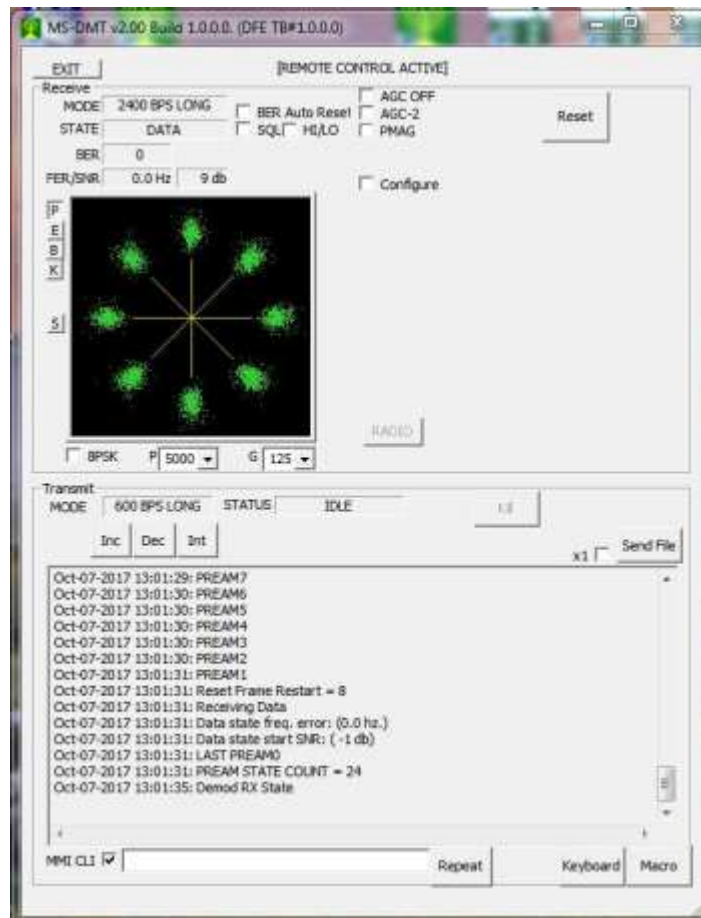# MS-DMT
Read Me First
Version 1.00

POC for this document is:
support@marsale.org

WARNING: Under current FCC rules, MS-DMT may only be used on the 60 meter Amateur Radio band as 60m rules are not symbol rate based. Be sure **NOT** to use greater than a 2.8kHz passband filter on data transmit with any HF SSB transceivers on the 60 meter band.

NOTE: For SDR radios and best results due to their brick wall filters are achieved with the RX filtering to a full 3.0kHz passband or even a bit more.

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MS-DMT USER LICENSE

MIL-STD Data Modem Terminal (MS-DMT) Copyright (C) 2005-2018 Avila Electronics and Steve Hajducek, N2CKH. All rights reserved.

MS-DMT is licensed for "Receive only use" by interested persons for private use only.

MS-DMT is licensed (where a license.dat file may be issued to users of groups 1, 2 and 3 herein for access to restricted features) for "Two-way communications use" by: 1. U.S. Military Auxiliary Radio System (MARS) members. 2. U.S. Armed Forces (Army, Marine Corps, Navy, Air Force and Coast Guard) and their supporting Auxiliaries, and U.S. National Guard members. 3. U.S. Government Agencies and their supporting Auxiliaries. 3. Any organized groups that provide auxiliary communications support to any current NATO nation Military forces or their Government agencies, for example the Canadian Forces Affiliate Radio System (CFARS) members. 4. Amateur Radio Emergency Service (ARES) operators in the United States and Canada and U.S. Radio Amateur Civil Emergency Service (RACES) members. 5. Individual FCC licensed Amateur Radio Operators when invited to participate in organized U.S. Armed Forces, U.S. National Guard or U.S. Government communication exercises where MS-DMT is required, who may train with MS-DMT in advance of the scheduled exercise.

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PREFACE

The MIL-STD Data Modem Terminal (MS-DMT) software is a sophisticated MS-Windows hosted communications tool developed in support of MARS to provide 2-way communications and broadcast intercept to U.S. Military and NATO Standards.

By reading this relatively short document you are off to a good start compared to just installing the software and running MS-DMT blindly. However this document provides only the absolute minimum information on MS-DMT. After installation of the software the additional documentation that is installed **MUST** be read prior to use of MS-DMT. **Don't assume** that you can just dive in and make use of MS-DMT like an Amateur Radio low symbol rate sound card digital mode application without reading the documentation as you will be very disappointed with the results.

The MS-DMT software is much more demanding of the host MS-Windows operating system, PC Sound Device and HF SSB radio equipment system components than are Amateur Radio digital communications applications. It will require time and effort to configure all system components for the MS-DMT software to provide the modem performance that equates to a MIL-STD hardware modem that it is capable of providing.

OVERVIEW

The MS-DMT software provides an interoperable HF data modem digital communications capability to the legacy MIL-STD-188-110A (MS110A) PSK serial tone modem standard which continue in use today by the U.S. Military sponsors of MARS and MARS U.S. Government customers as found in MIL-STD-188-110C. This includes adherence to STANAG 4415 (S4415) for ROBUST performance at 75bps.

The complex Military serial tone PSK waveforms supported by this software have a much higher symbol rate, wider bandwidth and higher data rates than do the Amateur Radio, Commercial and Military FSK (RTTY) digital modes commonly used in Amateur Radio and by MARS in the past. These Military PSK waveforms were designed to be implemented on dedicated hardware based modems and Military grade tactical HF SSB transceivers having SSB filters with wider bandwidth and better characteristics than normally used in Amateur Radio and most Commercial Radio grade transceivers.

Much more care must be taken in the initial configuration and subsequent configuration management of the host MS-Windows PC operating system and the radio configuration for the best consistent results when using this software. However, with some time and effort, most users can make needed adjustments to their computer system and radio system equipments that will provide good to excellent results when using MS-DMT to provide MS110A PSK modem based communications.

In application, the basic use of the MS110A PSK modem is similar to the use of MT-63 or any non-ARQ FEC protocol. However via the use of 3rd party data terminal applications and Data Link Protocols the MS110A PSK modem can also provide for more than just basic FEC based ASCII messaging provided by the MS-DMT internal terminal.

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The Military uses the MS110A PSK modem for everything from FEC orderwire ASCII messaging to broadcast and multicast use, ARQ linked message and binary file transfers, HF e-mail, IP based HTML support, Digital Voice and more, where data encryption is often employed.

At one time MT-63 was once the measure of performance in MARS on the PC sound device. The legacy MS110A PSK standard provides for waveforms that are just as robust in comparison, and much faster than MT-63. MS110A PSK provides data rates of 75..2400bps coded, that is to say with Forward Error Correction (FEC). In FEC operation both SHORT and LONG Interleave selections are provided where LONG provides the most robust operation.

For example in comparing MT-63 1K LONG, MS110A 75bps LONG is about 10% slower, however MS110A 150bps LONG is about 10% faster, where MS110A 300bps is almost twice as fast and MS110A 600bps is double that. In comparison to MT-63 2K LONG, MS110A 300bps LONG is about 30% faster and MS110A 600bps is about three times as fast. Then too MS110A provides for the faster 1200bps and 2400bps FEC coded selections for use during better than normal channel conditions.

In addition the MS110A 4800bps uncoded data rate is most useful for VHF FM application on simplex and through repeater systems. However the use of the 4800bps uncoded on HF above 24Mhz for Line-of-Sight (BLOS) communications on MARS circuits often works well, as does its use on very good NVIS paths.

KEY MS-DMT FEATURES

- Local or Remote Terminal operation.

- An MS-DMT aware external terminal can remote control MS-DMT via the Data Port where a full range of remote control commands are provided.

- The Data Port supports 3rd Party Remote Terminal applications for two-way communications via a user configurable asynchronous RS-232 serial port 8 bit interface providing both ASYNC and compatible SYNC Over-the-air (OTA) operation.

- PC Sound Device selection is provided by both Name and Number with no need to shut down and restart the software.

- Supports multiple USB 2.0 or greater sound devices of the same or different make/model for clean selection. Where for example, if using two of the same make/model USB devices, the 1st may be "USB Codec" and 2nd device would show up as "USB Codec 2".

- Supports mixing of sound devices, one for RX and one for TX.

- All sound device output and input level settings for the modem are achieved using the Windows Volume Control Panels at present.

- Provides modem base band modulation adjustment from 30..90% with 75% as the default.

- Provides automatic sample clock error correction that may mitigate as much as 75ppm RX sample rate error when receiving transmissions from a hardware modem based

station. However, overall native device sample rate error of less than 20ppm is required for good results. Less than 10ppm is required for excellent results. 1ppm or less sample clock error provides the best performance. Sample clock error is accumulative between stations, for example, if station A has +10ppm error and station B has -10ppm error, the overall error is 20ppm.

- MIL-STD-188-110A standard 1800Hz PSK carrier is used by default. However optional PSK carrier selections used in many hardware modems of 1650Hz and 1500Hz are also provided where the use of the optional PSK carrier to center signals within narrower SSB filters must be offset from the dial frequency of stations using 1800Hz by the difference.

- The software is compatible with MIL-STD-188-110A hardware modem SYNC (selectable EOM enabled or disabled on RX and TX) or ASYNC (selectable EOM enabled or disabled on RX only) modes in support of FEC based communications.

- ASYNC or SYNC with EOM enabled for transparent operation via the Data Port for external applications use for Binary, ASCII or Binary/ASCII data streams.

- Modem receiver reset is provided via either combination or EOM sequence, post EOM Flush (Null byte detection) when "Ron" is checked or just "EOM" in support of binary data streams when "Ron" is not checked. When the Data Port is enabled, the state of the "RoN" checkbox is overridden. When "Ron" and "TRANS" are checked in Local operations, reset is by automatic Reset on 100 errors of unknown data when in mode SYNC operation if EOM fails.

- Exceeds MIL-STD-188-110A SNR AWGN 3kHz channel with multipath delay and fading parameters and handling of +/-75Hz for all data rates. Meets Doppler spread rate of change of 3.5Hz/sec slope rate at 75bps and up to 2.5hz/sec at the higher data rates.

- Provides Digital Squelch (SQL) with High and Low settings to deal with noisy channel conditions that can cause false detections on the part of the modem receiver.

- Provides for sending data from ASCII or Binary files via the internal terminal and via the data port using remote control commands. This is NOT an FTP capability, we are not sending files, just data contained in a file.

- Provides a Man Machine Interface (MMI) command interpreter to execute macro commands for the control of the tool and external HF radio.

- RS-232 D.C. Power is provided from DTR or RTS lines for which ever line is not selected for PTT.

- CAT control is provided for a wide range of radios in support of CAT PTT. In addition the user can custom create a macro based radio control library using the DMT-RADIO interface.

- Selectable RS232 RTS or DTR radio PTT, CAT radio PTT, both RS232 & CAT PTT or EXTERNAL PTT sources are user selectable where RTS is the default.

- CAT control is provided for automatic DATA/VOICE switching between radio MIC and DATA ports is provided in support of all radio models where required.

- MARS-ALE Radio Emulation (REM) can be used to facilitate follow-on to ALE use of MS110A using MS-DMT. ICOM or KNWDxxx radio types are automatically used with the REM port. The MARS-ALE Radio Emulation (REM) can also be used in CAT Server Modem to control any make/model radio selection and PTT type which that software supports that is not directly supported by the DMT tool.

- Radio CAT Comport defaults settings default to those for the selected radio model automatically to include any require handshaking. Any baud rate from 1200 to 240,000 is supported, along with framing parameters for user selection. Communication ports COM1..COM255 are supported.

- At present the MS110A ASYNC mode TX/RX data parameters are fixed at 8 data bits, No Parity, 1 Stop Bit. The MS110A SYNC mode is always 8 data bits with no framing.

- Provides display of Signal-to-Noise Ratio (SNR) and when logging is enabled, it saves the peak SNR value during the decoding of the PREAMBLE.

- Provides display of Bit Error Count (BER).

- Provides for automatic modem receiver reset based on a user selected BER threshold.

- Supports automatic Touch Keyboard operation for Tablet PC use.

PC SOUND DEVICE MODEM

For the hardware modem component of MS-DMT, a dedicated **AC'97 48khz 16 bit minimum PC Sound Device** is required as the PC Sound Device Modem (PCSDM) physical layer device.

NOTE: Do **NOT** **use the Windows system sound device unless all Windows sounds have been disabled and no other application is making use of the device.**

The MS110A and S4415 standards currently included in MS-DMT, along with MIL-STD-188-110B Appendix C waveforms represent the basis of U.S. Military data modem based communications. For MS-DMT to provide the performance it is capable, the host computer must be capable of supporting "Streaming Audio". The goal of Streaming Audio capable systems is a **MUST** before we can even think about pursuing more the complicated waveforms of MS110B Appendix C or the newer MS110C Appendix D 3kHz waveforms, which provide for even higher speed throughput and the use or more complex QAM waveforms which put even more requirements on our software defined PC sound device approach.

It is preferred that the sound device used as the PCSDM be external to the PC or even located inside the HF SSB radio to achieve low noise floor (<-93db) and low jitter results. However some professional analog internal PC sound devices exist for about $300USD that even provide an onboard TXCO (e.g. ASUS Essence II) that are suitable for our needs. In addition the TI ezDSP

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C5535 DSP developer's board ($100USD) with firmware from the MS-DMT author provides professional grade audio at the lowest cost.

PCSDM options for MS-DMT are ranked as:

1. **BEST RESULTS:** An ASUS Essence STX II or an equivalent commercial device and the MS-PCSDM (https://groups.io/g/MS-PCSDM) project based on the TI ezDSP C5535 board are examples of analog PC sound device modem (PCSDM) options that provide the best MS-DMT modem performance results.

2. **BEST RESULTS:** A Virtual Audio Cable (VAC) with an SDR radio having high quality ADC/DAC devices are another route for the best results.

3. **VERY GOOD RESULTS:** An Amateur Radio grade (e.g. IC-7200) or Commercial grade (e.g. IC-F8101E) HF SSB radio with an internal codec will provide very good results.

4. **DECENT RESULTS:** The use of an external COTS radio/sound device interface for analog audio provide only decent results in most cases.

5. **DECENT RESULTS:** The use of an onboard AC'97 sound device can provide decent results if the device's sample clock is accurate and stable and if there is low noise and jitter, which is not typical of such devices. Thus most onboard devices are only good for use at 300bps and or 600bps due to the typical poor sample clock accuracy and drift at lower than 300bps and the noise floor and jitter issues at higher data rates than 600bps.

NOTE: Stations that do NOT have an HF SSB transceiver with a TXCO installed or less than a 2.4kHz SSB passband filter or have sound device sample rate error of greater than 10ppm should <u>NOT</u> be transmitting with MS110A PSK for anything but short order wire or "Through Me" partial fill messages.

HOST PC REQUIREMENTS

Either a 32-bit or 64-bit MS-Windows 7 SP1 or later operating system where Windows 10 is recommended, with at least 4GB of RAM for x86 and 8GB RAM for x64 is required to efficiently run MS-DMT.

Storage requirements for MS-DMT and the Microsoft Visual Studio C++ runtime libraries are rather low. MS-DMT can be run off a USB stick or other read/write media once properly installed.

The best results when using this software are obtained when it is run on a dedicated PC that has been configured with a fresh Windows OS install that has no wireless networking enabled or other non-MARS applications in use.

There are significant CPU and memory demands on the PC due to the MS110A/S4415 modems receiver DSP processing and significant demands on the PC sound device.

PHYSICAL RS-232 PORT

One **physical RS-232 port** is required for uninterrupted radio push-to-talk (PTT) that must be activated prior to and all during data transmission via either RS-232 DTR or RTS lines or CAT

PTT. Any drop in PTT during data transmission will likely cause a lost in DCD and definitely cause lost data.

NOTE: Optionally, for MS110A/S4415 an external hardware PTT based very fast VOX activated keying from the modem waveform audio is permitted as long as it is uninterrupted during the data transmission. For example, the DLY setting on the popular fast VOX PTT based Signalink USB must be at full CCW for absolute minimum PTT delay. Radio only based VOX keying should NOT be utilized.

A second **physical RS-232 port** is required for use of the MS-DMT Data Port if an external terminal program is running on a second PC.

NOTE: External terminal programs running on the same PC which is more common, require the use of a paired set of VCP ports where the use of vspMgr for 32 or 64 bit computers is recommended. Use of the 'enable overrun buffer" is recommended. For Window 7 and later a signed version of com0com is required.

Most users will configure MS-DMT for the Data Port to be on the same system via a VCP connection for external terminal applications. However on a lower end CPU based PC system, the MS-DMT Data Port will need to be configured via a real RS-232 hardware port with a null modem cable connection to your main PC where the external terminal application is running. This can be viewed as being similar to using those same terminal applications with a hardware modem where the PC that is dedicated to running the MS-DMT application would equate to the stand alone hardware modem.

NOTE: The MS-DMT tool MUST NOT BE subjected to MS-Windows power conservation saving settings and must never shut down the hard drive. The OS must NEVER go into system standby or hibernate modes. All screen savers and wireless networking MUST BE DISABLED. Wired networking may be tolerable on some systems but must be evaluated as to DPC latency.

8 SIMPLE MS-DMT RULES

There are "8 Simple Rules" to get the most from MS-DMT aside from the golden rule to read all the MS-DMT documentation contained within the "MS-DMT Technical Library" which cannot be stressed enough.

These 8 simple rules that will lead to excellent results using MS-DMT:

1. The HF SSB transceiver requires a TX/RX IF passband BW of at least 2.8kHz which is NOT what the typical HAM or Commercial radio 2.7kHz or 2.8kHz filter provides, which only 2.4kHz to 2.5kHz of passband or less respectfully. Any Roofing filter in the radio must be set to or wider than 3.0kHz. Many HF SSB radios, especially Amateur grade, provide features on RX and TX that need to be disabled or for use with for MS110A and other Military waveforms. The common parameter settings required are: Squelch wide open, RF gain wide open, RF attenuator off and all DSP noise reduction off. The IF SHIFT needs to be set near 1800hz if not using a wide enough passband filter.

Reason: Military HF transceivers with those physically large filters to meet STANAG 4203 characteristics provide 2.75kHz (3kHz nominal military channel) passband where filter variations in attenuation at most are +/-2db and a Group Delay time over 80% of passband must not be more than .5ms. The AGC time constant must be less than 10ms on desensitization and less than 25ms on resensitization for full performance. The HAM and Commercial radio filters do NOT equal the military filters and DSP filters are even worst and must be set to the full 3.0kHz on TX and a bit wider on RX (250..3350hz). Thus for best results a full 2.8kHz to 3.0kHz of passband is what we

are talking about as MS110A transmits a full 3kHz (300-3300hz) bandwidth waveform centered on an 1800hz PSK carrier.

2. An HF SSB radio with a Temperature Compensated Oscillator (TXCO) is a **MUST** for the best results.

Reason: Radio frequency accuracy and stability is required on TX and RX to minimize the load on the MS110A receiver FEC.

3. MIC ports with microphones wired for VOX operation must **NOT** be hot during data TX. Speaking of VOX, NO use of any VOX PTT method can be used if it momentarily cuts out during TX due to VOX threshold settings.

Reason: A hot mic will mix in any audio in the room that it picks up. Any drop out during data transmission can lead to lost data or lost DCD.

4. When decreasing RF power output from the HF SSB radio such as for dealing with Multipath, doing so must be via use of the TX Audio drive level to the radio ONLY! Any SSB output power control setting on the radio must be set to MAXIMUM at all times.

Reason: Only by decreasing the TX audio drive will a linear, clean change in RF power emission be achieved.

5. The PC Sound Device used as the MS-DMT modem device (PCSDM) must provide professional grade audio characteristics for optimal results. It must have a true 48kHz sample rate with 0ppm error and if possible having a TXCO reference clock. However adequate results can be had with stable, external to the compute r or inside the radio or perhaps even an internal to PC sound device all having less than 10ppm sample clock error. The use of SDR radios with highly accurate ADC/DAC and Virtual Audio Cable interfacing have been found to work very well if PC DPC latency is tamed.

Reason: Sample clock error and drift will cause the loss of DCD lock over the duration of the data transmission.

6. Clean, undistorted TX audio that does NOT over drive the SSB radio transmitter into ALC is a MUST.

Reason: We are not going for maximum RF output from the radio, LESS is MORE with 2400 baud symbol rate MS110A PSK. No ALC results in about 30..35% of exciter power on peaks, which will be more than enough for MARS NVIS and most Skywave communications paths. A bigger antenna system or use of an external High Power Amplifier (HPA) is required for a bigger signal. However bear in mind that more RF power output increases the chances of Multi-Path distortion.

7. A Windows OS with DPC latency tamed to below 500us during RX at all times during incoming data transmission interception is required. This is known as "Streaming Audio Quality" capability in the PC world and is a must for MS-DMT use.

Reason: DPC latency causes audio drop out which cannot be tolerated with MS110A PSK.

8. Allow the RX station based on their channel conditions to direct the use of the sending station Data Rate selection to be used and ALWAYS make use of LONG interleave. Also, when permitted make use of SYNC vs. ASYNC mode of operation as the lack of framing used by ASYNC is a 25% payoff as to signal integrity. Don't send at lower than 300bps if your PCSDM is not close enough to 0ppm @48kHz or drifts or has other negative aspects detrimental to good performance at the lower data rates. Defer to someone else to "SEND THROUGH" when asked more of your current station capabilities for anything but a short fill message.

Reason: To know and adhere to your station's limitations and not send at data rates that you don't have the required IF BW filtering or sound device accuracy/stability to support, saves the receiving stations from the frustration of not being able to grab the traffic as soon as possible by needed to ask for a resend.

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INSTALLING MS-DMT FOR THE FIRST TIME

Disable all antivirus/spyware software prior to starting the installation process. Should you desire to use antivirus/spyware software when making use of MS-DMT or any of its associated files and have issues with antivirus/spyware software you will need to set an exception to ignore the issue or otherwise resolve issues with the antivirus/spyware software publisher(s).

Run INSTALL.EXE as Administrator. The MSDMT_32.EXE or MSDMT_64.EXE and the MSDMTLIB.EXE (MARS install version only) and the .DLL files will be installed to run as Administrator by INSTALL.EXE when run. If being added manually the user will need to do so.

The install program (INSTALL.EXE) by default installs to "C:\MS-DMT\" or "C:\MSC\MS-DMT\" depending on the distribution package, the end user can change the install location as desired.

The software may be installed to any drive on your computer and any user created sub directory. However, Do **NOT** install the software under any Windows system folders. This means you cannot install to "C:\PROGRAM FILES\" or "C:\PROGRAM FILES (86)\" when using MS-Windows 7 or later due to file access restrictions imposed with the Windows operating systems.

NOTE: Do NOT specify to run as a Windows XP SP3 application or anything else using Compatibility Mode emulation settings.

The required installation steps are:

1. Either directly install from the full distribution archive file MSDMTxxvxxxBxxxx_FI.ZIP or the partial install distribution MSDMTxxvxxxBxxxx_PI.ZIP by proceeding to step 2 or unzip into a temporary directory and then proceed to step 2.

2. Run the INSTALL.EXE and accept the license agreement, then follow all screen prompts through to completion of the install program.

3. If using the MSDMTxxvxxxBxxxx_FI.ZIP file, upon completion of the INSTALL.EXE the Microsoft VS 2017 redistribution install (vcredist_x86.exe) will automatically start, accept the license agreement, then follow all screen prompts through to completion.

The software should now be installed and awaiting configuration.

If you are in possession of a license.dat file now would be a good time to copy it to the folder where you installed the MS-DMT .EXE file.

At this point it is time to read the MS-DMT documentation installed before ever executing the MS-DMT software.