
17		42		67		92	
18		43		68		93	
19		44		69		94	
20		45		70		95	
21		46		71		96	
22		47		72		97	
23		48		73		98	
24		49		74		99	
25		50		75		100	

Number Successful: **Percentage:**

SCORING INSTRUCTIONS: If the unit under test indicates that the call is postponed or attempts to call on another channel, this is scored as a go (1); if the unit under test attempts to make the call in the presence of the degraded signal, this will be scored as a no-go (0). Any unusual events should be noted in the Comments section (next page) of this form.

Authentication

Name	Signature
Data Collector Name:	**Signature:**
Data Verification Name:	**Signature:**
Data Collector:	**Signature:**

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MIL-STD-188-141B CONFORMANCE Occupancy Detection		Control Number:
DATE: ____/____/____ (MM/DD/YY)	TIME:________________ (LOCAL)	
COMMENTS:		

Authentication	
Data Collector Name:	Signature:
Data Verification Name:	Signature:
Data Collector:	Signature:

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MIL-STD-188-141B CONFORMANCE TEST ALE Word Decode Matrix	Control Number:

DATE: ____/____/____ (MM/DD/YY)	TIME:________________ (LOCAL)
File Number	**Subtest Title and Number**

Word Number:	Repeat Number:

Transmitted Tone																									
Transmitted Bits	A1	B1	A2	B2	A3	B3	A4	B4	A5	B5	A6	B6	A7	B7	A8	B8	A9	B9	A10	B10	A11	B11	A12	B12	
Transmitted Tone																									
Transmitted Bits	A13	B13	A14	B14	A15	B15	A16	B16	A17	B17	A18	B18	A19	B19	A20	B20	A21	B21	A22	B22	A23	B23	A24	B24	S49
Decoded Bits	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	
Decoded Word																									

Word Number:	Repeat Number:

Transmitted Tone																										
Transmitted Bits	A1	B1	A2	B2	A3	B3	A4	B4	A5	B5	A6	B6	A7	B7	A8	B8	A9	B9	A10	B10	A11	B11	A12	B12	A13	B13
Transmitted Tone																										
Transmitted Bits	A14	B14	A15	B15	A16	B16	A17	B17	A18	B18	A19	B19	A20	B20	A21	B21	A22	B22	A23	B23	A24	B24	S49			
Decoded Bits	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12		
Decoded Word																										

MIL-STD-188-141B CONFORMANCE TEST ALE Word Decode Matrix	Control Number:

DATE: ____/____/____ **(MM/DD/YY)**	**TIME:________________** **(LOCAL)**
File Number	**Subtest Title and Number**

Word Number:		Repeat Number:

Transmitted Tone																									
Transmitted Bits	A1	B1	A2	B2	A3	B3	A4	B4	A5	B5	A6	B6	A7	B7	A8	B8	A9	B9	A10	B10	A11	B11	A12	B12	A13

Transmitted Tone																								
Transmitted Bits	B13	A14	B14	A15	B15	A16	B16	A17	B17	A18	B18	A19	B19	A20	B20	A21	B21	A22	B22	A23	B23	A24	B24	S49
Decoded Bits	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
Decoded Word																								

COMMENTS:

Authentication

Data Collector Name:	**Signature:**
Data Verification Name:	**Signature:**
Data Collector:	**Signature:**

MIL-STD-188-141B CONFORMANCE TEST Tone/Bit Breakout	Control Number:
DATE: ____/____/____ **(MM/DD/YY)**	***TIME:***______________ **(LOCAL)**

Start Time:

File Name:

Number	Tone	Bits	Number	Tone	Bits
1			26		
2			27		
3			28		
4			29		
5			30		
6			31		
7			32		
8			33		
9			34		
10			35		
11			36		
12			37		
13			38		
14			39		
15			40		
16			41		
17			42		
18			43		
19			44		
20			45		
21			46		
22			47		
23			48		
24			49		
25					

COMMENTS:

SCORING INSTRUCTIONS: Capture ALE tones and indicate sequentially each tone and its related Bit Code. This will be repeated for each ALE word. Any unusual events should be noted in the Comment section of this form.

Authentication	
Data Collector Name:	**Signature:**
Data Verification Name:	**Signature:**
Data Collector:	**Signature:**

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APPENDIX E

REFERENCES

MILITARY STANDARDS (MIL-STD)

E-1 MIL-STD-188-141B, “Interoperability and Performance Standards for Medium and High Frequency Radio Systems,” dated 1 March 1999

E-2 MIL-STD-188-114, “Electrical Characteristics of Digital Interface Circuits”

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