MIL-STD

Data Modem Terminal

User Guide

Version 1.06

Current for MS-DMT v1.01 Build 1.0.1.3

POC for this document is:

support@marsale.org

NOTE: Due to the large number of changes to the MS-DMT Graphical User Interface (GUI) in the current release build, not all screen captures contained herein have been updated to reflect use of the actual tool's GUI 100 percent.

WARNING: Do NOT use greater than a 2.8kHz filter on transmit or a 3.0kHz filter on receive.

NOTE: Authorized MS-DMT users with Amateur Radio licenses be aware that Military data modem serial tone waveforms use 1200 (S4529) or 2400 baud symbol rates which are NOT legal for all Amateur Radio use on HF. FCC rules that took effect on 05 MARCH 2012 for 60m band permit data transmission use as long as the emitted signal is held to 2.8Khz BW or less. FCC rules also allow 1200 baud symbol rate use for data transmission at 28Mhz and above, which would allow S4529 on 10m. Also, current FCC rules seem to permit use of military serial tone waveforms for Digital Voice or Image transmissions were such transmissions are permitted. Future FCC rule making will likely improve this situation.

NOTE: The release notes text file in the distribution .ZIP file may contain additional information beyond this document for a build release that is more recent than when this document was last updated.

UPDATES

The MS-DMT does not automatically update. Updating is performed manually. Updates are usually provided in .zip file format without an install.exe and simply require extracting to the installed directory location. All full install and updates releases can be found in the files section of the Yahoo support forum at:

http://groups.yahoo.com/group/MARS-ALE/

or at the open web site at:

http://www.n2ckh.com/MARS_ALE_FORUM/MSDMT.html

and its mirror at:

http://www.marsale.org/MARS_ALE_FORUM/MSDMT.html

SUPPORT

All support for this software is provided via the MARS-ALE Yahoo forum at:

http://groups.yahoo.com/group/MARS-ALE/

VERSION AND BUILD NUMBERING

MS-DMT does not look like or perform as did the first test build, it has drastically changed, in both appearance and performance. The first formal release of MS-DMT was v1.00 build 1.0.0.0 at the completion of the initial development and testing of the tool. The build number is displayed in the upper message window and the programs about box should anyone ever locate the later.
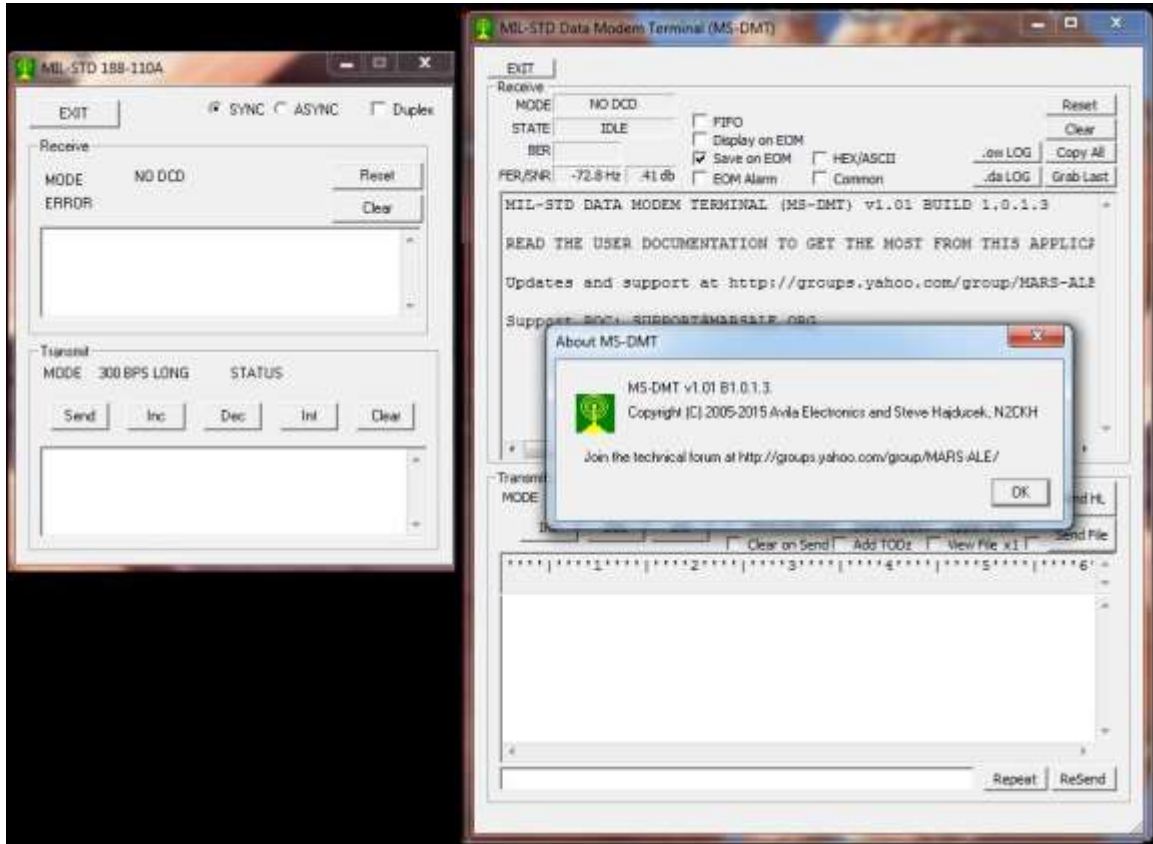
The correction of any bugs found or the addition of minor features shall result in the next build number being incremented, e.g. v1.00 build 1.0.0.0 would be incremented to v1.00 build 1.0.0.1 and successive builds in kind would result in another increment to build 1.0.0.2, 1.0.0.3 etc. until the 10th build if it gets that far at which point we would automatically move to software version 1.01 build 1.0.1.0 and continue on from there.

However, the addition of more significant user features or changing to a newer compiler which usually brings about better performance, would result in a build where the minor version number would increment and bring the build number inline, e.g. from v1.00 build 1.0.0.2 to v1.01 build 1.0.1.0 and continue from there.

The development of a new modem or a new mode or anything that represented new over-the-air operational capability would bump the major version number and reset the minor version number and bring the build inline, e.g. v1.00 build 1.0.0.2 to v2.00 build 2.0.0.0 and continue from there.

MS-DMT Guide v1.06

Released 10-31-2015

The debut of a 64 bit version port of the tool, should that develop, would also result in a major version number increment of the 32 bit version with the 64 bit version starting at that version and build number. However from that point the 32 and 64 bit baselines may deviate from one another as to version and build numbering depending on the driving factors for each baseline from that point moving forward.

It will only be the full release of a new version build that will not contain a banner at the top of the program for the purpose of identifying a test build. Prior to making an actual full release of a new release complete with full documentation and a full install program, any Software Development Team (SDT) test versions will carry the new numbering and contain a banner stating an SDT Candidate build number for the build. Any Beta build made for all hands to perform testing with will carry the new numbering and contain a banner stating a Beta number.

The file name for the MS-DMT release build will always remain either MSDMT_32.EXE for 32 bit versions and when applicable, MSDMT_64.EXE for 64 bit versions for consistency and to ease the ability to provide full install release and install update distributions if more than a .zip file is required to just drop in the .EXE for use. Any MS-DMT test builds will have a different naming convention.

LICENSE FILE REQUIREMENTS:

At this time there is no license file required to run the software. This may change with future versions of the tool depending on the features added during the tools life cycle development.

TABLE OF CONTENTS

PREFACE

The MIL-STD Data Modem Terminal (MS-DMT) application with its software defined MIL-STD-188-110A PSK modem core has been developed to provide the MARS member that cannot afford or otherwise acquire a MIL-STD hardware data modem. This optional means of MIL-STD data modem communications provides for interoperability by using a General Purpose MS-Windows computer and a high quality (e.g. low noise <-93db, low jitter, artifact free, accurate and stable sample clock) PC Sound Device as the modem hardware device.

The fixed 2400 baud symbol rate of the MS-DMT data modem requires effort on the part of the user in the configuration and management of their computer system. Those with previous PC Sound Device Modem (PCSDM) experience from the use of Amateur Radio class modem software and low symbol rate waveforms commonly used in Amateur Radio and in MARS in the past, must not make any assumptions regarding their existing systems. It can **NOT** be assume that an existing Windows operating system configuration (or means of running Windows software using Wine or Winskins or other such utilities under other operating systems), the PC sound device and levels, the HF SSB radio setup or PC-to-Radio interfacing as configured will work properly in meeting the requirements of this software's supported Military waveforms.

The results from use of this software depend on the user adhering to all recommendations herein. It is **STRONGLY** recommended that MS-DMT be the only application running that makes use of the PC Sound Device. Furthermore all directions on configuring and testing your operating systems latency, sound device sample clock error, setting up the sound device levels and the HF SSB radio parameters detailed herein **MUST** be followed to obtain the best possible results with your equipment. In addition, although optional reading, it is highly recommended that the MARS member read the "MIL-STD/STANAG Data Modem Primer" document for a good understanding of all military HF data modem waveforms of interest to MARS and their intended applications.

As to questions often raised about the MS110A software defined modem core found in MS-DMT and MARS-ALE. The MS110A modem core is fully capable of providing 75bps through 2400bps operation in ASYNC or SYNC to the maximum supported 32kb in size submitted (unknown data payload) message even in FEC only RATT operation within the confines of the minimum MS110A performance requirements. The mitigating factors in providing this support begin with the audio quality and sample clock accuracy and stability of the PC Sound Device used as the hardware modem component. The next mitigating factor is the level of host operating system Latency issues. The final factor is the HF SSB transceiver in use and its SSB filter characteristics, receiver and transmitter adjustments and it having a TXCO installed. Stations that do NOT have a radio with a TXCO installed should **NOT** be transmitting with MS110A for anything but short messages.

It must be appreciated that a conventional MIL-STD hardware based data modem has an accurate and stable sample clock and performs only one function, that of a MIL-STD data modem. Whereas this software based MIL-STD modem communications tool is being developed to work within the challenges of the MS-Windows pre-emptive operating system with no dedicated resources compared the traditional dedicated embedded hardware modem environment.

There are both technical challenges in dealing with any desktop Computer Operating System (OS) choice as well as the use of a PC Sound Device as the hardware Modem Device and the suitability of the HF SSB transceiver for MS110A use. However the concept of a Software Defined MIL-STD Data Modem running on a General Purpose PC under the popular MS-Windows or any similar multi-tasking computer operating system provides an economical and flexible alternative to an expensive and rigid MIL-STD software modem system, which is not without it challenges in MARS application as well.

The MS-DMT software as detailed herein represents a virtual MIL-STD data modem that does not benefit from having a dedicated environment in any aspect for its operation. Thus the modem is presented with a host of challenges to achieve the goal of meeting the minimum performance requirements (see Appendix A herein) as detailed in the military standard and with consistent results. However this software comes close to meeting all of the minimum MIL-STD performance requirements when used with the best known crop of COTS external USB 2.0 sound device radio interfaces if all other system parameters specified herein are met. The software provides even better performance, nearly equal to that of a hardware modem when the use of higher quality external USB professional grade sound devices are utilized.

The operating system and MS-Windows in particular, must be tamed as to mitigating, if not completely eliminating the demands on the computer system resources and the operating system latency issues that affect real-time audio streaming and RS-232 signaling timing. It is recommended that a clean native Windows OS install be used that is properly configured and maintained on a MARS communications dedicated PC, or on PC that is booted from a USB 2.0 or greater Flash drive or an external USB hard drive or solid state drive during MARS communications use.

Aside from non-modem related processes causing CPU loading and latency issues, the PC sound device sample clock accuracy and stability and noise floor, deterministic phase jitter and other parameters are key factors in modem performance. The best possible modem results will be achieved using the best sound device the user can afford to purchase, which rules out all on-board sound devices in achieving the best results.

In addition, as we are not talking a Turn-Key system approach, there are also configuration management challenges as to providing and maintaining the best possible operating system configuration dedicated to the task. First program capture of the sound device is also an issue if running another sound device application at the same time as MS-DMT. Thus to achieve the best results with this software the MS-DMT tool must be the only application that is making use of the PC Sound Device. If for any reason this advice is not abided by, then MS-DMT **MUST** be the first application to have access to the sound device.

OVERVIEW

The MS-DMT application is a software defined modem based communications terminal tool developed as a Microsoft Foundation Class (MFC) based (and not .NET thus it will operate fine under Wine and Winskins) Multi-threaded 32 bit application. It is currently designed to run under MS-Windows XP SP3 and later versions of both 32 and 64 bit MS-Windows operating systems. The tool is written in C++ using the Microsoft Visual Studio 2008 compiler and requires the installation of the VS2008 C++ runtime redistribution libraries which are part of the full MS-DMT install distribution only.

The MS-DMT tool functions as both a MIL-STD modem and basic data communications terminal and provides MARS a MIL-STD-188-110A[1] (MS110A) compliant Serial Tone (ST) waveform modem based Message Terminal capability providing message composition and automated message storage to simplify MARS MS110A Forward Error Correction (FEC) message handling. The software's terminal provides numerous features to aid in message handling and the software also supports the use of more fully featured external asynchronous terminal applications. Additional features such as Data Link Protocol, Data Compression, Data Encryption and others may be added to the MS-DMT tool as required and in accordance with the specific standards as requested or left to implementation in external terminal applications.

MIL-STD-188-110A details FSK Radio Teletype (RATT), PSK Single (Serial) tone and both 16 tone Differential Phase-Shift Keying (DPSK) and 39 tone Quadrature Differential Phase-shift Keying (QDPSK) parallel modems. At this time our main interest herein is detailed in MIL-STD-188-110A section 5.3.1.1, the MS110A Serial Tone waveform. The U.S. Military and Standard NATO Serial Tone modem waveforms have been found to be superior to the Military DPSK and QDPSK parallel waveforms to the point where the U.S. MIL-STD 16 tone DPSK waveform has become officially obsoleted and removed from the standard series as of MIL-STD-188-110C[3] and the 39 tone waveform although retained in the current standard, is considered obsolete by many. However the 39 tone modem is still being fielded in new HF-ALE tactical radios and some external modems such as the Harris RF-5710A and Rockwell MDM-Q9604 and thus is being considered along with STANAG waveforms for software modem implementation.

The MIL-STD-188-110A standard, superseded by MIL-STD-188-110B[2] has recently been superseded by MIL-STD-188-110C. However the MS110A ST waveforms specification has remained unchanged. The MS110A ST waveforms are one of a number of MIL-STD and NATO Standard (STANAG) ST waveforms that MARS must become familiar with. The other standards and their waveforms of interest include MIL-STD-188-110B Appendix C, STANAG S4285[4], S4415[5], S4529[6] and S4539[7] which all have specific roles in Military HF Beyond Line-Of-Sight (BLOS) communications and are all planned for software modem development and integration into the MS-DMT application over time.

The MS-DMT baseline also serves as the basis for Research and Development (R&D) in pursuit of improved MS110A serial tone modem performance and additional MIL-STD and STANAG waveforms development in support of MARS. Already a more advanced Metric Inversion Equalization (MIE) based MS110A modem vs. the existing Decision Feedback Equalization (DFE) MS110A modem exists, as does an STANAG 4285 and MS110B modem in alpha of development form.

In conjunction with a properly configured computer system, viable sound device and properly configured HF SSB transceiver as detailed herein, the MS-DMT software supports basic FEC based ASYNC (with EOM) or SYNC (with or without EOM being sent) modes interoperable with hardware modems for FEC based ASCII message communications using the internal terminal or an external terminal application via the data port. Also supported is an asynchronous serial port High Speed ASYNC mode which is SYNC (with EOM) Over The Air (OTA) compatible which supports transparent (when TRANS is checked) data port external communications applications in support of binary data streams such as Data Link Protocol layers. To communicate with hardware modems via any SYNC selection in the MS-DMT requires the hardware modem used to be wired to an RS-232 Synchronous port and placed into SYNC mode or wired for RS-232 Asynchronous and placed into "High Speed ASYNC" mode if provided by the hardware modem. High Speed ASYNC is usually only found in 110B.class hardware modems. MS-DMT also provides a comprehensive remote control interface protocol.

This software has been tested against various make/model MIL-STD hardware modems under dumb terminal control for FEC operation using the hardware modems operating in ASYNC or 110B class "High Speed ASYNC" (SYNC compatible over the air (OTA) mode) modems using MS110A and found to be 100% compatible. In addition the same external terminal software applications have been used with both the hardware modem and the MS-DMT via the MS-DMT external data port in testing where the MS-DMT has been found to perform properly with these terminal programs. In addition test software has been used with hardware modems in High Speed ASYNC to test "TRANS" mode where binary data has been sent and received properly. Thus MS-DMT can support more elaborate uses beyond that of FEC RATT with then proper external application software that will also control a hardware modem for the given requirement when said application software developed and configured to support MS-DMT.

The MS110A ST waveform and other MIL-STD/STANAG waveforms perform best with an HF SSB 100w or greater (where 400w plus for CONUS broadcasting is recommended) RF output for the best Signal to Noise Ratio when channel multipath conditions are not an issue. The HF SSB radio needs to have a Temperature Compensated Oscillator (TXCO) and IF passband of 2750Hz (nominal Military 3kHz bandwidth) at the 2 dB points with low group delay as detailed in STANAG 4203 (and the radio performance specifications detailed in MIL-STD-188-141C[9]) which specifies the properties of military radios which receives the baseband audio signal (3 kHz bandwidth) from the modem and modulates it onto a carrier.

MIL-STD MODEM IMPLEMENTATION

The MIL-STD/STANAG modem has traditionally been implemented in hardware as an Embedded System designed specifically to perform its functions as a military data modem. Embedded systems contain processing cores that are typically either Microcontroller (MCU) or Microprocessor (CPU) based in conjunction with one or more Digital Signal Processors (DSP) or Field Programmable Gate Arrays (FPGA) based or in recent years embedded Linux based with a combination of DSP or FPGA. The key characteristic being that hardware based military modems have processing power dedicated to the processing requirements of the modem and are not shared resources among non-related tasks running on the hardware. Since the embedded modems are dedicated to the specific modem tasks, design engineers have an optimized environment for consistent reliability and performance of their hardware modem firmware, not to mention accurate and stable reference clocks.

The new trend among some military hardware modem designers in the 21st century has been based upon using a Unix or Linux embedded operating system with specially designed hardware that include high precision Analog to Digital Converter (ADC) and Digital to Analog Converter (DAC) devices due to lower cost, faster development and ease of debugging and life cycle maintenance and the ability to provide Software Development Kit (SDK) offerings for end user customization as an alternative to past embedded approaches. An example of a Linux based modem is the Rockwell-Collins Q96xx family of modems which even support direct video, keyboard and mouse for configuration setup and some user controlled operation without the need of an external computer to provide such user tools as Constellation and Channel Impulse Response displays and an SDK for additional user tool development that traditional military modems do not provide. However, even with these types of modems, the only tasking taking place by the embedded Linux OS is that dedicated to the modem use, thus we are still talking a dedicated, optimized environment for consistent reliability and performance of these military modems.

The MS-DMT software is much more demanding of the PC Sound Device, the operating system and the radio equipment vs. Amateur Radio digital communications applications which support the low symbol rate data modes that make use of the PC Sound Device as the modem hardware. The complex Military serial tone PSK waveforms being supported by this software have much higher symbol rates, wider bandwidth and higher data rates than do the Amateur Radio, Commercial and Military FSK (RTTY) digital modes commonly used by MARS in the past and implemented on the PC Sound Device as the modem. **Much more care must be taken in the initial configuration and the configuration management of the PC operating system and the radio configuration for the best and consistent results when using this softwar**e.

The standard Military serial tone waveforms utilize either a constant 1200 baud (S4529)or the more common 2400 baud symbol rate where the design of the IF passband filtering and radio receiver dynamic range determines how faithfully the radio reproduces these complex signals. The MIL-STD/STANAG serial tone signals contain information in both phase state and amplitude value and occupy an instantaneous bandwidth as wide as 3kHz at the 2400 baud symbol rate, requiring a minimum of 2.75Khz of IF filtering for optimal results. As the passband response of radio IF filtering alters both phase and amplitude of a complex signal, any marginal radio design considerations can

cause degraded performance of these complex waveform signals. In transmitting these complex waveforms radio linearity is more critical as well where only full STANAG 4203[8] compliant filtering provides for the best results.

The use of the MS110A ST waveform for FEC only peer-to-peer, broadcast and multicast communications can most closely be compared to the use of MT-63 from a MARS user's perspective. They both make use of robust FEC and some common features from outward appearance in application, such as operation at different data rates and interleave settings. However they also differ greatly in numerous ways, where MT-63 although influenced by various Military standards, MT-63 does not adhere to any Military standards. In addition the author of MT-63 developed the protocol to take into account all of the negative issues of implementing the protocol as a software modem running within the MS-Windows environment and on Ham radio equipment with narrow voice grade filters. The same is true of most other sound device protocols such as WINMOR, where even the use of VOX PTT and its latency was taken into account in designing the waveform protocol. **This software however, attempts to meet the rigid requirements of the Military standards within a general computer and operating system environment that is just not suited to doing so without additional effort made on the part of the end user to mitigate known issues that impact modem performance, such as latency**.

In keeping with the requirements of MIL-STD-188-110B, Appendix E, a Rockwell MDM-3001 single channel modem with a two path HF channel simulator (HFCHANSIM) per CCIR-549-3[10] is used to verify the MS-DMT's MIL-STD-188-110A modem compliance with the minimum serial tone modem performance requirements in a 3kHz AWGN channel. At present the software comes close to meeting the minimum performance requirements at all data rates and exceeds them at 75bps. All HFCHANSIM testing is performed with a single sound device looping back through the MDM-3001 to eliminate sound device sample clock error and phase distortion issues. This configuration does however present the worst case as to PC sound device noise floor and jitter and other PC based artifacts when testing is conducted using a laptop and its' AC'97 on-board sound device which is always used in addition to the best case use of an external USB sound device in all use of the HFCHANSIM. Testing is now conducted using Windows 7 32 bit Professional, Win 7 32 bit Home, Win 64 bit home, Win 7 Starter, Win 8 Professional, Win 8.1 Tablet, Windows Embedded Standard 7, where operating system latency issues are both mitigated (such as disabling wireless networking and all other offending items) for best results and at times unmitigated for stress testing. All comments regarding the software modem and the meeting of minimum performance requirements are in reference to testing with the HFCHANSIM as the control environment and the single AC'97 on board sound device and minimum OS latency and the use of LONG interleaving.

At present, the bulk of MARS members will likely be limited to about 600bps in MS110A operation for consistent results. Assuming all latency issues are mitigated, this will largely be due to their radio filters not meeting S4203 parameters and/or lack of radio TXCO and also the continuing use of on-board or plug-in AC'97 sound devices and USB sound devices that do not provide the required quality audio characteristics. However reliable 600bps FEC operation is a huge step forward for MARS FEC communications. The use of MS110A ST FEC is just the first major use of MIL-STD waveforms by all

MARS members. It alone provides for a level of MIL-STD interoperability with our Military sponsors we had been without almost too long.

CURRENT MS110A DMT FEATURES

- PC Sound Device for 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 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".

- 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 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 MIL-STD-188-110A symbol rate is fixed at 2400bps requiring 2.7kHz IF filters minimum to meet full performance specifications. Less than 2.7kHz BW filters will impede the performance of data rates higher than 600bps.

- An external Data Port is provided in support of 3rd Party Applications for two-way communications via an RS-232 serial port for data, but not remote control at this time. The Data Port defaults at 19,200 baud with fixed parameters of 8N1 and CTS/RTS handshaking. Any baud rate from 1200 to 240,000 is supported for selection. Communication port support is limited to COM1..COM16 at present. The DTR line is asserted to indicate an active PTT state. The Data Port supports RS-232 Asynchronous interfacing providing both ASYNC and compatible SYNC Over-the-air (OTA) operation.

- 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 ASCII dumb terminal messaging using the internal terminal.

- 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, Flush Null Character when "Ron" is checked or just "EOM" with a variable time reset when"Ron" is not checked. Via the Data Port reset is by EOM when "RoN" is not checked. When "Ron" and "TRANS" are checked, 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 a full range of remote control commands for 3rd party terminal tool application.

- Provides for sending from files via the internal terminal and via the data port using remote control commands.

- RTS or DTR is supported for hardware PTT where RTS is the default.

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

- CAT control is provided for a wide range of radios in support of CAT PTT.

- Selectable RS232 RTS or DTR PTT, CAT PTT, both RS232 & CAT PTT or EXTERNAL PTT sources are user selectable.

- CAT control is provided for automatic DATA/VOICE switching between 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. ICOM or KNWDxxx radio types are 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 port support is limited to COM1..COM16 at present.

- 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 just 8 data bits with no framing.

- Supports mix and match of sound devices for RX/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 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.

FEATURES PLANNED FOR DEVELOPMENT

- Additional modem support, where S4285 and MS110B Appendix C is currently in stages of development.

- Data Port streaming of unknown data for transmit with minimal buffering where transmitting of the preamble and known data will begin immediately vs. requiring to buffer all the data prior to transmitting the data.

- Graphical Constellation display for both analysis of the radio equipment used to transmit and receive the waveforms and ongoing HF channel state analysis of multipath, fading and other conditions affecting the channel.
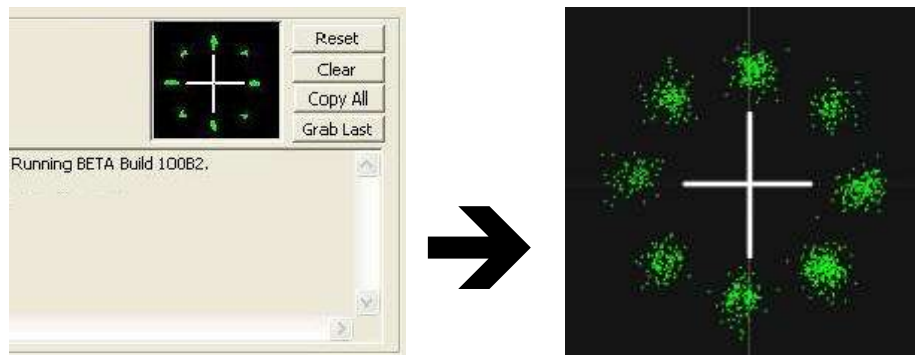
NOTE: The constellation display shows a series of points representing the received symbols as a signal-space display of the detected symbols by the equalizer. For an ideal channel, the symbols will appear as distinct points. Noise and other channel disturbances will cause the points to widen into clouds of dots around each of the symbol locations. As long as the shape of the constellation is roughly visible, the channel conditions will usually be adequate to receive data, with any error corrected by the associated error correction code. If the constellation points are clear and distinct, it is unlikely that errors are being made. As signal to noise ratio decreases or other channel impairments arise, the constellation points will become less distinct. When enough noise or interference is present to move received symbols across the boundary from one symbol to another, errors will begin to be seen. In many cases, forward error correction can compensate for this up until the point where the constellation is no longer recognizable at all. Radio induced distortions in the form of clipping or nonlinearity may often be identified in the constellation as a radial smearing of the constellation points outward from their center. If the usual constellation point is thought of as a circle around a nominal point, with the size of the circle dependent upon the amount of noise in the system, nonlinearities tend to result in the constellation points appearing as ellipses, with the major axis radially outward from the center of the constellation.

- Graphical and Numerical Channel Impulse Response (CIR) displays.

NOTE: A CIR provides the channel impulse response as an ongoing indication of the structure of the HF channel propagation in one or more distinct modes of propagation, or paths, which spread the received signal in time that interleaving and FEC deals with. If the signal being received arises from a single steady path then the graphical impulse response power display will show a single steady peak with

some small ringing due to radio filtering on either side of the main peak. Fading will result in the displayed impulse changing in amplitude, this can be seen in just the raw data. The impulse itself is changing in both amplitude and phase, but only magnitude is displayed in the impulse response power window, we just view the raw data for numerical display. When any amount of multipath propagation occurs, two or more distinct peaks may be present, each changing independently with time. I don't know yet how to approach this with just raw data, but I will figure it out as the first step with MS-DMT use of channel impulse data as a metric.

- User selectable automatic reset based on Bit Error Count.

- Integration of Listen-Before-Transmit (LBT) technology as a user selected option.

- Data Link Protocol layer Broadcast mode support in addition to ASYNC and SYNC modes.

- Test Probe Waveform (2400bps) to characterize signal path between modem/radio pairs to determine SNR, available bandwidth, radio ALC and AGC effects and distortion from non-linear effects with CIR display of I and Q data and other parametric information.

- Sync-on-Data (SoD) supporting late entry and recovery where the known data bits are used for synchronization.

- Selected sound device output and input level control and retention via the PCSDM dialog instead or using the Windows Volume Control Panels as found in MARS-ALE.

REFERENCES

[1] MIL-STD-188-110A, "INTEROPERABILITY AND PERFORMANCE STANDARDS FOR DATA MODEMS", 30 SEPTEMBER 1991

[2] MIL-STD-188-110B, "INTEROPERABILITY AND PERFORMANCE STANDARDS FOR DATA MODEMS", 27 APRIL 2000

[3] MIL-STD-188-110C, "INTEROPERABILITY AND PERFORMANCE STANDARDS FOR DATA MODEMS", 23 SEPTEMBER 2011

[4] NATO STANAG 4285, "CHARACTERISTICS OF 1200/2400/3600 BITS PER SECOND SINGLE TONE MODULATORS/DEMODULATORS FOR HF RADIO LINKS", BRUSSELS, EDITION 1, 17 FEBRUARY 1989

[5] NATO STANAG 4415, "CHARACTERISTICS OF A ROBUST, NON-HOPPING, SERIAL-TONE MODULATOR/DEMODULATOR FOR SEVERELY DEGRADED HF RADIO LINKS", EDITION 1, 21 JUNE 1999

[6] NATO STANAG 4529, "CHARACTERISTICS FOR SINGLE TONE MODULATORS/ DEMODULATORS FOR MARITIME HF RADIO LINKS WITH 1240 HZ BANDWIDTHS", EDITION 1, 20 JANUARY 1998

[7] STANAG 4539 C3 (EDITION 1), TECHNICAL STANDARDS FOR NON-HOPPING HF COMMUNICATIONS WAVEFORMS, 8 JUNE 2006

[8] STANAG 4203 C3 (EDITION 3), TECHNICAL STANDARDS FOR SINGLE CHANNEL HF RADIO EQUIPMENT, 27 APRIL 2007, ANNEX B and ANNEX C.

[9] MIL-STD-188-141C, INTEROPERABILITY AND PERFORMANCE STANDARDS FOR MEDIUM AND HIGH FREQUENCY RADIO SYSTEMS, 25 July 2011

[10] CCIR REGULATIONS, VOLUME III, ITU, "HF IONOSPHERIC CHANNEL SIMULATORS", CCIR REPORT 549-3, RECOMMENDATIONS AND REPORTS OF THE CCIR, ANNEX TO VOL. 3, PP. 47-58, GENEVA, 1990 0-7803-5538-5/99

[11] W. N. FURMAN, J. W. NIETO, "UNDERSTANDING HF CHANNEL SIMULATOR REQUIREMENTS IN ORDER TO REDUCE HF MODEM PERFORMANCE MEASUREMENT VARIABILITY," PROCEEDINGS OF HF01, NORDIC HF CONFERENCE, FARO, SWEDEN, AUGUST 2001.

MS-DMT Guide v1.06

Released 10-31-2015

NOTE: Many of the above referenced documents can be found at many places on the Internet, to include: https://assist.daps.dla.mil/quicksearch/ **and** http://groups.yahoo.com/group/MARS-ALE/files/

PC HARDWARE AND OS REQUIREMENTS

The requirements and recommendations herein must be taken seriously. Although some users may find it all a bit challenging to achieve, the alternative to this approach is to purchase a hardware modem solution.

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

There are significant CPU and memory demands on the PC due to the modems receiver DSP processing and significant demands on the PC sound device. The best results when using this software are obtained when it is run on a dedicated PC that has been configured with a fresh OS install that has no networking enabled or other applications in use.

Storage requirements by the MS-DMT and the Microsoft Visual Studio 2008 C++ redistribution runtime libraries are rather low and the application can be run off a USB stick or other media once properly installed, to include installed to bootable portable media.

At a minimum the computer requirement is one or more older **Intel Pentium 4 HT** processors @ 3.06Ghz (some later Intel P4 models that had Hyper-Threading disabled and are not suitable) or compatible CPU supporting Hyper-Threading Streaming SIMD (Single instruction, multiple data) Extensions (SSE) 2 and a minimum of **1GB** of physical RAM (with **2GB** recommended) and **3GB** virtual memory. The MS-DMT software will **NOT** work properly on a lesser PC hardware system.

The best results on minimum PC hardware are achieved by the use of **Windows Embedded Standard 7 (WES7)**. This has been proven using WES7 on a Dell GX-520 Intel Pentium 4 system.

The MS-DMT software at this time will operate on **Windows XP Home or XP Professional, SP3 Build 2600** as the minimum OS supported. However in the near future the bar will be raised to desktop Windows 7 as the minimum OS supported. This move takes into consideration the fact that Microsoft dropped Windows XP support in April 2014 and that Windows Vista is scheduled for end of support in April 2017. Also taken into consideration are the issues with XP and Vista and the low number of remaining users in MARS. Most of the Vista user have already moved to Windows 7 or later on their made for Vista PC hardware. This move will allow taking full advantage of Windows 7 features in the tools and the use of newer compiler libraries in building the MS-DMT executable.

MS-DMT can be used with external Terminal applications via its data port interface. The Army MARS ACP Communications Terminal and Army MARS Message Terminal (AMT) previously known as BlockTerm are currently used examples. The use is similar to using those applications with a hardware modem where the PC that is running the MS-DMT would equate to the stand alone hardware modem. Although MS-DMT will operate on the minimum hardware configuration as exemplified by a Dell GX-520 P4 on which MS-DMT has been heavily tested during development of the software. The use of external terminal applications on minimum PC hardware along with MS-DMT is **NOT** recommended. To attain best results when MS-DMT is used on minimum PC hardware

configurations, any external terminal application should be running on a second PC via an RS-232 null modem connection.

However the use of an external terminal application on the same PC via VCP based communications has been found to work properly using as a minimum system an **Intel 1.86Ghz Intel Pentium M or 1.66Ghz Intel Core 2 class processor with 2GB physical RAM**.

An AC'97 compliant PC sound device that natively support a 48kHz sample rate at 16 bits is required as the modem hardware. **It is recommended that and external Professional grade sound device be used to attain the best modem performance results.** A professional grade sound device is expensive at $500USD+, however they provide the best audio characteristics in a COTS device.

The sound device used should be dedicated to that of being the radio modem physical layer device and not used as the Windows system sound device or used by any other software application. If for some reason another two-way communications sound device based software tool MUST be running and using the same sound device, the MS-DMT tool **MUST** be started running first.

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

NOTE: Optionally, 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, but if you do so all delay settings must be at their absolute minimum.

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

NOTE: External terminal programs running on the same PC require the use of a paired set of VCP ports where the use of Com0Com 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.

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

INSTALLING MS-DMT FOR THE FIRST TIME

The install program, INSTALL.EXE, by default installs to "C:\MS-DMT\". The software may be installed to any Windows directory on your computer using Windows XP. However, Do **NOT** install the software under "C:\PROGRAM FILES\" when using either MS-Vista, MS-Windows 7, MS-Windows 8 or later due to file access restrictions imposed with these operating systems and be sure to install using Administrator rights.

NOTE: When running on native versions of Windows newer than Windows XP do NOT specify to run as a Windows XP SP3 application or anything else using Compatibility Mode emulation.

The required installation steps are:

1. Either directly install the distribution archive file MSDMTxxvxxxBxxxx_FI.ZIP in step 2 or unzip into a temporary directory and 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 2008PRO redistribution install (vcredist_x86.exe) will automatically start, accept the license agreement, then follow all screen prompts through to completion.

NOTE: If the INSTALL.EXE used is not the most recent, then before running the MSDMT_xx.EXE file, acquire the partial install archive (MSDMTxxvxxxBxxxx_PI.ZIP) and run its INSTALL.EXE, or just unzip the contents of an update archive (MSDMTxxvxxxBxxxx_UD.ZIP) or run its INSTALL.EXE if one exists, into the sub directory where MSDMT_xx.EXE was originally installed on your computer.

The software is now installed and awaiting configuration, skip the next section and proceed to "REQUIRED FOLDERS".

INSTALLING AN MS-DMT UPDATE

The process for installation of a software update can be one of two methods as detailed below.

NOTE: **If you have NOT previously installed an earlier MS-DMT version, then you MUST run the current full install of MS-DMT before installing an update version.**

1. With an existing MS-DMT installation that has been properly configured and tested, make sure you save the existing MSDMT_32.EXE and DMT.DAT file to a safe location as the update may have a changed DMT.DAT file structure, thus your existing DMT.DAT file will be considered corrupt and will be over written if present by the new version when started.

2. Then after backing up your existing MS-DMT installation either write over it or create a new sub directory to copy over all existing files before installing the updated files.

3. Depending on the update distribution contents, either run the INSTALL.EXE contained in the partial install archive (MSDMTxxvxxxBxxxx_PI.ZIP) update or run the INSTALL.EXE if one exists or just extract the files contents of an update archive (MSDMTxxvxxxBxxxx_UD.ZIP) into the sub directory where MSDMT_xx.EXE was originally installed.

NOTE: Users of Vista or later should not copy or install updates into additional directories without first uninstalling as the log files in the originally directory will likely be used by both installations.

REQUIRED FOLDERS

There are three folders or directories if you prefer, that are created during the execution of the INSTALL.EXE which must exist, the "dalog, owlog and Download" directories as seen below.

Name	Size	Type	Date Modified ▲
dalog		File Folder	4/15/2013 7:00 PM
Download		File Folder	4/15/2013 7:00 PM
owlog		File Folder	4/15/2013 7:00 PM

When installing the software for the first time these directories will be created, the same is true of installing any updates that provide an INSTALL.EXE, which will create the directories should they not exist. However, when extracting an update where no INSTALL.EXE is provided or when moving the software to a new location, such as a USB stick, these directories must be copied or otherwise created in the process for all features of the software to work properly.

NOTE: Users of Vista or later should not copy or install updates into additional directories without first uninstalling as the log files in the originally directory will likely be used by both installations.

COMPATIBILITY MODE

Do **NOT** select to run MSDMT_32.EXE in Compatibility mode under Vista or later.

However it is recommended to initially check "Run the program as an administrator" in order get all the features to work properly. When you resize MS-DMT and or move it around your desk top it will retain those settings for the next time you use the tools, but only when doing so if being run in Administrator mode.

To run as Administrator requires the user to right click on the MS-DMT_32.EXE in its folder, select Properties, select Compatibility and check "Run this program as an Administrator".

The complication is that after you do so, you will then get the stupid message dialog displayed stating "Do you want to allow the following program from an unknown publisher to make changes to this computer?" each time you start the tool where you need to click the "Yes" button. This stupid dialog will come up each time you run the program unless after setting the size and location of MS-DMT how you want it once, you shutdown MS-DMT and then go back and uncheck the Administrator rights box. After doing so the re-sizing and re-positioning will work as you set it just fine until you want to change those settings or a new build replaces the existing one, where you will need to repeat the Administrator steps.
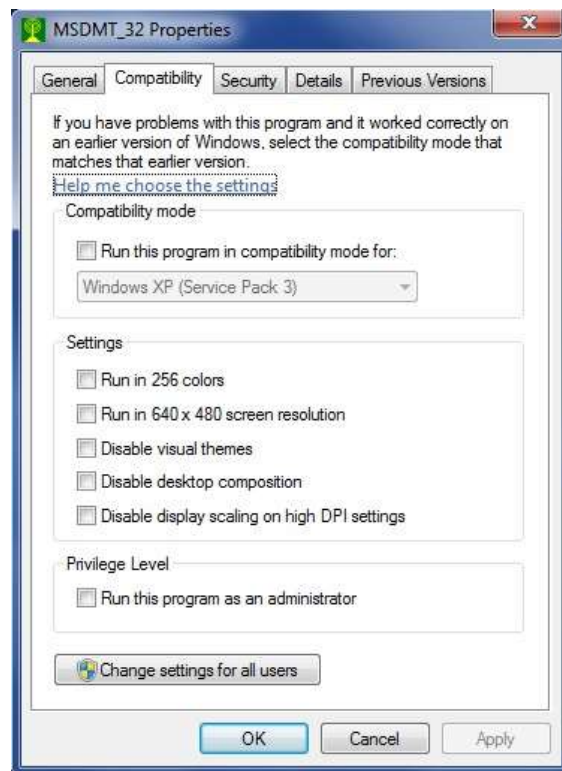
TESTING FOR SYSTEM LATENCY

The Windows OS must be tested for DPC latency issues where excessive latency issues must be mitigated to within tolerances for real-time audio streaming applications for best results using MS-DMT.

Desktop MS-Windows versions are not true real-time operating systems and do not provide low-latency response to events, predictable time-based scheduling or explicit resource allocation. MS-Windows was designed to maximize aggregate throughput and to achieve approximately fair sharing of resources, which for the most part, does improve with each new version of Windows. Desktop Windows 7 should be considered the entry level Windows OS for use with MS-DMT.

The worst case latency that can be tolerated for streaming audio support is observed when using any version of Windows while running MS-DMT as seen below on Windows 7 32 bit using the "DPC Latency Checker" tool: http://www.thesycon.de/deu/latency_check.shtml
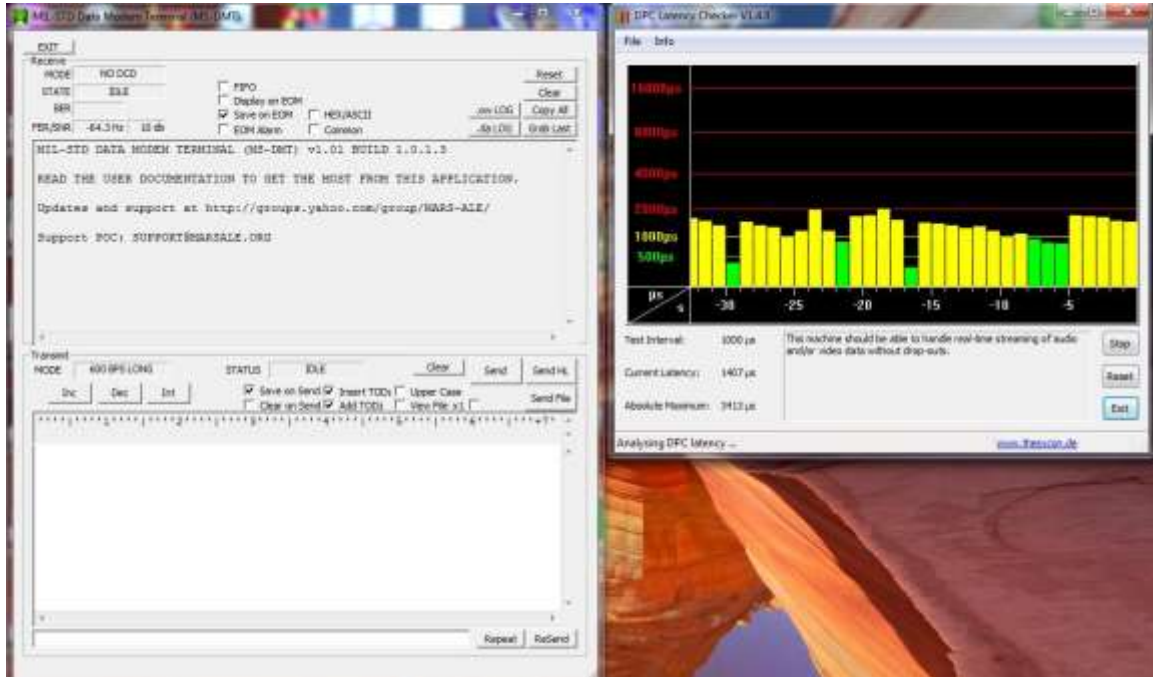
The latency with desktop Windows 7 out-of-the-box is pretty good, even with wireless networking enabled, which is a real show stopper under XP versions. However there are things that are issues, the Windows anti-virus software as to it Malware protection was an issue as seen below on the version of Windows 7 Profession 32 bit unit under test (UUT).
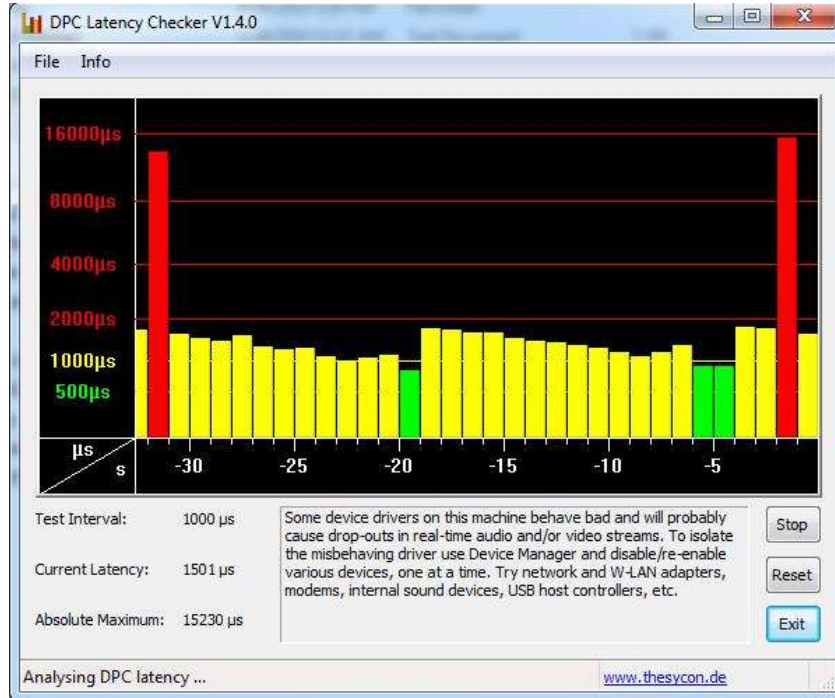
The Latency Monitor too; provides a processes display facility rapidly provides a view of the offending process as being the Microsoft Malware Protection (msmpeng.exe) process that at time was hitting well over 800 hard page faults as seen below.

Changing the "Priority" of "msmpeng.exe" to LOW or disabling it using Windows Task Manager resulted in the following low latency on the laptop UUT:
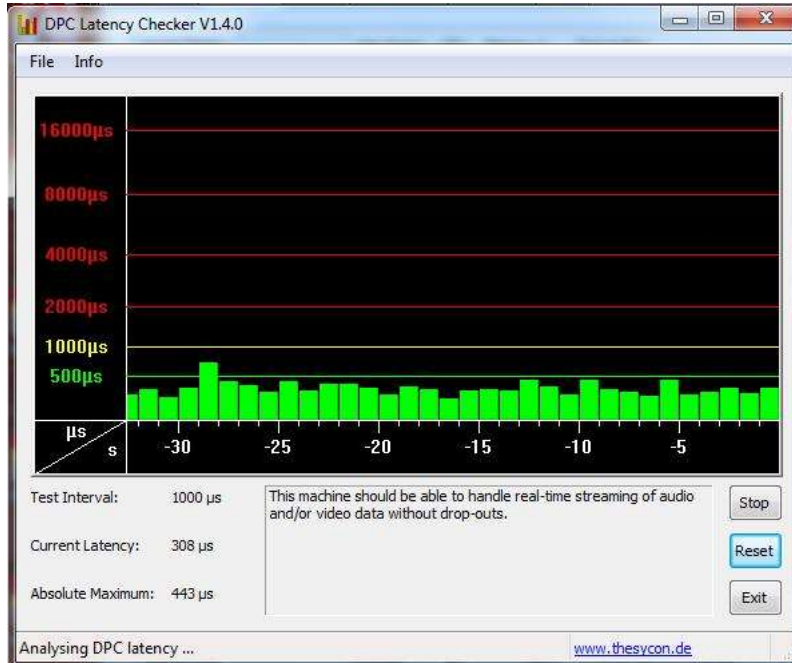
The Windows Embedded Standard 7 (WES7) OS has been extensively tested using MS-DMT, and provides extremely low latency and it also works the best on the minimum PC hardware supported. Windows 8.1 on Tablet PC's from all reports and extensively tested on a Winbook TW700 unit also provides low worst cast latency out-of-the-box as seen below on a low end Atom CPU based Winbook TW700 tablet as a worst case example.


However the amazing low out-of-the-box latency as seen below when using WES7 is absolutely a perfect example of what is desired and required. In all testing of WES7 on two different PC's from an

30

MS-DMT Guide v1.06

Released 10-31-2015

older Dell GX-520 P4 to a modern Atom based unit, nothing ever spikes the latency too high. Below is a screen cap from the GX-520 P4 system as a worst case example!
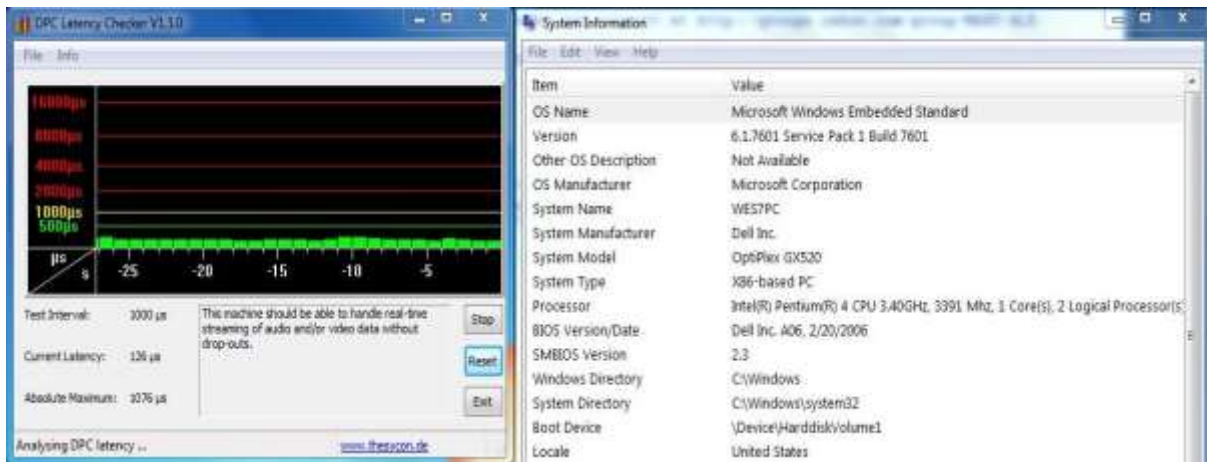
Any latency issues on any version of Windows that even briefly spikes into the RED using the visual display of the DPC tool when NOT running the software defined MS110A modem precludes its use on that computer system.

When a Windows device driver cannot process data immediately in its Interrupt Service Routine (ISR) it schedules a Deferred Procedure Call (DCP), both of which operate at the highest priority code that runs in the system. Neither an ISR or DCP can be pre-empted by the operating system, they each run to process completion. ISRs and DPCs that run too often or too long degrade system performance by using too much CPU time and can cause audio timing issues, serial port timing issues, video pauses, erratic mouse behavior and numerous other system problems.

The recommended tool for audio latency testing of DPCs which can be used through Windows 7 can be downloaded from:

http://www.thesycon.de/deu/latency_check.shtml

Another latency test tool that requires MS-Vista or later versions of Widows can be found at:

http://www.resplendence.com/download/LatencyMon.exe

These tools will identify both DPC and ISR issues as aids in tracking down such issues to the offending process. The LatencyMon tool provides a number of display modems that aide in tracking latency issues down the offending process(es) or driver(s) that require disabling.

Here is the DPC Latency Checker tool is running on an XP Home SP3 system with excessive latency, which requires mitigation prior to use of the software.
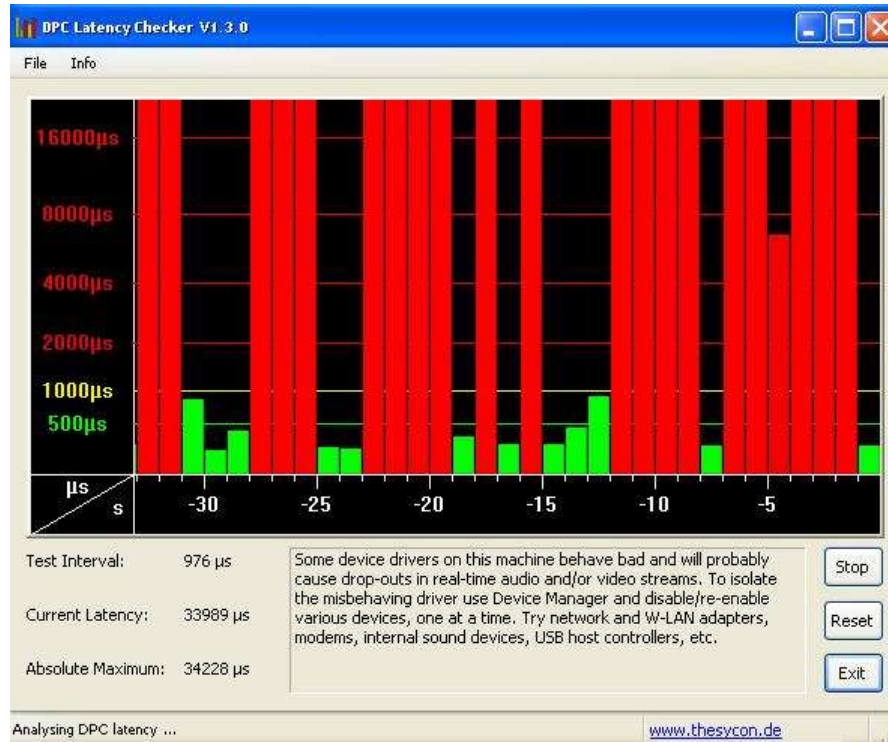
The process of determining what process is the offending one requires motoring all processes with the Windows Task Manager or better yet Process Explorer (procexp.exe) available free from http://technet.microsoft.com/en-us/sysinternals/bb896653 to associate the timing of CPU loading or RAM increases with latency spikes and disabling the process to see the results on latency. When you look at Windows Task Manager and sort the running processes by CPU (Processor Utilization), the System Idle Process is almost always at the top of the list. What you may not know is that "process" is really a roll-up of several things. Among other things, included in that CPU number, is hardware interrupts and DPCs.

After you have disabled a process watch DPC Latency Checker. When excessive latency values disappear you found the responsible device driver. If there are still exceptional large DPC latencies try the next process. You will likely see large spikes of short duration when opening and closing applications and or files and during mouse moment, continual such spikes would be a negative issue during use of the software. The MS-DMT program itself while running will cause latency issues.

It has been found that network card drivers and wireless networking especially and various programs making use of network connections, such as e-mail clients, web browsers and others are some of the worst case processes regarding latency. Any device driver for plug-in devices are suspect, to include your sound device. Other negative processes affecting latency are viruses and malware, firewall, anti-virus and anti-malware software, screen savers, system hibernate, resources that power down devices, any process that automatically starts whenever it wants, especially ones that try to connect via the Internet, e.g. GoogleUpdate.EXE and other such processes that load CPU, RAM and cause DPC.

MS-DMT Guide v1.06

Released 10-31-2015

The replacements of a HDD with an SSD will also reduce latency during data storage I/O.

If a PC cannot be dedicated to running the software it recommended that disabling wireless networking and anything found to be a latency issue and that a startup check list be created and checked prior to use of the software in disabling all such processes.

Below, the same XP Home SP3 box after disabling Wireless and Wired Networking and all associated processes, the amount of latency is now well within tolerance. However use of XP is limited taking into account all that must be done to make is usable. In the not-to-distant future XP and Vista will cease to be supported.
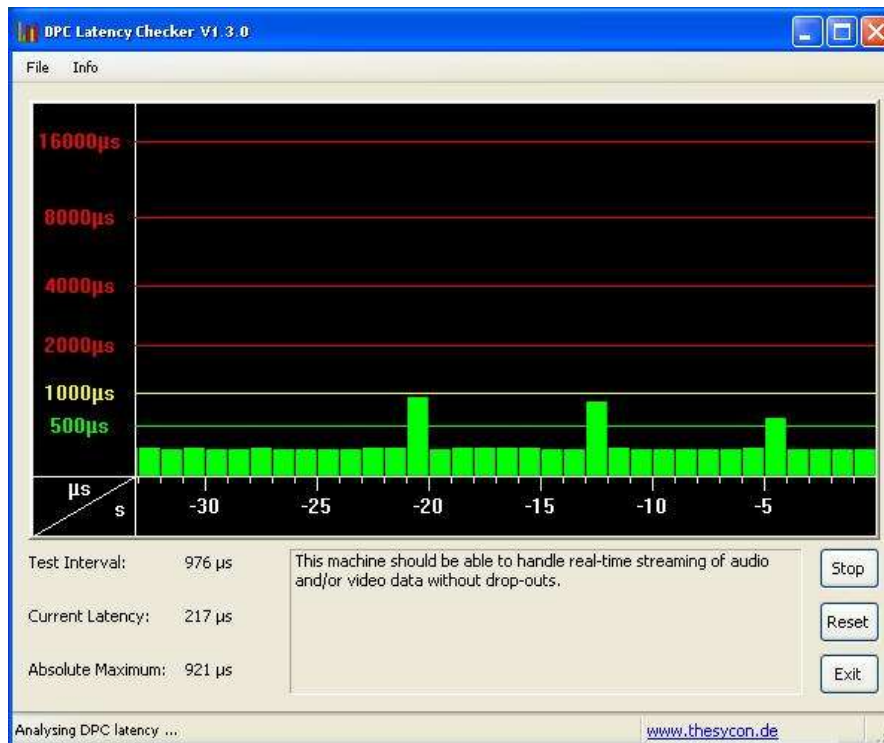
For streaming audio it must never go above 2000us and for our use we want it below 1000us and best results are had below 500us.

Whatever is found to be an issue must be disabled during MS-DMT use. If it is something that you feel you must have working during MIL-STD modem use of the PC you will need to find a substitute that is under 1000us in latency or better. Remember to periodically check after system updates and installs of new programs to determine what new offending processes may have been added if you abstain from such practices and dedicate the PC to MARS communications.

Windows XP support is limited, however to achieve better Latency while it is still supported navigate to System Properties and click Advanced > Performance options. Optimize performance for Background Services, not Applications which can enhance sound device driver performance.
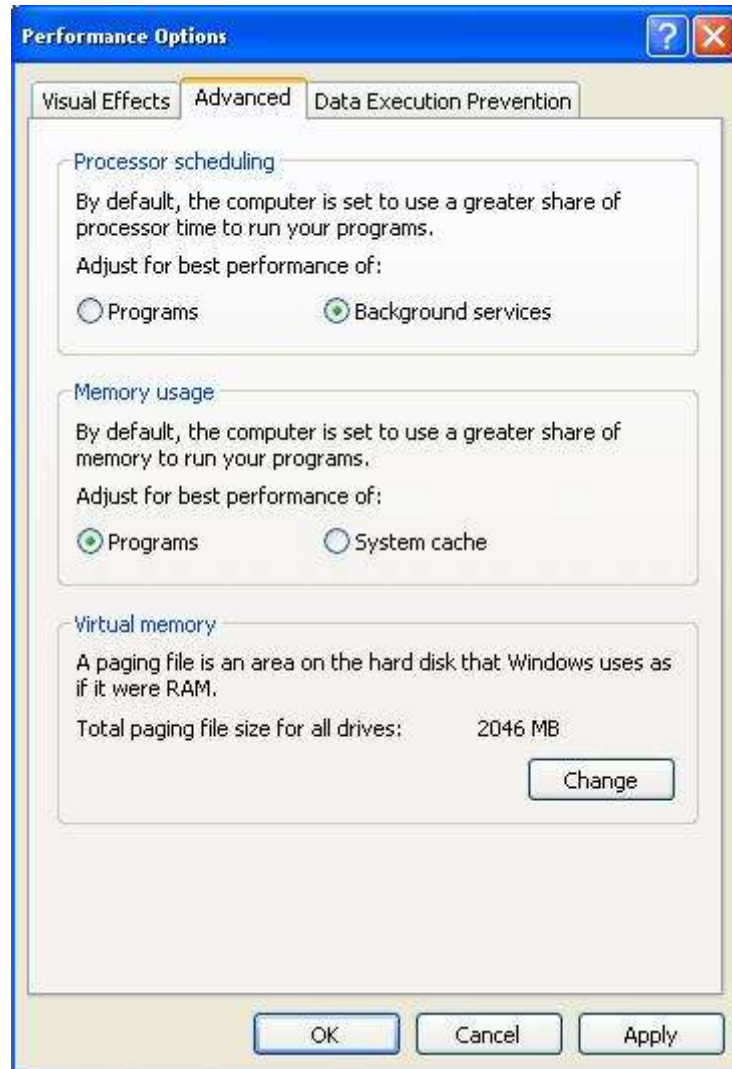
A decent reference on many more issues and OS versions can be found at:

http://www.tweakheadz.com/troubleshooting_audio_cards.htm

A clean install of the Windows operating system and never connecting the computer to the Internet is the best situation.

However if the computer is to be used for general application and connected to the Internet at times, it is recommended that either the computer run software applications such as real-time anti-virus and anti-malware when being used for such purposes that that such software be disabled prior to the use of the MS-DMT tool. At a minimum, the computer should be checked prior to the use of the MS-DMT tool for any infestation. For those on a budget, there are a number of good free tools available for such testing of the most common threats, some of the best tools which are updated frequently are:

McAfee Root Kit Remover: A stand-alone utility used to detect and remove complex rootkits and associated malware when the user decides to use it.

http://www.mcafee.com/us/downloads/free-tools/rootkitremover.aspx

McAfee Stinger: A standalone utility used to detect and remove specific viruses when the user decides to use it. It is not a substitute for full anti-virus protection, but a specialized tool to assist administrators and users when dealing with infected system. Stinger utilizes next-generation scan technology, including rootkit scanning, and scan performance optimizations. It detects and removes threats identified under the "Threat List" option under "Advanced menu options" in the Stinger application.

http://www.mcafee.com/us/downloads/free-tools/stinger.aspx

Clamwin Free AntiVirus: An Open source GPL virus scanner. ClamWin is a Free Antivirus program for Microsoft Windows 8/ 7 / Vista / XP / Me / 2000 / 98 and Windows Server 2012, 2008 and 2003. ClamWin Free Antivirus is used by more than 600,000 users worldwide on a daily basis. It comes with an easy installer and open source code. You may download and use it absolutely free of charge. It features: High detection rates for viruses and spyware; Scanning Scheduler; Automatic downloads of regularly updated Virus Database. Standalone virus scanner and right-click menu integration to Microsoft Windows Explorer; Addin to Microsoft Outlook to remove virus-infected attachments automatically.

http://sourceforge.net/projects/clamwin/files/clamwin/0.97.8/clamwin-0.97.8-setup.exe/download?use_mirror=softlayer-dal

SpyBot Search and Destroy: Advanced Spyware protection for home use without the always resident running code and nagging messages to update the database, the user looks after their updates to the tool manually and decide what actions to take regarding potential threats found.

http://www.safer-networking.org/dl/

MalwareBytes: Advanced Malware Detection and Removal of Viruses, Worms, Trojans, Rootkits, Dialers and Spyware. Industry Proven Clean-up Technologies Eradicate Existing Malware Infections. Rapid Response Malware Database and Heuristics Updates where the tool is always resident for use and updates and must be exited from manually by the user after rebooting the computer.

http://www.malwarebytes.org/lp/malware_lp_form/

STARTING THE PROGRAM

When the program is started for the first time after initial install or update it may generate a "Windows Security Alert", if so just click just on "Unblock". In addition, any Anti-Virus or other such tools may also need adjusting to allow the MSDMT_32.EXE executable to run, but such programs should really be disabled during the use of MS-DMT.

When the MS-DMT software is started for the first time a DMT.DAT file will be created with default configuration settings and the main screen will appear as follows:
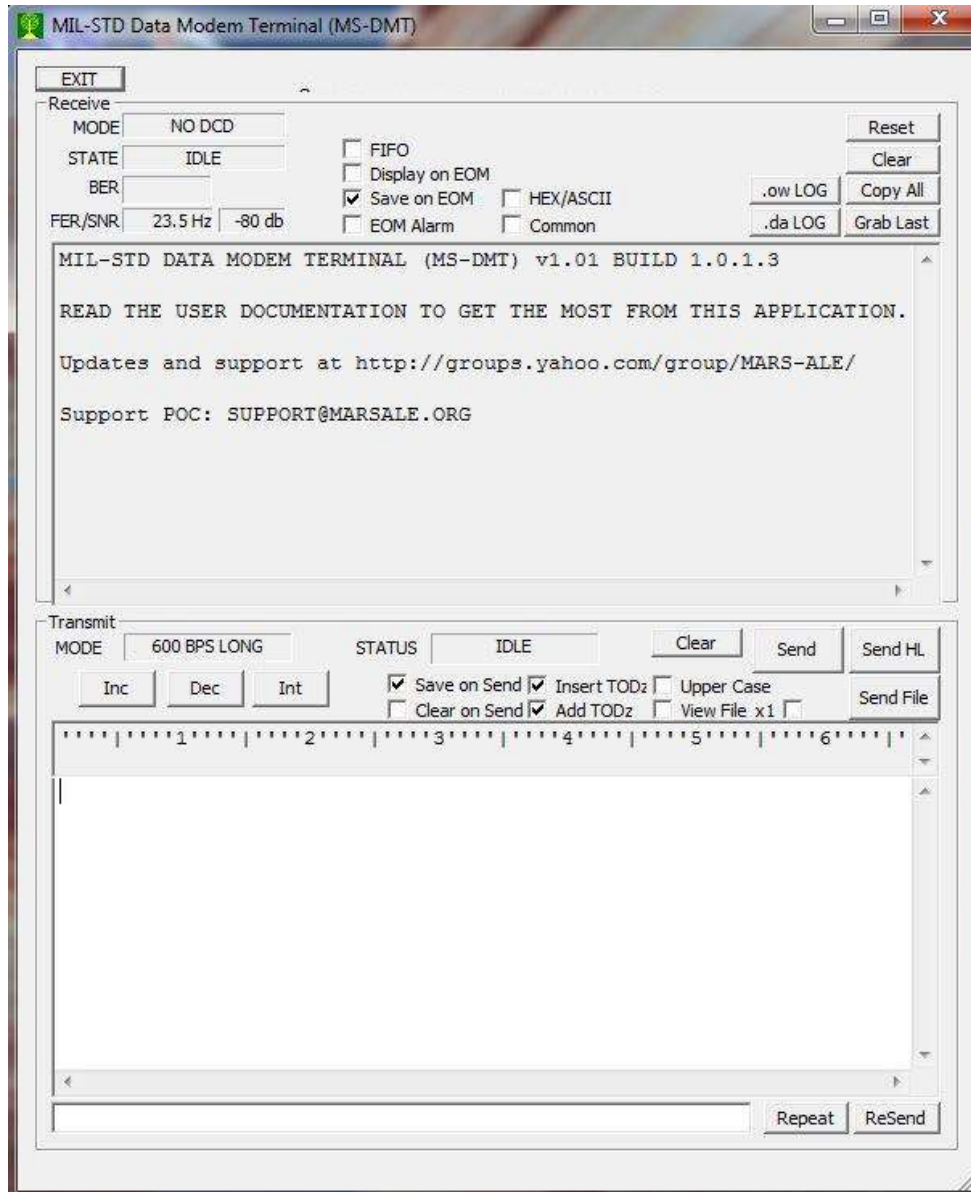
If the prerequisite mono spaced font "Letter Gothic MT" is not installed then the screen will appear as seen below using the MS Dlg Font size 8, which is not a mono spaced font.
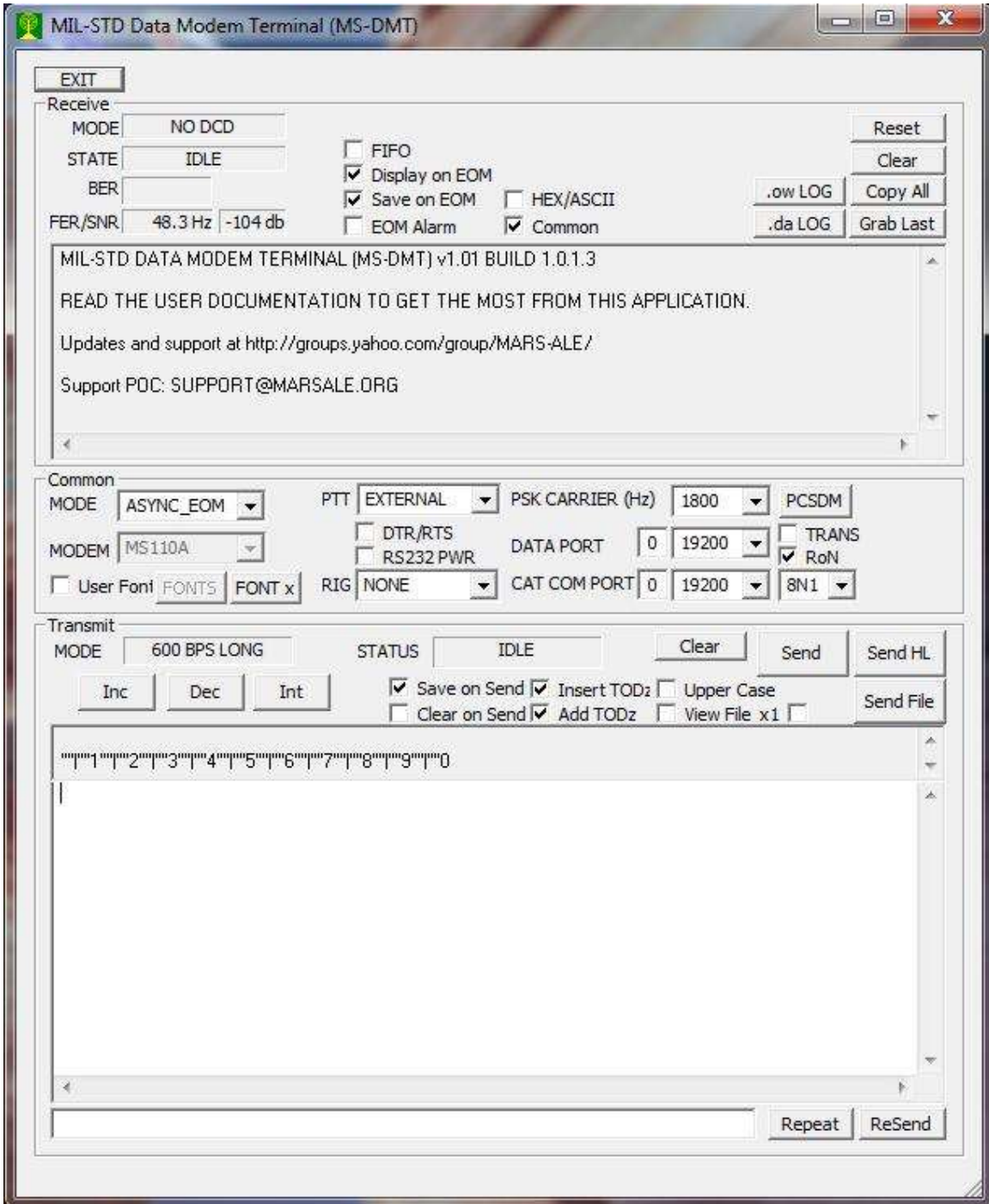
The default coding of the application requires that "Letter Gothic MT" be installed, otherwise check "User Font" and click the "FONTS" button to select a mono spaced font like Courier New for best text display and proper operation of the 'Ruler" display bar else double click it to hide.

The "Ruler" display bar is setup to the same font as the message windows and thus allows the user to keep an eye on their text line length during composition based on the GUI being sized large enough to display the entire message as the "Ruler" does not scroll at present. The "Ruler" display

can be disabled by double clicking the "Ruler" (then double clicking the transmit window to re-enable) and right clicking the "Ruler" will enable/disable the 69th character marker as seen below.

NOTE: Should the Ruler display become corrupt, delete the DMT.DAT file and reconfigure.

The use of a mono spaced font causes each character to take up the same amount of horizontal space so all characters line up for rapid visual for such things as coded groups to detect any hit in the message received. Also the zero's are slashed when the default "Letter Gothic MT Bold" or other fonts that support slashed zero's such as Consolas are used.
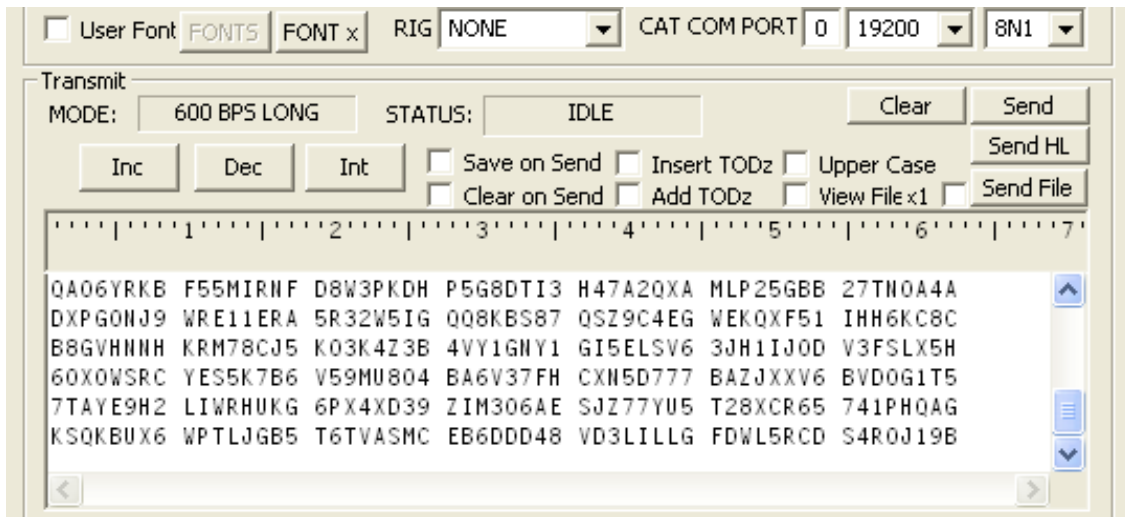
The Ruler display for the given GUI default size will display a calibrated scale sufficient for a 69 character line length with using "Letter Gothic MT" size 8, the default font. If the optional size 12 font or any custom font is selected the GUI will require resizing. When resized large enough, depending on the font and size and screen resolution, it can be seen that the Ruler is calibrated out to 100 characters as seen below, which far exceeds the normal line length used in MARS and Military communications.

The GUI foot print of the program is completely resizable to full screen and to a reduced footprint within reason for use on netbooks, tablets and whatever other small or hand held Windows computers with reduced screen sizes and resolution, however resizing requires some attention to detail, see Appendix B for the full details. The size, location and state of the GUI is saved upon normal termination of the program for use upon restart.

When the MS-DMT software is started for the first time, the main screen divided into three panels from top to bottom; "Receive", "Common" and "Transmit". The Common panel is enabled for display and use whenever the "Common" check box on the "Receive" panel is checked, when unchecked as seen below, its hidden.
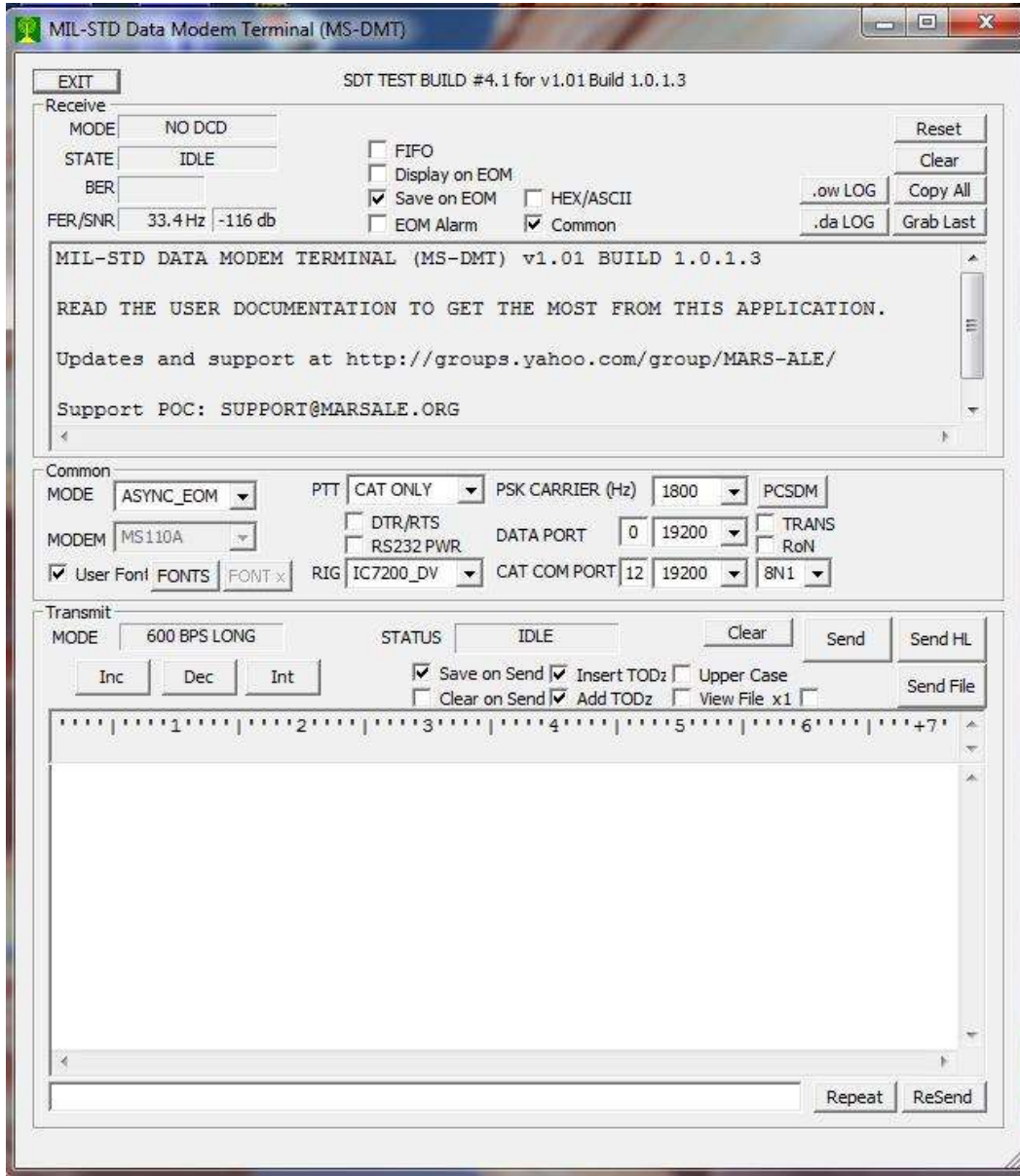
The various selections on the "Common" panel apply to both "Receive" and "Transmit" whereas the selections on the other panel pertain to "Receive" or "Transmit". The "EXIT" button which is outside the panels is accessible even during transmit, must be used to properly terminate the application.

The program is easy to use, just select the configuration settings for your station particulars then close the "Common" panel or leave it open, then select the desired data rate and interleave for transmit and the other terminal parameters as detailed herein and you are ready to automatically receive using MS110A at any incoming settings and to edit or paste or load from a file your message and to send your message.

All user selected settings are saved each time program is properly terminated, however should the DMT.DAT file be corrupted or deleted all settings (aside from the screen position which are saved to the Register) for the last use will be lost and the program upon restart will once again come up as if it was first installed.

SETTING MS-DMT PRIORITY

If a program (windows process) has a higher priority, it gets more processor time compared to a process having lower priority. The MS-DMT tool will work ok with the "Normal" priority level as the most important threads in the application itself are prioritized, however running MS-DMT "Above Normal" or higher can be an advantageous, especially on decoding during receive. However depending on the particular host PC/OS environment, it may also be a negative, users with older PC systems will need to test the performance benefits of changing the priority level of MSDMT_32.EXE on their systems. MS-DMT has been tested running in "Real time" under the minimum OS/CPU/RAM combinations specified here in with excellent results.

To change a process priority using "**Windows Task Manager**". Open Task Manager by right-clicking on Taskbar and select "Task Manager" or by pressing "**Ctrl+Shift+Esc**" keys together. Once you open Task Manager, go to "**Processes**" tab, right-click on any running process and change the priority using "**Set Priority**" menu. You'll notice some system processes are set to "**High**" priority and almost all 3rd party processes are set to "**Normal**" by default.

However, although you can change the priority of an application according to your requirements, the priority is not set permanently. Once you restart your system, Windows forgets your custom priority and assigns the process a default priority**.** So how to set a process priority permanent? Don't worry, here is the solution. "**Prio**" (http://www.prnwatch.com/prio.html) is a free for personal use utility which solves the problem. It adds a new option "**Save Priority**" in context menu to save the priority permanently.
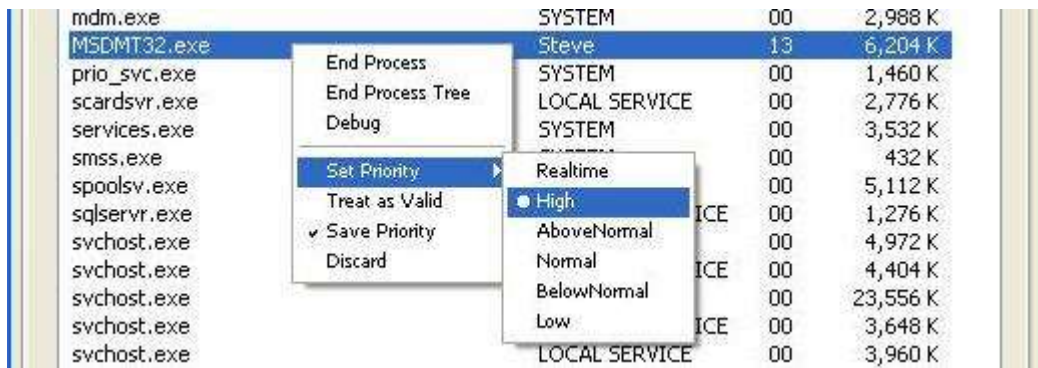
PRIO also adds a few extra features, the new tab "**Services**" which shows the installed processes along with their status. The new tab "**TCP/IP**" which shows all established TCP/IP connections and all open ports. A new option "**Silent Elevation**" which allows you to execute a software with administrative privileges. You can download PRIO using following links for 32 and 64 versions supporting through Windows 7:

http://www.prnwatch.com/prio.exe

http://www.prnwatch.com/prio_x64.exe

Alternately, you could launch MSDMT_32.EXE via a batch file and set the priority for the duration of each use by creating a Batch file such as DMT.BAT which contains:

cmd /C Start /high C:\MARS\MSDMT\MSDMT_32

SETTING PROCESSOR AFFINITY

If you have a computer with more than one processor, you can set Windows processes to use different processors in order to make a program run faster or to isolate a particular program that uses a lot of processing power. This is called Processor Affinity. Setting Processor Affinity (a.k.a. CPU Pinning) limits the execution of the program or process to the selected processors and might increase the programs performance but may decrease overall performance. The use of Processor Affinity with the MS-DMT tool will depend on the CPU or CPU's on the host PC and the effects noted in performance.

Windows XP, Windows Vista, and Windows 7 applications by default run on all available cores of the processor. If you have a dual or quad core processor, then you can set affinity to an application to control which core of the processor an application can use, in this way you can assign one application or a program to use only one physical processor or one core of a multi-core processors while all other applications can run on other processor or cores. Although you cannot set priority to system services but you can set affinity to applications, in this way you can achieve a good overall performance. When installing additional software you need to check that the installation does not invalidate your MS-DMT tools dedicated configuration or either its own processor or core.

In Windows, you can force a process to run in a specific CPU just using the Task Manager (right click your process and select "Set Affinity"). The "Set Affinity" command selection is available only on multiprocessor computers supporting its use. To set affinity, you can go to the Processes tab in the Windows Task Manager. The process for making use of the Task Manager to set affinity if supported on the system in question is to first right click on the application and click on "Go To Process" as seen below.

Then the MSDMT_32.exe will be highlighted and again right click and click "Set Affinity".

You'll now get the Processor Affinity dialog, which will have 32 check box options, all grayed out except for the number of CPU's on your computer. You see that MSDMT_32.EXE is making full use of the dual core processor. The process is the same for Vista and above.
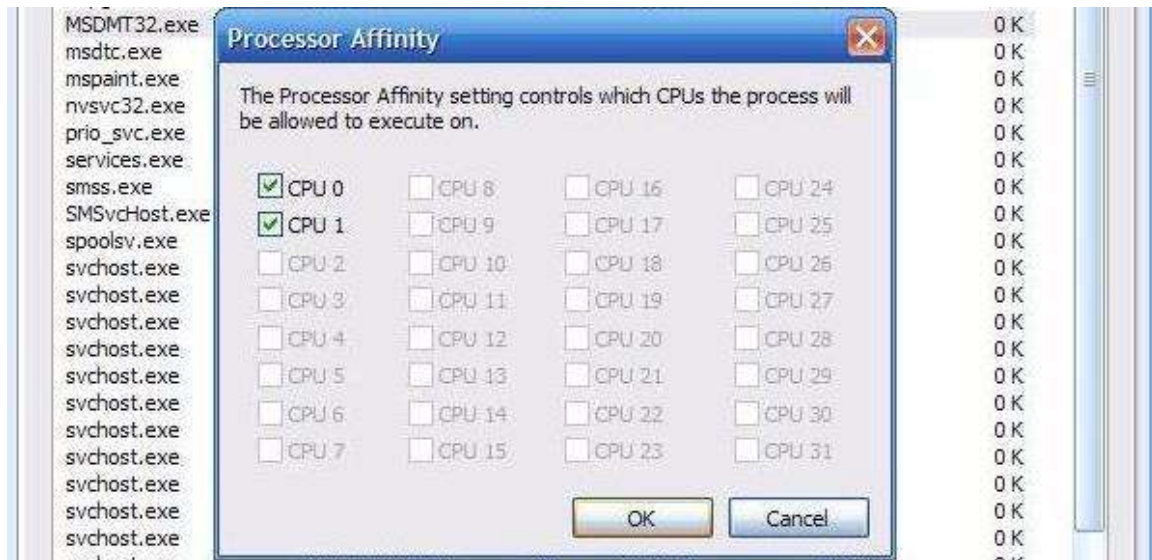
In Windows, if you have a dual core processor, it will look like there are two processors in Windows, however there really is only one processor and TWO cores. So in a single dual core system you'll see CPU 0 and CPU 1. The first one is the physical process and the second one is the virtual processor.

In a computer that has two dual core processors, you'll see CPU 0, CPU 1, CPU 2, and CPU 3 where CPU 0 and CPU 1 are both the physical processors and CPU 2 and CPU 3 are the virtual processors. Note that setting processor affinity is only useful for programs that actually support hyper-threading.

If you try this on a non-hyper-threading process, it won't make any difference and could actually slow your computer down. An issue you might see on a dual core machine is slower running and using up 100% of the CPU. You can go into the Processor Affinity dialog and un-check one of the cores so that the program uses only a single core/

- It is recommended **NOT TO** change the **Process Affinity** for **System Processes**.
- The processor affinity setting lasts as long as an application is open, when you close the application or restart the computer, the affinity returns to the default.

Set processor affinity can be set automatically from a batch file down to Windows XP using Microsoft's Sysinternal's psexec's -a flag.

Usage: psexec [\\computer[,computer2[,...] | @file][-u user [-p psswd]][-n s][-l][-s|-e][-x][-i

[session]][-c [-f|-v]][-w directory][-d][-][-a n,n,...] cmd [arguments]

 -a   Separate processors on which the application can run with commas where 1 is the lowest
       numbered CPU. For example,   to run the application on CPU 2 and CPU 4, enter:

    "-a 2,4"

For example:

psexec -a 2 cmd /c "echo.|MSDMT_32.EXE"

Windows7 has affinity for the start command, but XP does not, for example:

start /affinity 2 MSDMT_32.EXE

PC SOUND DEVICE SELECTION

All PC Sound Devices (a.k.a. Sound Cards) are not created equal and all operating systems do not treat the same sound device equal. There are a number of important considerations when selecting the PC sound device for use as the hardware modem portion (PC Sound Device Modem) of this software solution.

In general a PC sound device (or sound chipset) includes, among other things, an Analog to Digital Converter (ADC) for converting external sound signals to digital bits. A Digital to Analog Converter (DAC) for converting digital bits back to sound signals. The MS-DMT software requires an Audio Codec 97 (AC'97) compliant sound device where for our needs both ADC and DAC are two-channel (stereo), 16-bit resolution or better, and must natively sample at 48kHz or higher and provide at least a 100-4,000hz flat frequency response with no artifacts. Details are provided on sound device driver configuration in the next section, which cover devices with greater raw maximum sample rate than 48kHz.

The dynamic range and frequency response of the average sound device is more than adequate for low symbol rate software modem needs. However for our high 2400 baud symbol rate modem needs the sound device must adhere to more rigid characteristics, in particular:

- High Signal to Noise Ratio (DAC 100db SNR or greater and ADC 92db SNR or greater preferred) and Dynamic Range (DAC 95db SNR or greater and ADC 90db SNR or greater preferred) on input and output.

- Low Total Harmonic Distortion + Noise on input and output.

- An accurate, high stability sample clock (less than 10ppm error being best) on input and output.

- Low sample clock thermal drift stability.

- Sample clock with low deterministic jitter (where period jitter of less than 100 pico secs. (ps) RMS) is required for DAC/ADC data conversion timing.
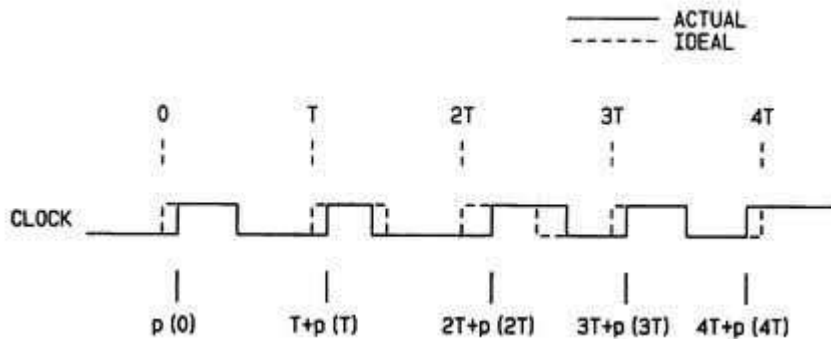
Low jitter is a big issue in digital audio system related with timing variation in variable clock position. If you have high jitter in your system (ADC or DAC) then the actual result of the conversion process can be either too early or too late rather than ideal. Jitter is the timing variations of a set of signal edges from their ideal values. Jitters in clock signals are typically caused by noise or other disturbances in the system. Contributing factors include thermal noise, power supply variations, loading conditions, device noise, and interference coupled from nearby circuits.

The sound device characteristics will determine its usefulness as a PC Sound Device Modem for use with the software defined modem due to the complex MS110A waveform and its constant 2400 baud symbol rate. An accurate and stable sample rate is critical for accurate Digital Signal Processing (DSP). Differences in sample clocks between stations, thermal clock drift and latency will lead to symbol decoding errors and loss of synchronization.

NOTE: Never have any external PC Sound Device Modem resting on top of equipment that heat and or cool and never have them in direct sun light, a stable thermal environment means less drift.

The screen cap (and video at the URL provided) below are of two external USB sound devices in closed loop baseband audio testing. As can be seen, the top device has artifacts being generated internally which raise the noise floor and mix in with the incoming MS-110A signal being received causing the modem receiver to work harder. Whereas the bottom devices exhibits the qualities desired of a USB sound device for our modem needs.
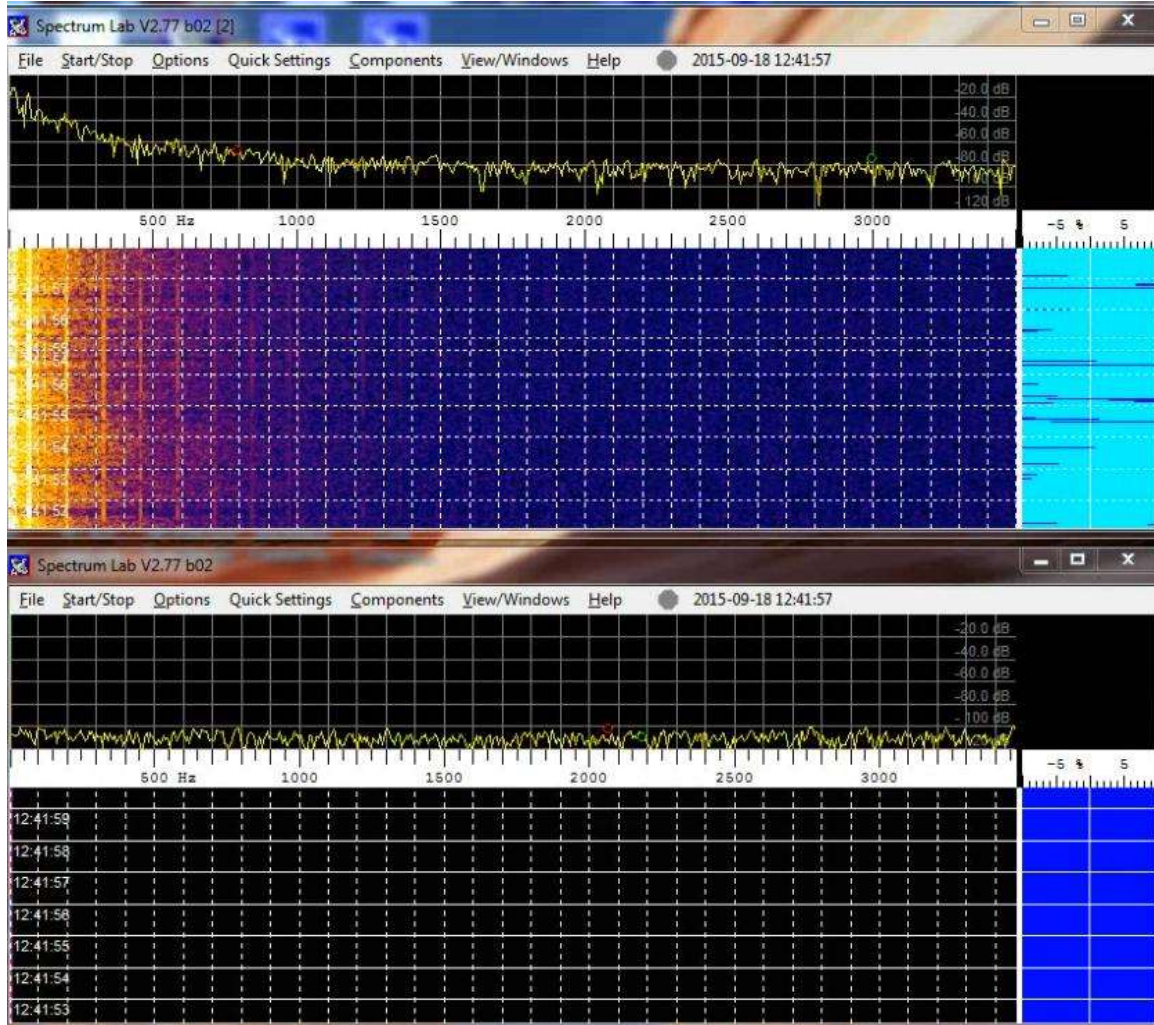
www.n2ckh.com/MARS_ALE_FORUM/SideBySide.wmv

The following sound device class solutions will provide different minimum and maximum data rate operation over the range the specified channel condition performance requirements found in the MIL-STD as follows:

- On-the-Board PC sound device chipset use is NOT recommended. If one is lucky they can often provide reliable support of 75bps to 600bps for reliable MS110A operation at **MOST** due to their noise floor and deterministic phase jitter issues. However they often suffer at the lower data rates due to poor sample rate accuracy and drift which causes loss of DCD the longer the message. The issue of sample rate issues are most noticeable at the lower data rates, especially 75bps. If using an On-the-Board device and it is the only sound device in the PC, then System Sounds **MUST** be disabled, which is SOP for all such device use in digital comms and an absolute requirement with this tool. The cabling between the PC and radio are often susceptible to RF interference and are also often sources of EMI, which limit effective operation.

- Plug-In (e.g. PCI card, PCMCIA CardBus Type II) sound devices are likely to fall short of providing the modem with the required environment to provide full modem performance. Some can be found to support 75bps to 600bps and often 1200bps and in some cases 2400bps for MS110A reliably if one is lucky. These devices have somewhat less noise and phase jitter than on-the-board devices. However they too often suffer at the lower data rates due to poor sample rate accuracy and drift which causes loss of DCD the longer the message. The cabling between the PC and radio are often susceptible to RF interference and are often sources of EMI, which limit effective operation.

- External sound devices (e.g. USB 2.0/3.0 port devices and Firewire 400 (IEEE-1394) Firewire 800 (IEEE-1394B) sound devices) usually offer the lower noise and lower phase jitter than most internal devices. The use of most external devices should provide reliable operation at 75bps through 2400bps for MS110A operation. Support of the higher coded data rates of MS110B Appendix C and S4539 waveforms when supported in software modems is also likely. However USB ports and the use of USB hubs can have a negative impact on sample rate accuracy. As such all USB ports need to be tested for use with CHECKSR.EXE to determine the best USB port to use. USB devices can also suffer from additional latency issues when not using USB 2.0 or later. Also, be sure the USB sound device is on its own PC USB port, never go through a hub. The use of high speed USB 2.0 or USB 3.0 or eSATA/USB combo ports are best. The use of short, double shielded USB cables or cables with ferrite common mode chokes reduce RFI issues. According to Listen Inc., Firewire audio devices appear to have a problem with computers that use NEC or Agere Firewire chipsets, where Texas Instruments chipsets are preferred and Toshiba chipsets are found to work well. Radio communications interfaces with USB sound devices made specifically for Amateur Radio use provide native 48kHz sample rate at 16 bit resolution support maximum with relatively low noise and phase jitter. The use of manufacturers made radio cabling designed specifically for use with HF radio communications will usually offer higher immunity to an RF environment then do general purpose PC sound devices in the same cost range. However the use of more expensive ($500USD+) Professional USB sound devices with their custom DSP processors, where some offer TXCO referenced sample clocks and their excellent audio connectors and shielding will provide the best audio characteristics for our modem needs, they don't however provide for radio PTT or CAT control and some support nothing less than 48kHz which is just fine for our modem needs. **NOTE: Many of USB radio interfaces manufactured used "pre-revision C" PCM2900 Codec devices with their known issues under MS-Windows.**

- Another class of external USB sound device is the HF SSB radio providing USB port based internal Codec support and provide a maximum native 48kHz sample rate at 16 bit resolution support with low noise and phase jitter. There use usually provides reliable operation 75bps through 2400bps for MS110A class waveform data rates. Support of the higher coded data rates of MS110B Appendix C and S4539 waveforms when supported in software modems is also likely. These radios support codec and radio CAT use via Windows and other OS's via customer device drivers. This approach usually offers higher immunity to RF than internal to the PC and external USB sound device interfaces designed for radio use

due to the single USB cable approach. The single USB cable provides for both TX/RX audio and CAT control of the HF SSB radio. However as with all USB devices, the PC USB port used can introduce issues. **NOTE: Many radios manufactured also used "pre-revision C" PCM2900 Codec devices with its known issues under MS-Windows.**

- Based on user feedback, the FlexRadio (5000/6000) systems with PowerSDR and Virtual Audio Cable (VAC) use of the radio on board TXCO and high precision ADC/DAC converters working in the virtual digital domain instead of conventional Windows driver based PC Sound Devices result in stable and clean digital mode operation as well as providing higher RF immunity. This may also be true of other similar SDR radio models such as the FlexRadio 3000 (using lesser grade ADC/DAC devices) and ANAN models and others to come along. Thus with any Windows and SDR latency tamed, the use of FlexRadio (5000/6000) and similar systems should provide reliable support of 75bps thru 2400bps for MS110A and similar class waveforms and data rates. Support of the higher coded data rates of MS110B Appendix C and S4539 waveforms when supported in software modems is also likely. For the FlexRadio setup proven to work for MS-DMT see:

  http://w3jjj.com/m110a.html and http://groups.yahoo.com/group/MARS_Flexers/

Based on these categories of sound devices, the common range of supported reliable data rates among all sound device class types is 300bps-600bps. Moving away from On-the-Board and Plug-In sound devices raises the bar to the full range of 75bps to 2400bps for coded MS110A class waveforms. However the individual radio SSB filter characteristics can be a limiting factor as to maximum data rate. The lack of a TXCO in the HF SSB radio is another limiting factor with respect to all data rates. Then there is the operating system latency issues that need to be managed with on-going review and mitigation efforts.

PC SOUND DEVICE DRIVER

All sound devices under Windows (and most all operating systems) require a device driver. A device driver is a low-level program that handles the data connections between the physical hardware and the operating system. Traditionally the manufacturers of sound devices provided drivers for their sound device hardware or family of sound device hardware. However, since Microsoft's Universal Audio Architecture (UAA) initiative, which supports HD Audio, FireWire and USB audio device class standards, a universal class of driver written by Microsoft has seen a lot of use by generic and composite USB sound device manufacturers.

It is usually best to use the latest specific manufacturers' driver for your sound device if one exists, where all features not required for modem use are disabled if possible and other parameters are configured for the best modem use performance. The use of the latest driver may even lower your sound device sample clock error which is a critical parameter in the operation of this software.
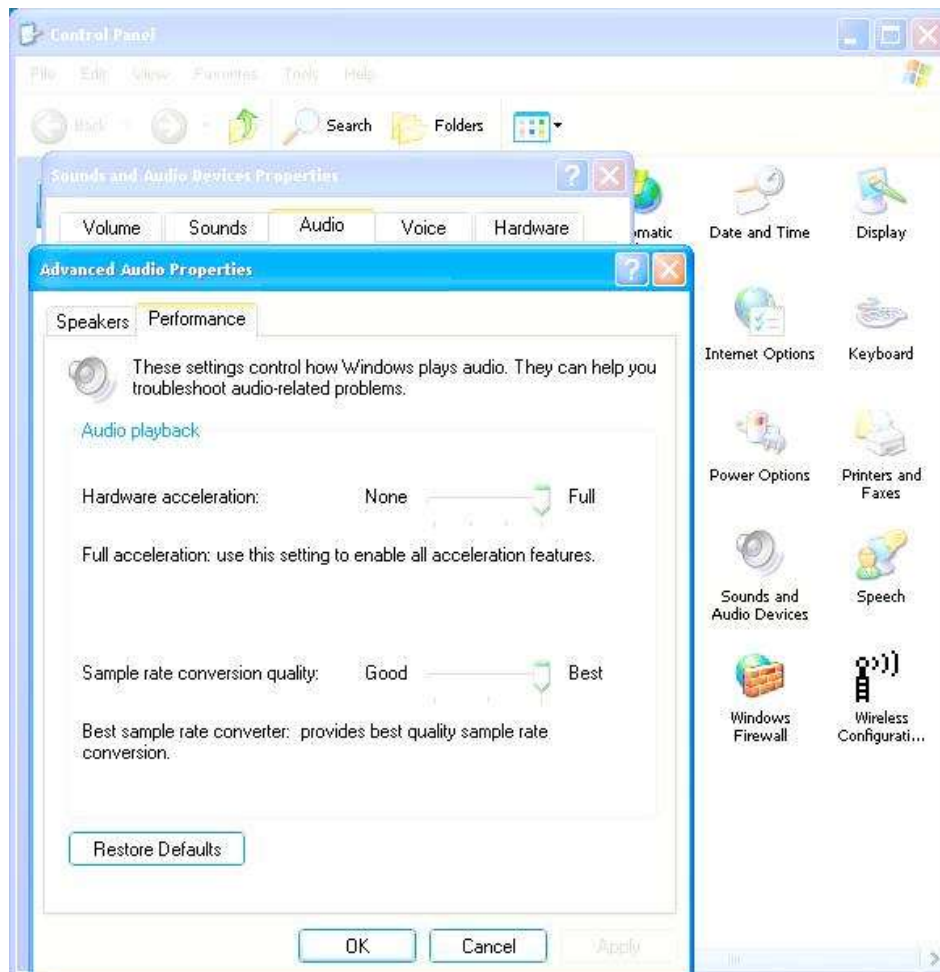
Although PC sound devices appear to support different sample rates, they actually have only one raw hardware sample rate which is the maximum rate that can be used for modem applications and achieve the effect of lower (and some times higher) sample rates by means of sample rate conversion. Such conversion is performed by the sound device driver and cannot be monitored or

disabled by application software. The sample rate conversion may introduce certain low-level distortions to the signal which preclude usefulness for modem applications, this is especially true of up conversion. In addition, most sound device drivers provide user selected levels of sample conversion to mitigate overhead in processing.

Should your sound device support a higher native maximum sample rate (e.g. 96k or better) you must select the best quality sample rate conversion in the sound device driver setup. However the use of sample conversion from a lower native raw sample rate, such as 44.1k or lower to achieve 48k must be avoided. In addition, should your sound device provide for Hardware Acceleration in its driver parameters, select full acceleration. To check these parameters select Control Panel > Sounds and Audio Devices > Audio > Advanced (Advanced Audio Properties) > Performance as seen below under Windows XP Home as seen above.

In addition, default sample rate selection under the driver properties is very important on Windows Vista and Windows 7 otherwise sample rate variance or "Error opening sound device" may occur, if your sound device driver (aside from USB port devices which are set to 48kHz default) provides for selection of 48k, select it as the default format to prevent sample rate conversion from taking place that will cause distortion artifacts even between say 48kHz and 44.1kHz. In Windows 7 the selection required as seen below is 2 channel, 16 bit, 48000Hz. Should there be any reason to run an additional program using the sound device during the use of this software, it too must use a 48kHz sample rate.

NOTE: Many external USB radio interfaces and HF SSB radios with internal USB codec support were manufactured with "pre-revision C" PCM2900 Codec devices where under MS-Windows the USB driver adds 30db of gain. One way to address this issue in Windows is to use the audio control panel by clicking on sound and then the recording tab. While observing the green level meter click properties, then go to the levels tab. Right click on the slider and change the value from Percentage to DB. If 100% on the slider reads +30db, you are affected by the bug. If the device was properly enumerated as a line in device, 100% on the slider would be 0db. Now if you have confirmed the device is seen as a microphone and +30db has been added, lower the slider until it reads as close to 0db as possible.
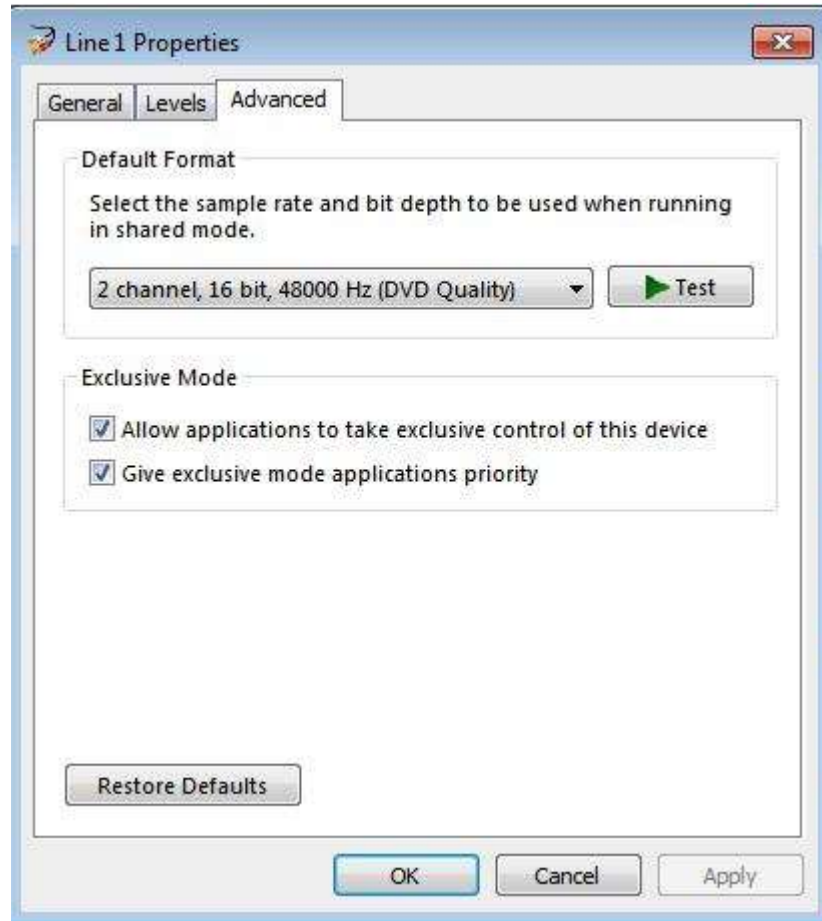
In Windows 7 and later share mode streams run in low-latency mode. The audio engine runs in pull mode with a significant reduction in latency. This is very useful for communication applications that require low audio stream latency for faster streaming.

The technical read on all this is that the hardware is programmed with the sample rate at every call to KsCreatePin:

http://msdn.microsoft.com/en-us/library/ff561652.aspx

Each exclusive mode stream results in a call to KsCreatePin.

A shared-mode stream will either:

1 .Result in a call to KsCreatePin (if there are no other shared-mode streams active)

2. Result in the audio engine mixing multiple streams and passing the mixed result down to the already-created KS pin.

The "default sample rate" exposed in the Sound control panel is what the audio engine passes to KsCreatePin for shared-mode streams.

MS-DMT Guide v1.06

Released 10-31-2015

At present this software uses one channel at a 16 bit sample size and 48kHz raw sample rate only and performs high quality sample conversion between 48kHz and the 9.6kHz sample rate required by the modem. Additional raw sample rates of 96kHz and 192kHz and additional sample sizes of 24 and 32 bits are planned for user selection so that the user can select the maximum native sample rate their sound device supports without software resampling coming into play and the best sample size. When the software provides greater sample size selections the user will need to note their sound device dynamic range to make the best choice.

Many 24-bit cards only have a dynamic range (Signal-to-Noise Ratio) of about 100dB, which actually corresponds to a resolution of only 17-bits. Whereas a 16-bit sample size theoretically provides 96dB of dynamic range. In other words, the additional bits are used to digitize noise. Thus using 24-bit cards at the currently coded 16-bit resolution in this case is better than using 24-bit resolution as there is no additional noise. Thus when 24-bit and higher resolution is coded, it will be up to the user to determine what selection is best with their hardware.

NOTE: Under Windows 7 and likely later, the MS-DMT application must be the first and preferably the only application running that uses the sound device. If the MS-DMT application is not first and the first application must be using the required 48khz sample rate as used by the MS-DMT, otherwise aliasing will occur which will degrade modem performance on both transmit and receive.

PC SOUND DEVICE CONFIGURATION

At this point the selection of your PC Sound Device is required, do so by clicking on "PCSDM" (PC Sound Device Modem) button on the Common panel, and the "PC Sound Device Setup" dialog as seen below will open.
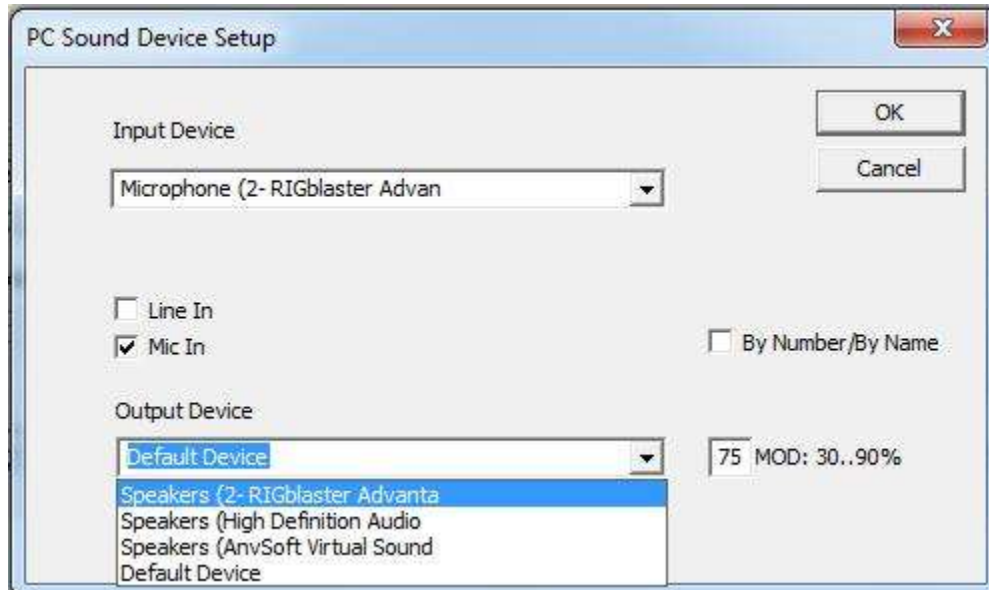
This dialog supports the selection of the PC Sound Device to be used as the modem for the software. The device selected should be a sound device dedicated to radio communications and not the system default sound device.

At first use either "Default Device" or perhaps nothing will be displayed for the Input and or Output devices. In either case, this indicates the default system sound device will be used, which we do not want. All sound devices displayed can be selected as the PCSDM by one of two means, by "Number" or by "Name". Where by "Name" is the default, to select by Number the "By Number/By Name" check box must by checked, which would be the case if upon returning to this dialog or on restart, the selected device as reverted to "Default Device". The same device should be used for both the Input and the Output device normally.

NOTE: Under Windows Vista and later the sound card inputs are only detected when a cable or Microphone is plugged in.

By default Line In is selected, but can be changed. Line In is preferred over MIC In for the radio RX audio.

After selecting the device of interest click Ok, there is no need to shut down and restart the program

If your selected device is not displayed upon return to the dialog or on restart, then try the other "By Number/By Name" If neither methods work, there is a driver issue under your OS and either another driver will need to be tried or your device will need to be made the default sound device under Windows for now.

MS-DMT Guide v1.06

Released 10-31-2015

The setup of RX and TX device levels at present is via the Windows level panels for the sound device selected as the modem. The settings of external sound devices that offer manual adjustments must be taken into consideration so as to return all settings to normal for use with MS-DMT should they be changed for other applications.

You may also want to maintain a database of sound device settings if you plan to make use of different sound device modem based communications applications and forego just setting the output sound panel level to max so that you return to the proper settings. The following tools are popular for this purpose:

- QuickMix (http://www.ptpart.co.uk/assets/unsupported/quickmixin.zip)

- RoMac Sound Card Manager(http://www.romacsoftware.com/SoundManagement.htm)

The next sections provide details to consider regarding setting program priority level and affinity followed by sound device selection and configuration. Thereafter the program interface and features will be detailed.

RoMac Sound Card Manager has the following note:

> **"Vista and later users Note :** If launching a program that has been set to "Run as Administrator" the software will not detect the software running and will return the sound card settings to Normal Windows. You may workaround this problem by setting the Sound Card Manager to Run as Administrator (right click, select properties, compatibility) , but then you lose the capability of dragging and dropping programs into the Sound Card Manager."

PC SOUND DEVICE MODEM TESTNG

The requirement for synchronization clocks between MS110A ST terminals' must be 10ppm of the sample clock. Clock accuracy for generation of the 1800-Hz carrier shall be within ±1 Hz. At the symbol rate of 2400 symbols-per-second this requires accuracy of 0.024 (10 ppm) symbols-per-second. Thus the PC Sound Device sample clock accuracy and stability is very important in the role of a PC Sound Device Modem for our application.

The software user needs to do everything possible to achieve the lowest possible PC Sound Device sample clock error as well as low drift, low noise and low jitter. There is no requirement for user entered sample clock error factors pertaining sound device sample clock error for calibration to the sound device deficiencies. The software is coded to provide nearly +/-5Hz (almost +/-100ppm) of automatic raw sample rate error correction in the decimation/interpolation between the sound device raw 48000hz (48kHz) sample rate and the 9600hz (9.6kHz) sample rate required by the modem. However, due to the constant 2400bps symbol rate, when high sample clock errors exist, the underlying phase error issues cannot be overcome with correction approaches as is the case with low symbol rate modes typically used in Amateur Radio with PC sound devices as modems, thus the results expected from the 100ppm range of correction is not being had, about 75ppm error at most can be tolerated and only if working against a hardware modem based station.

If your sample clock error is not less than 75ppm, performance on RX at and below 300bps when a hardware modem is the TX source, will suffer the most and will likely be even worst with the average end user sample clock error when using the software modem as the transmitting source. Depending on the other sound device critical factors which can affect the higher data rates more than sample rate error, your data rate range may be limited to 300 and 600bps. Less than 20ppm overall sample clock error between stations is required for adequate results down to 75bps with 0ppm of course being the best. Stations that transmit with greater than 20ppm add to the difficulties of those attempting reception. Let's take 10ppm error into account for two stations, both stations may experience clock error above or below 48000hz, say -10 ppm and +10ppm, when that error spread is both negative or positive for the two stations communicating, results are good, however when the two stations are on opposite sides of center, then results will be less due to the increased frequency spread and phase error. Should both stations be close to 0ppm as would be the case with a hardware modem, results will be optimal. Thus interoperability with a hardware modem user will usually always be better than working another software modem user unless they are both below 10ppm or have the same +/-ppm error from center. Stations that make transmissions in broadcast scenarios using the software modem must be well below 10ppm when software modem users are the receiving audience.

The test program Check Sample Rate (CheckSR.EXE) from MixW is the simplest way to test sample rate error on both input and output. However making use of HF reception of WWV using various software programs is the most accurate way to test your RX sample rate error. Once your receive sample rate error is known, you can then perform a loop back test to determine your TX error.

When using a USB port based sound device, do not go through a hub unless the hub is one of the expensive TXCO or GPS referenced types (e.g. Maestro-GS22 and Maestro-iS22, see

http://www.fiberbyte.com/maestro_home.htm) as the hub will likely introduce additional sample rate error. Check all USB ports directly on the PC to determine the port with the lowest sample rate error. If you still have a high sample rate error check the USB sound device on another PC if one is available to determine if perhaps it is the device itself that has the issue.

Allow 20 minutes of sound device warm up. Be sure that all latency causing processes are mitigated, in other words always below 1000us, preferably under 500us on latency. Then with and no sound device software running, not even the Windows sound panel and no audio input to the sound device, with any screen savers disabled, suspend and power saving modes disabled. Start the test and just leave the PC alone after starting the test, do not even move your mouse. Run the CheckSR.EXE at least 30 minutes before clicking on stop.

NOTE: Windows Vista and later sound card inputs are only detected when a cable or microphone is plugged in.
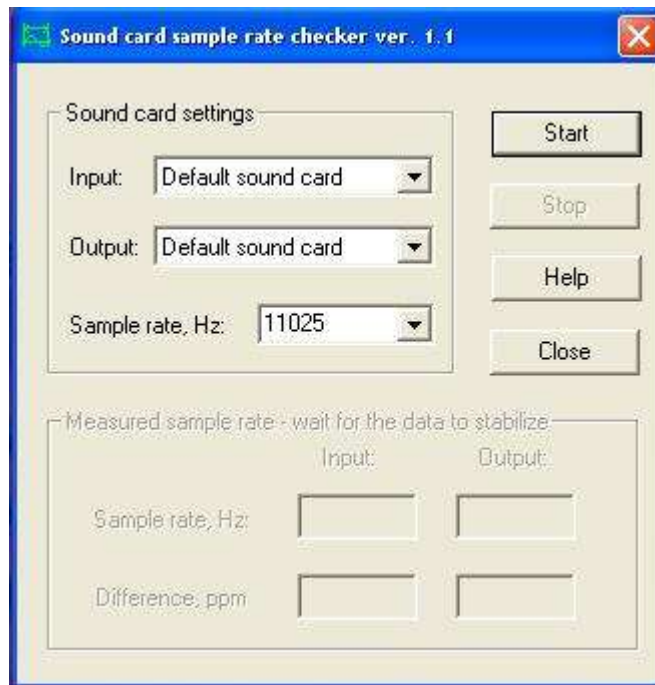
The CheckSR program, upon startup selects the "Default sound card" and 11025hz as the sample rate. Select the Input and Output device of interest and 48000hz for the test.

The resulting "Sample rate, Hz" must be less +/-5hz different from 48000Hz or the "Difference, ppm" must be less than +/-100ppm at 48000Hz for the PC Sound Device to be usable at all with this software and then only when the TX station is near 0.0ppm. In the example depicted above, 41ppm on RX is within usable tolerance and –111 on TX is way out of tolerance for our needs.

MS-DMT Guide v1.06

Released 10-31-2015

The MS-DMT software supports the 48K sample rate only at present. However 96kHz and perhaps 192kHz may be supported in the future. Thus at some point, instead using the pull down to select the sample rate, you will delete the default 11025 that comes up and enter any desired sample rate manually.
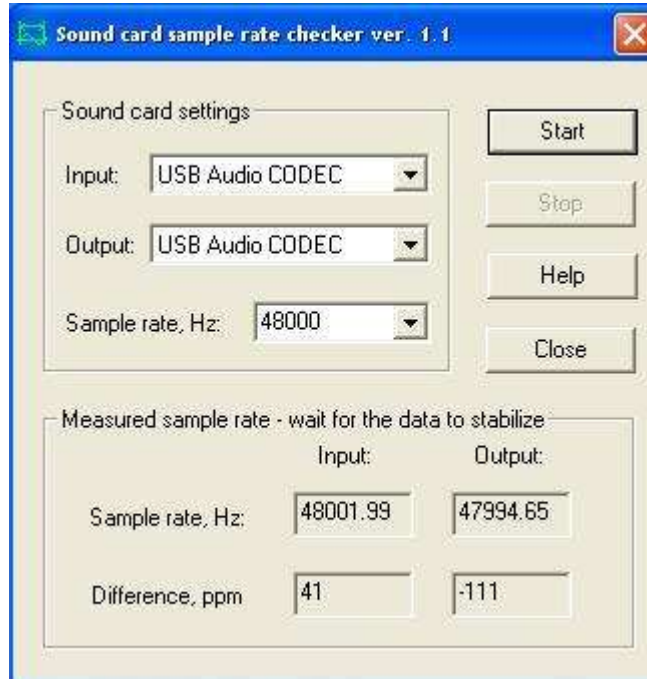
NOTE: Some professional and even some lesser sound devices provide for an external clock source, however most devices do not. Many devices can be modified without much effort to reference to an external frequency standard. The common 24.576Mhz and other frequency reference crystals used in sound devices can be swapped out for a more accurate crystal or better yet a TXCO reference can be soldered in place of the crystal. These practices have been used by many MARS members and others to achieve accurate and stable sample rates, however such practices are beyond the scope of this document.

For a more complete battery of tests of your sound device see:

http://audio.rightmark.org/index_new.shtml

This tool immediately displays sound device latency when you first click to start testing, see the effect that moving you mouse about has on latency and why you should not do so during serial tone modem signal reception. Then too the battery of tests will allow you to gauge your sound devices as to Frequency Response, Noise, Distortion, THD, IMD, and more when you configure for loop back testing.

As with all tools reading the documentation will allow you to get the most from the tool, see: http://audio.rightmark.org/download.shtml

.HF SSB RADIO REQUIREMENTS

In general, an HF SSB transceiver with TXCO and 100w pep or greater output is required. A radio capable of data transmission at 100% duty cycle is highly recommended for long broadcast message transmissions.

NOTE: Additional fan cooling is recommended for extended transmitting such as sending greater than a 5Kb message at less than 600bps

The use of a dedicated Data Port for RX and TX audio provides the best audio characteristics as well as consistent audio levels.

The STANAG 4203, "Technical standards for single channel HF radio equipment", as excepted in Appendix H herein, provides the detailed Military HF SSB radio requirements for the best performance using MIL-STD data waveforms.

A 2.8kHz SSB filter centered on the PSK carrier which for MS110A is 1800Hz, is a must for best results, less SSB filtering will result in poor results at high data rates above 600bps.

NOTE: The SSB filter must come as close as possible to meeting STANAG 4203 requirements. If not the maximum data rate achievable will suffer. The design of the IF passband filtering determines how faithfully it reproduces complex signals. MIL-STD serial tone signals contain information in both phase state and amplitude value and occupy and instantaneous bandwidth as wide as 3kHz. The passband response alters both phase and amplitude of a complex signal. Any marginal design considerations can cause degraded performance of this complex waveform signals.

Any use of an Automatic ATU (AATU) must be made where the AATU has already been tuned to the frequency and is **NOT** being tuned by the data transmission when the preamble data at the start is being sent. Such tuning will have a negative effect on the signal and thus the reception of the preamble portion of the transmission used for synchronization on intercept. Retuning by the AATU during transmission is also detrimental, as it will not only affect the data payload but also the known data used to maintain synchronization.

In addition, take into account the ATU wattage rating and its duty cycles rating. For example the popular LDG tuners are rated in watts peak envelope power (PEP) and for ST modes you need to use less than half its rating as the ST modem is a high duty cycle mode. Thus if you are able to run 100 watts with MS110A (as properly seen on a spectrum analyzers or thermal power meter) then you will need a 200 watt ATU. If using an external PA for greater power, say 200-250 watts then the 600 watt or greater model ATU will be required.

SETTING UP TX AUDIO

Select the same sound device for use as the Input as the Output device using Line In vs. Mic in if possible. Leave the Modulation level at the default 75% to start, only use it if the sound panel and other controls do not provide enough range in setting your radio ALC to zero.

At **NO** time during transmitting MS110A do you want to have any ALC movement on your ALC meter scale if it is just an indication of ALC voltage. For example, the Elecraft K3 ALC scale serves two purposes at the same time I am told, first as a VU meter, where the ALC begins, you never want to get to.

Do not use the radio MIC port for TX audio if your radio provides an Auxiliary input which are preferred to Mic inputs as they are less sensitive to RF and never have their levels accidentally re-adjusted.

NOTE: Make sure that your MIC audio is not hot during data modem transmissions. Any audio mixing in with the modulation from the modem in the radio transmitter can be detrimental. A medication of the MIC so that audio is NOT hot for VOX use or the integration of automatic bypass on MS-DMT TX is required. The MS-DMT PTT selections support DTR and RTS PTT via RS-232 as the only method and in conjunction with CAT PTT. If you are now using DTR or RTS for radio PTT, just wired for MIC audio bypass with diode isolation for the MIC bypass circuit and radio PTT lines.

The ALC setting is significant in reducing distortion by maintaining linearity and thus improving performance. The TX Audio level for MS-DMT must **NOT** drive the radio into ALC. ALC can drive signals too high into the power amplifier, distorting the signal and possibly the modulating signal. This effectively limits the maximum SNR measured at the demodulator and may cause bit errors. For those with radios without ALC meters, no ALC typically equates to about 30-35% of your SSB voice RF output for data, however some Amateur grade and most Commercial and Military radios will often provide much more than 35%. Also be sure to power your radio from a clean, stable power source and if running off batteries, be sure that the voltage does not drop too low otherwise distorted audio and other issues may develop.

It is recommended, if possible with your sound device interface controls, that the sound panel be used to set the TX level to max and then make use of an interfacing level control to adjust for proper TX level to allow for easy manual adjustment when changing frequency as typical Amateur Radio and Commercial Radio transceivers do not provide a constant RF output across 2-28Mhz. For ALE follow on use of the software with am ALE hardware radio, the proceeding applies. When used with MARS-ALE instead of its internal MS110A capability, the process can be the same where you setup per the MARS-ALE docs with one level setting used for all channels and derive whatever output you get across 2-28Mhz. Alternately MARS-ALE can be setup per the docs to automatically adjust the sound control panel level for each frequency, in which case your interface control would be set close to maximum to achieve a constant RF output for each channel, this still requires no ALC for PSK and whatever ALC achieved for ALE FSK.

Released 10-31-2015

NOTE: In a dire emergency situation use of this software via close acoustic coupling between a PC speaker out put into the radio microphone will support sending a message, use of this technique at 300bps and below is recommended.

SETTING UP RX AUDIO

The separate document "Getting the Most from MS-DMT" details a process that can be followed for setting your receive audio level based on actual on-the-air decoding of MS110A transmissions.

The MS-DMT application requires the HF SSB radio provide a fixed radio line audio out, typically 100 mV rms @ 600 ohms be fed into the PC sound device used as the modem hardware. The interfacing between the HF SSB radio and the sound device input must be ground loop isolated using appropriated impedance matching between the ports. Never use the radio speaker out port. If you radio does not provide a fixed RX audio port, it is highly recommended that one be added by wiring to the high side of the radio volume control for a fixed output port regardless of the volume position.

Using Spectrum Lab (http://www.qsl.net/dl4yhf/spectra1.html) with a fresh install, select your sound device and then setup the Spectrum display by Right Clicking on the top part of the spectrum as follows:
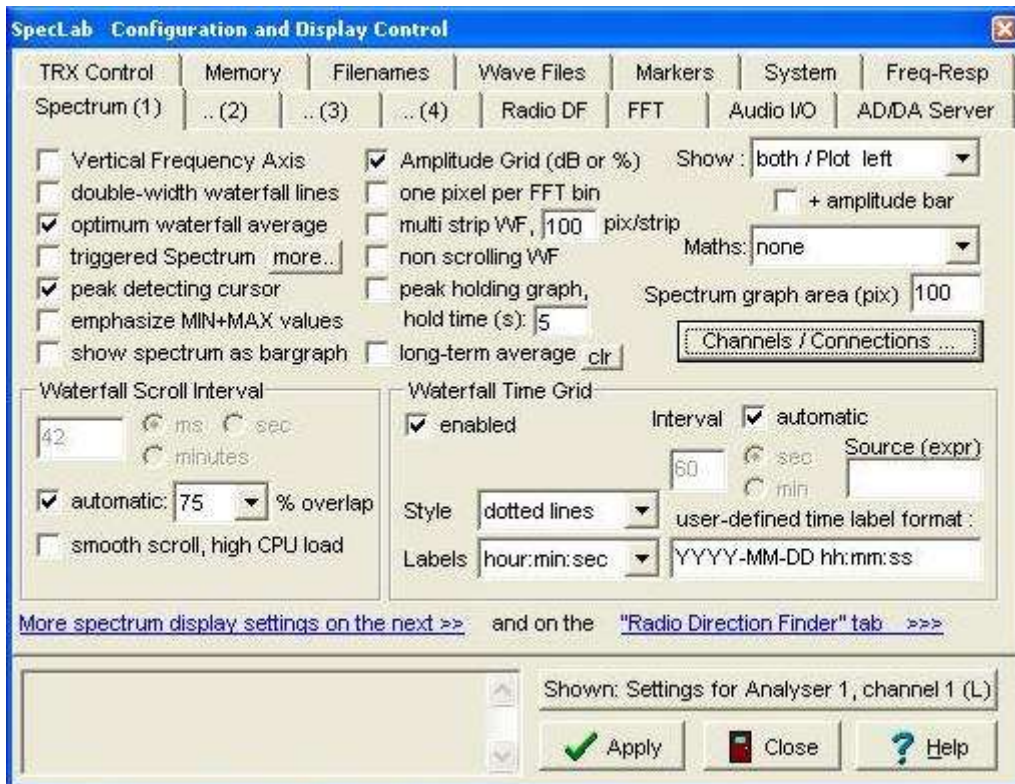
The fixed 100mv level requires adjusting your sound device line in level for -80db or less (with your radio on a dummy load) as your device will permit. The best results will be had with devices that offer -90db or less noise floors with a flat response and no artifacts.

Below is the fixed data port output of an IC-7200 USB codec.
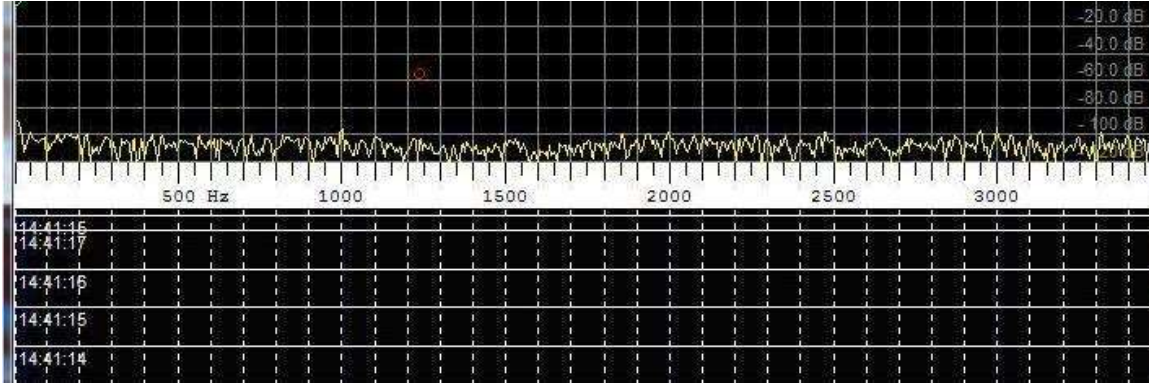
Below is the fixed 100mv RX audio of an old FT-890 with stock 2.4kHz filter with its IF Shift adjusted properly, preamp off and the radio is on a dummy load with S0 on the meter.
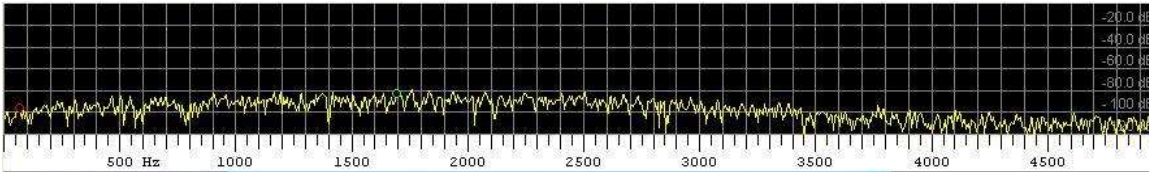
A typical incoming serial tone signal will cause an increase in radio line out by 25db regardless of actual S meter reading for an audible by ear signal.

The screen capture below depicts an MS110A 300bps signal transmitted from a MICOM 2 transceiver using its 3kHz data filter (into a dummy load), while the FT-890 receiver output displayed is -55db. The actual S meter reading from the MS110A signal transmitted at a power level to cause and audible signal registering around S0 and MS110A signal transmitted at power levels to reach an S9 had no effect on the amplitude of the receivers fixed port output displayed.

Also, as can be seen, 3kHz on transmit using the 1800Hz PSK Carrier when using the MICOM 2 3kHz data filter is out of band. As such only the SSB voice filter on the MICOM 2 can be used.
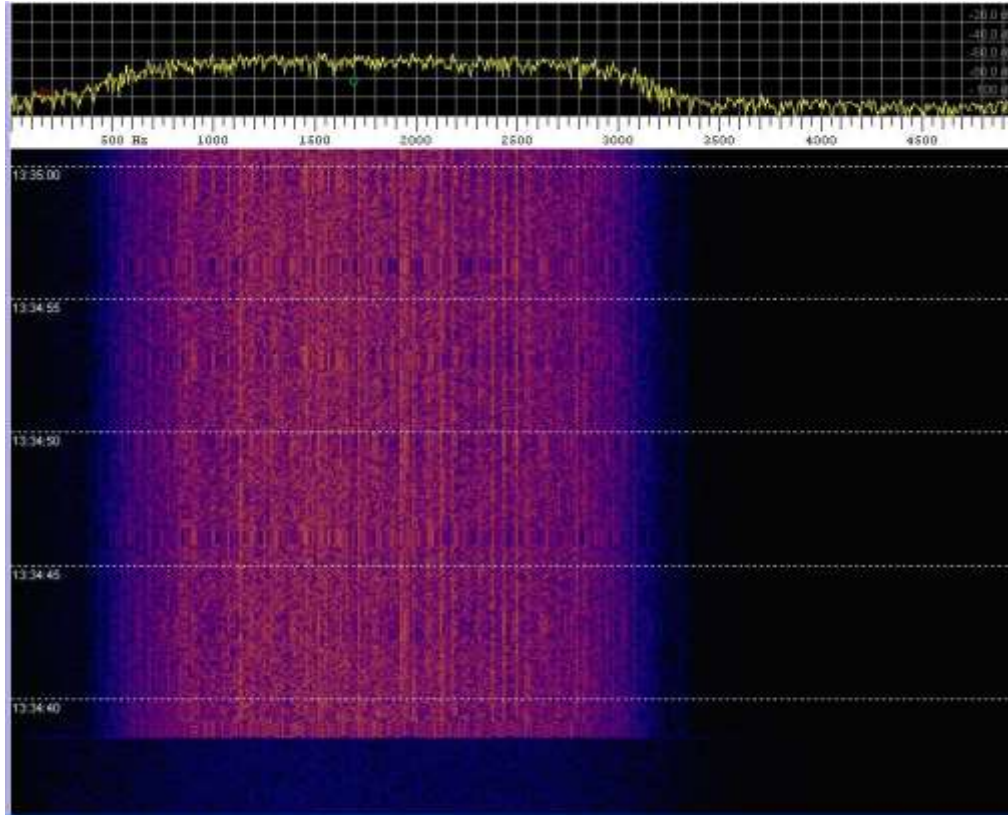
Here is the same signal displayed using MixW with an 80db dynamic range setting and an average curve setting of normal.
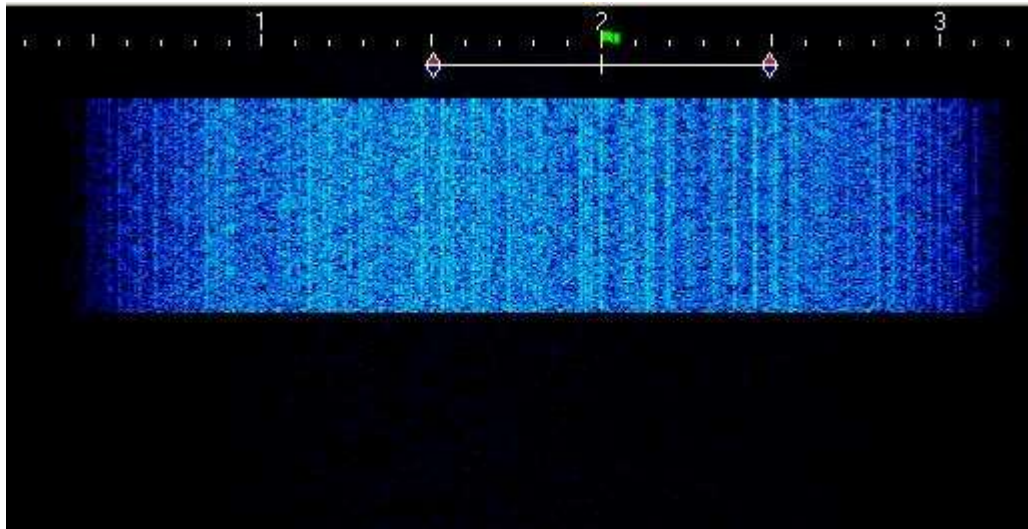
You may also want to maintain a database of sound device settings if you plan to make use of different sound device modem based communications applications and forego just setting the input sound panel level to max so that you return to the proper settings. The following tools are popular for this purpose:

- QuickMix (http://www.ptpart.co.uk/assets/unsupported/quickmixin.zip)

- RoMac Sound Card Manager(http://www.romacsoftware.com/SoundManagement.htm)

NOTE: In a dire emergency situation use of this software via close acoustic coupling between a the PC Mic input from the radios speaker may support receiving a message, use of this technique at 300bps and below is recommended.

LOOP BACK TEST

There are a number of purposes of the loop back test:

- Verify that the operating system latency issues have been mitigated.

- Check the effects of sound device distortion, noise and jitter.

- Determine a relative starting point for RX and TX sound device level settings.

- Check the effects of cable wiring as to noise when the radio cables are jumpered for loop back testing.

Neither Sound Device Sample Rate Error or Stability enter into the loop back test as the same sound device is being used for TX and RX which equates to a 0ppm error. How your system performs during the loop back testing is an indication of how your system would perform using radios were you to have a 0ppm sample clock error.

The Loop Back test requires a jumper from the sound device Line Out to Line In or Mic In if required. The full benefit of the test is achieved when the actual cabling between the sound device and HF radio are jumpered for loop back verses just using a separate jumper. That being said, if there are issues when testing using the full cable set, then performing the tests with a separate jumper can be used instead of the cables to determine if system cables are an issue. It is usually with RF that issues with cables are the most prevalent.

Performing a loop back test requires two instances of the software running on the same PC. On both instances uncheck "Save on Send" and "Save on EOM". On the instance that will send the message, select the 4800bps uncoded data rate by clicking the "Inc" button in the lower Transmit panel displays "4800 BPS" in the MODE window.

As this is a loop back test, first send some short messages first and adjust TX level and RX level so that the ERROR window in the receiving instance is at its lowest reading which should be less than 0.25Hz. Too much TX or RX audio or too little will cause the ERROR value to increase.

The loopbacktest.txt file in the full install distribution is used for the loop back test message. The use of the 4800bps uncoded data rate will easily reveal issues on the system being as 4800bps has no FEC and no Interleaving. Open the file with Notepad and copy the message and past it into the lower "Outgoing Message Window". Then click "Send" to start the test and do nothing else on the computer during the test. The message will take 1 minute and 10 seconds to complete if uninterrupted.

Review the loop back message on the RX instance of the software and verify that you displayed the message 100% correct. If 100%, your system (aside from possible sample clock error and drift when not using the sound device in loopback) has passed the basic test.

You can repeat this test at all data rates using SHORT interleave, however 4800bps has more potential to detect issue's as it's the least robust. The message will take 2x plus for each lower data rate starting at 2400bps SHORT at 2 minutes and 22 seconds and 2 minutes 27 seconds for 2400bps

LONG. The interleaving adds additional time beyond just the data rate change. If the 32kb test message does not pass at any data rate below 4800bps then your system has real issues requiring mitigation.

RADIO RECEIVER SETTINGS

An MS110A waveform occupies an audio base-band bandwidth of 300-3300Hz where STANAG 4203 (refer to Appendix H herein) specifies the IF filtering and properties of the radio which receives the audio signal (nominal 3 kHz bandwidth) from the modem and modulates it onto a carrier along with radio performance specifications that are also detailed in MIL-STD-188-141C.

Per S4203, the base-band frequency response of the transmitter and of the receiver (IF filtering) over the range 300Hz to 3050Hz (2.75kHz) shall be within, variations in attenuation are at most +/-2 dB of the response at 1000Hz for HF Manpack equipment and within ±1.5dB for all other equipment and the group delay time over 80% of the passband must not vary by more than 0.5ms. In addition the time constant of the automatic gain control (AGC) circuit must be more than 10ms on desensitization and less than 25ms on re-sensitization. The frequency accuracy of the transmitter and receiver must be at least 10^{-6}.

However most Amateur Radio and Commercial grade HF SSB transceivers only offer 2.4kHz filters, typically over the range of 300-2700Hz. Such radios can be used with MS110A at data rates of 600bps and less on TX and somewhat better on RX when using IF Shift or Passband tuning to achieve a wider RX bandwidth. Radios that have no IF SHIFT really need to have a wider filter installed. For reliable performance at data rates of 1200bps and higher the transmitting station must be using filters of 2.7-2.8kHz.
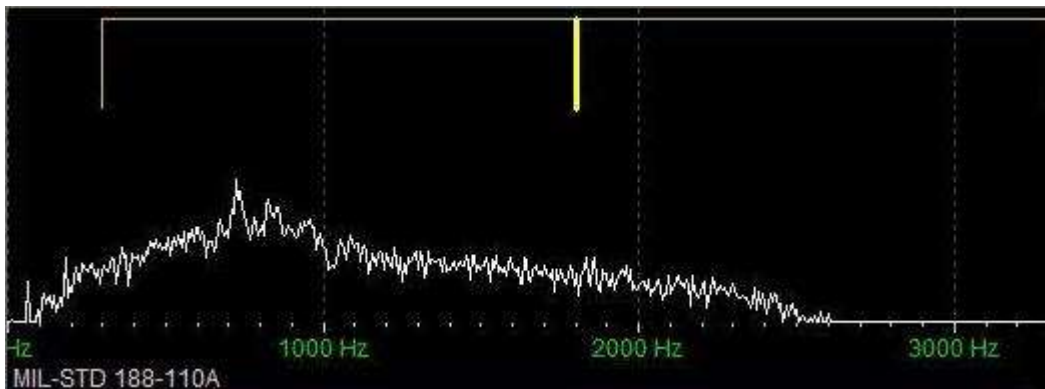
Above is the passband display of an old TS-450 captured while monitoring a 4Mhz channel where its 2.4kHz first IF filter is selected and the 2nd filter is in the THRU position and the IF Shift set at the normal 1500hz center during the intercept of MS110A from a station using 3kHz filtering on TX. The passband displayed below is the same TS-450 being and the same station transmitting, the difference being the IF Shift is now adjusted to above center to pass beyond 3kHz.

The vertical yellow marker in both images depicts the MS110A standard 1800Hz PSK carrier in the passband. Even the old TS-450 and is 2.4kHz filter when using IF shift can be adjusted to pass a full 3Khz 110A signal on RX for good decode. However this particular TS-450 will suffer as to the maximum data rates on TX as the passband will be restricted to the characteristics of the installed 2.4kHz filter as can be seen in the image.

MIL-STD 188-110A
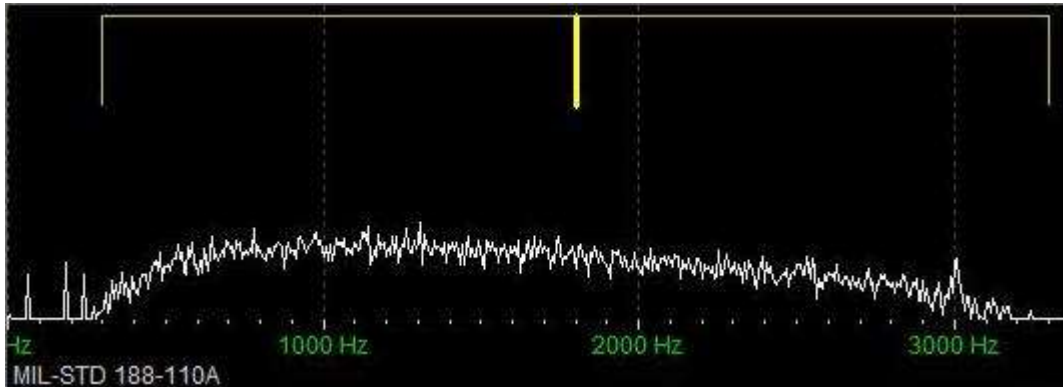
Military radios run their receivers wide open, they do not provide the type of receiver features found in most Amateur and some Commercial radio equipment. In taking some of those non-Military radio receiver features into consideration the following settings are recommended:

- IF BW as close to 2.8kHz on TX as possible and no more than 3.0kHz on RX.

- IF Shift if equipped, set to 1800Hz instead of 1500Hz center if using filters under 2.8kHz.

- The longest receiver time constant of the automatic gain control (AGC) circuit must be used to prevent rapid gain changes arising from channel fades. More than 10ms on desensitization and less than 25ms on re-sensitization is required. Thus if AGC is selectable, SLOW or MEDIUM or perhaps even OFF should be used depending on the characteristics of the make/model radio being used.

- Receiver NOISE BLANKER for pulse type noise that is not DSP based can usually be ON if really required, but on some radios it may need to be OFF, experimentation with the given radio in actual use of the DMT tool will be required.

- All receiver DSP features such as NOISE REDUCTION, DUAL WATCH etc. should be OFF.

- Receiver NOTCH FILTERING of any type must be OFF.

- Receiver SQUELCH should be wide open.

- Receiver RF GAIN should be full open, especially for unattended use, however the user can adjust it to quiet the receiver if needed when the user suffers from a high noise floor to the point where the channel SNR improves for reliable communications. The same is true of using a selectable RF step Attenuator.

- Some receivers that have additional IF stage filer selections where filters are at a low IF frequency and a high IF frequency, if selectable for bypass, the higher frequency IF filter should be bypassed. If not selectable for bypass, use the widest filter in the highest IF, such as the FM or AM filter and a filter closest to 2.8kHz at the lowest IF stage.

- Where one button on the radio drops or adds a stage of amplification, be it called PREAMP or other, the user can make use of this amplification stage as long as it does not cause non-linear characteristics or introduces an undue amount of noise that reduces the SNR of the channel.

MS-DMT USER INTERFACE

The software defaults on first start to the configuration seen below and returns to the same configuration should the required DMT.DAT database file which resides in the same directory as the MSDMT_32.EXE either be missing or corrupt. Otherwise the program retains all user changed parameters in the DMT.DAT for use on the next program start.
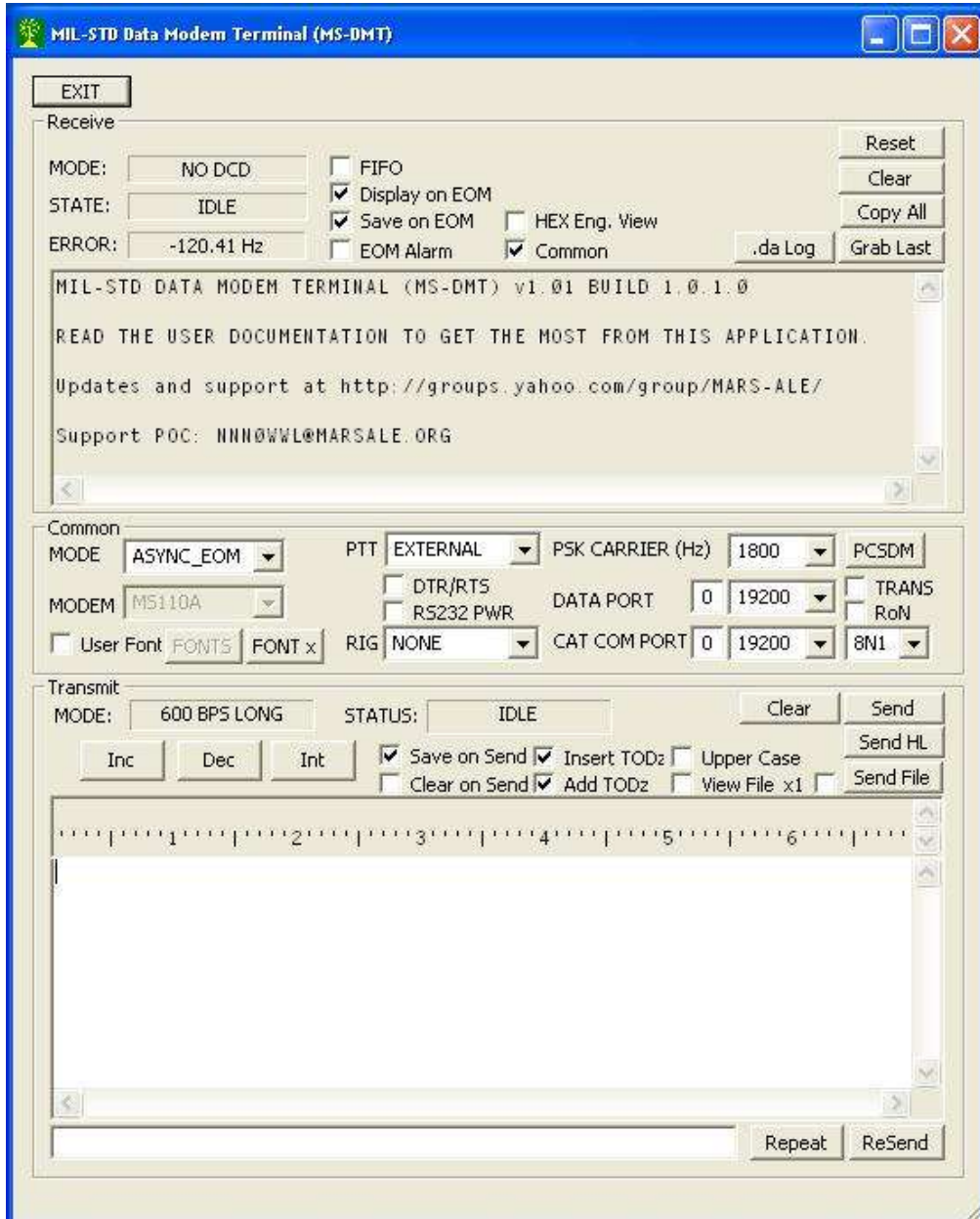
The software provides an upfront display of all user entered parameters aside from those pertaining to PC sound device on first start. Many of the parameters will likely be changed infrequently if at all after initial setup which are found on the "Common" and can be hidden by unchecking the "Common" checkbox. However many MARS members will find the need to change some of these

often and thus the display design. It has been found that having immediate select to parameters up front speeds the process verses navigating menu's to find the needed selection in the heat of two-way communications.

The software's user interface is presented with the top most panel for "Receive" parameters and display, the center most panel for "Common" parameters which can be hidden and the bottom most panel for "Transmit" parameters and message origination.

The two message windows are auto scrolling and provide display of incoming and outgoing message text, the top window in the Receive panel displays the received message and the bottom window in the Transmit panel supports typing and pasting and editing of up to a 32kb ASCII text message. There is also a third single line transmit window at the bottom typing or pasting up to a 1kb messages that are sent on the "Enter" key stroke intended for rapid peer-to-peer communications.

The following three sections break down the tools three panels in detail and detail how to configure the MS-DMT tool and its parameters for proper operation.

COMMON PANEL

NOTE: MS-DMT v1.01 B1.0.1.3. GUI has changed and this section has not yet been updated to completely reflect those changes.

This panel contains parameters that aside from mode selection and perhaps PSK carrier are basically one time set and forget unless a hardware change is required.
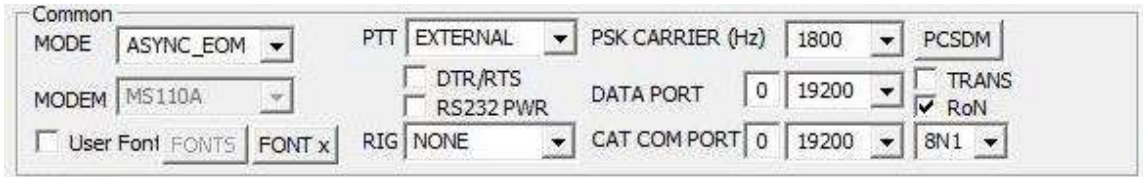
Buttons

"FONTS" - The FONTS button when enabled by "User Font" being checked, selects the Font dialog for custom user font selection parameters vs. the use of the default font "Letter Gothic MT Bold" if installed or if not, "MS Shell Dlg" as applied to the message boxes aside from Peer2Peer which is locked to "Letter Gothic MT Bold size 8".

Whatever the user selects for their Font properties is saved for use when the tool is restarted it "User Font" was selected when the tool was last used.
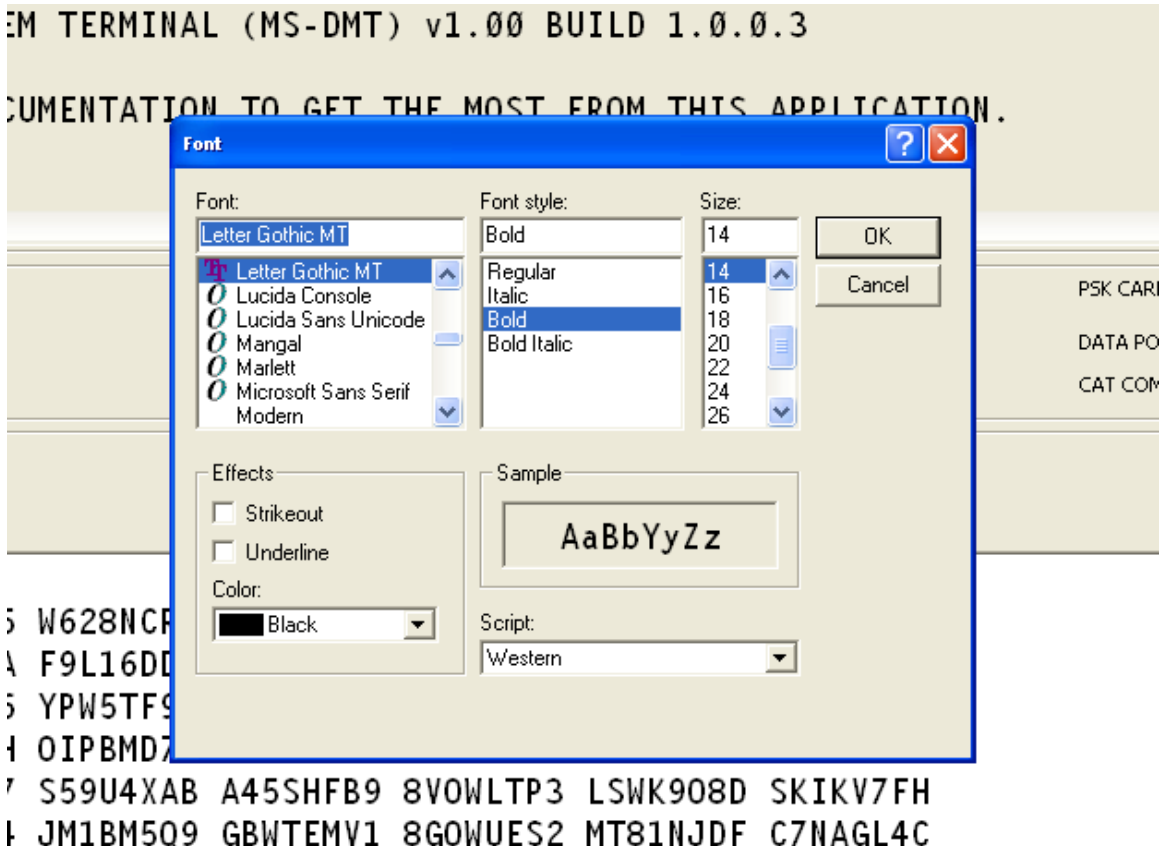
"FONT x" - The default font is configured for a size of 8, clicking "FONT x" when enabled will toggle between a size of 8 or 12 for the default font when in effect..

"PCSDM" - As used earlier this guide, the "PCSDM" (PC Sound Device Modem) button provides access to the Sound Device Setup dialog when clicked.

MODE

The MODE pull down provides for all over the air modes which can be used with both the internal display window as well as an external terminal. At present there are three mode selections provided: ASYNC_EOM, SYNC_EOM and SYNC_NOE (no EOM).
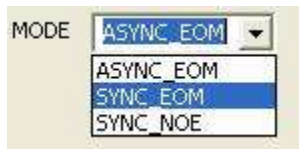
ASYNC_EOM is the default mode when the program is run for the first time or whenever the DMT.DAT file is missing or corrupted. ASYNC_EOM is the most commonly used of the MS110A modes in MARS.

However, when permitted under MARS policy, especially during poor channel conditions, the use of SYNC mode (SYNC_EOM in our tools) for RATT use of MS110A is preferred as there are no framing (start and stop bits) sent with resulting issues to contend with that contribute to decoding challenges. This is why SYNC is mainly used by the Military and is SOP for all Data Link Protocol (DLP) based applications such as ARQ, Broadcast, Digital Voice etc. is over SYNC.

However it must be noted that when it comes to the use of SYNC mode, a hardware modem user without "High Speed ASYNC" support as detailed in MIL-STD-188-110B provided by their modem, requires an expensive Synchronous Serial Port adapter for SYNC mode operation. Also they can't just

switch between ASYNC and SYNC with a mouse click as in MS-DMT. The SYNC adapter goes between the PC asynchronous RS-232 serial port and the modems data port. There are few hardware modem users in MARS with "High Speed ASYNC" capable modems in hand.

"RoN" which stands for "Reset on Null" is checked by default. When "Ron" is check and the mode is either ASYNC_EOM or SYNC_EOM, the modem receiver will reset on the first "Null" character that comes along. The intent is that of the "Null" characters sent as the flush that follow the EOM indicator will reset the receiver if the EOM indicator is not detected. The reason for this is that the EOM consists of only a few bytes at the end of the message content. If just one EOM byte gets corrupted or missed in decoding or if the EOM is not even sent, then the modem receiver will not automatically reset. The receiver will then run on printing all the flush content (144 Null character bytes) as gibberish and the operator will need to manually reset the modem. However, RoN cannot be used if any binary data is being sent that contains even one ASCII value 0x00 Null byte or else the Null character in the message text will prematurely cause a modem receiver reset.

NOTE: During extremely poor channel conditions when it's is known that the messages being dealt with in FEC RATT use of the tool are pure ASCII, the use of Reset-on-Null (RoN) is highly recommended to reduce the need of the user to click on RESET should EOM detection fail.

When the DATA PORT is active, which uses RS-232 Asynchronous interfacing (via either a hardware port to another PC or a VCP port pair on the same PC) when in SYNC modes the use of "High Speed ASYNC" operation is provided. High Speed ASYNC supports SYNC mode operation over-the-air without the need of a hardware ASYNC-to-SYNC adapter with MS-DMT.

The mode selections when the DATA PORT is active (not 0) can be overridden by "TRANS" when checked, which places the tool into SYNC with EOM compatible mode of operation setup for a binary data streams rather than just ASCII. In addition, "TRANS" also bypasses the internal message and data windows during DATA PORT operation, thus all use of the modem is with the external software application only. In that regard, a user of the DMT application that is not using "TRANS" is compatible with when SYNC_EOM for all ASCII data that is sent, and can view any non-ASCII data if "HEX Eng. View" is checked. However if the sending station sends any content that contains a Null (0x00) character while in SYNC_EOM the modem receiver will reset at that point. Additional information of the "DATA PORT" follows herein.

If all stations are not set to the same mode, depending on the combination of mode selections between stations and what is being sent only gibberish may be displayed on the receiving station terminal. Also, depending on the combination of modes in use, the receiver may run on with characters if the receiver is set for EOM use and the sending station is not, in which case the manual Reset will need to be used. This will be especially true of hardware modem users and "DATA PORT in TRANS" as the ASYNC_EOM and SYNC_EOM are coded to expect the EOM and deal with it properly but are also coded in a way that if there is no EOM sent, the modem receiver will still reset properly.

NOTE: When in TRANS mode SYNC operation and RoN is not checked, Automatic Reset on 100 errors of unknown data will occur if the 3rd party terminal application does not make use of the remote Reset command on its EOM first.

The MS110A SYNC mode is used with or without an EOM more commonly than ASYNC is used without the EOM and thus only SYNC mode is provided for use with and without EOM on transmit. A station that is using a hardware modem will know their configuration, which they cannot change on the fly as can be done with software modems, thus a hardware modem based user may request data sent for them in SYNC vs. ASYNC and either with or without EOM. Many hardware modems do not support disabling of the EOM, however when they do and if they are used for ARQ and other applications, the modem will likely be setup for SYNC with EOM disabled.

The SYNC without EOM mode is the most used MS110A hardware modem configuration when modems are setup for ARQ, FTP, Digital Voice (usually Secure Voice) and with Crypto devices. At present this software only directly supports basic FEC operation of standard ASCII character range (decimal 20..128) messages via the SYNC mode with or without EOM via its internal terminal. However the DATA PORT can also be setup for ASCII or Binary data streams. A SYNC_EOM compatible mode is used via the Data Port when "TRANS" is checked, regardless of the mode selection made elsewhere. TRANS supports the use of external software applications and binary data streams over the full binary byte range of 0x00 through 0xFF where such applications can send ASCII, Binary or a mix of ASCII/Binary data as achieved with hardware modems.

MODEM

At present the Modem selection pull down is disabled as the MS110A modem is the only selection, however that will change in the future when S4285 will likely be the next selection.

PSK CARRIER

The PSK carrier selections provided will follow the mode selected as additional modes selections become available. For the MS110A ST waveform the 1800Hz selection is the standard PSK carrier and the default for MS110A in the software. The 1650Hz and 1500Hz selections have been provided for MS110A as optional non-standard selections as they are supported in many hardware modems for MS110A.

All stations must either make use of the same PSK carrier or offset tune their frequency based on the difference between the PSK carrier that they are using and what has been directed for use on the given frequency. If either is not the case, the PSK carriers will not be aligned and communications will not occur.

The use of 1500Hz supports maximum use of narrow SSB filters that don't meet S4203, its use is recommended for use during broadcast message reception and all digital net operation ONLY and not in mix Voice/DATA nets.

The use of data rates higher than 600bps is dependent on the TX station IF passband filtering. If not to STANAG 4203 requirements, the higher data rates will be negatively impacted on TX and thus also on RX, especially when using the 1800Hz PSK carrier. Using a 1500Hz PSK carrier on TX places more of the 300-3300Hz ST waveform into the passband of IF filters that don't meet S4203 which improves the use of higher data rates when the TX frequency is offset to align with users of the standard 1800Hz PSK carrier. Likewise, if stations are using 1500Hz on RX their filter will pass more of the waveform for reception and decoding.

CAT Com Port

By default CAT serial support is OFF, this is achieved by setting the CAT com port to 0. To make use of CAT a com port between 1..16 must be entered. The com port parameters are user selectable for baud rate and framing if other than the default values for each radio type selected are required. For those radio models that require handshaking, the appropriate handshaking is hard coded for the radio type selected and not user selectable.

You can also set the CAT com port to 0 temporarily to run another program, this is faster than shutting down the MS-DMT to start another program and also alleviates the possibility of shutting down and starting the next program too fast and having com port access issues.

It is best to always set the data rate for the CAT com port to the highest rate supported by the radio to minimize latency, this is especially true if CAT PTT is being used or CAT commands are being sent in support of automatic Data/Voice port selection.

Radio PTT

The software provides for user selectable RS232 DTR/RTS line hardware PTT as well as CAT PTT and or no software controlled PTT.

The first time the program is started CAT com port is set to 0, thus the software provides no type of PTT support. This is often the only configuration used with fast VOX based external interfaces providing a source of hardware PTT. However even if CAT PTT support is not required, for some make/model radios with dedicated digital ports, CAT support may be desired to automate the switching between the digital port for TX and back to the Mic port on RX for mixed Data/Voice nets.

The PTT pull down menu is used to select the PTT mode if the CAT com port is active. By default when the program is first used, EXTERNAL is selected. The choices are CAT ONLY, CAT&RS232, RS232 and EXTERNAL.

For RS232 or CAT&RS232 selections, by default DTR/RTS is not checked, as such if the serial port is other than 0, RTS will be selected, if DTR/RTS is checked, DTR will be selected. Should an external interface be in use that requires D.C. power from the RS-232 port, check "RS232 Power", whichever line, RTS or DTR is not being used for PTT will be used for DTR power.

The CAT&RS232 selection supports CAT PTT for the radio and use of the RS232 DTR or RTS line for other purposes, such as antenna switch on TX, amplifier standby on RX, hot MIC audio bypass on TX, etc.

MS-DMT Guide v1.06

Released 10-31-2015

RIG

The RIG pull down menu is used to select the radio type for CAT support. By default when the program is first started radio type NONE is selected, which precludes the sending of any CAT commands.

All CAT serial port parameters are automatically configured when the radio type is selected, the fast baud rate should always be used to minimize latency. There is no provision for the user to change either handshaking parameters or radio addressing parameters. If the given radio type selected ends with _DV or _DVx, the CAT commands are sent in support of Data/Voice switching between Mic and Digital ports, even if CAT PTT is not selected for use. For details on all currently supported CAT radios see Appendix G.

NOTE: If using an SDR transceiver and or Virtual Audio Cables (VAC) which can add latency either transmit or receive signals be sure to utilize minimum buffer sizes for radio or VAC operation. The http://groups.yahoo.com/group/MARS_Flexers/ forum is highly recommended as a resource Q&A site.

DATA PORT

The "DATA PORT" capability is in support of 3rd party external terminal applications use of the software's data modem capability on RX and TX where the MS-DMT software can be setup and minimized if desired and all communications can then be handled by the external application.

WARNING: Prior to release of MS-DMT v1.00 Build 1.0.0.0 as file MSDMT_32.EXE in April 2013, the tool was coded to support CTS/RTS handshaking on the Data Port and CTS/RTS or just RTS for PTT was recommended to be used by any external terminal application during all of the development Alpha and Beta builds. Also, if the Data Port was not set to 0 and there was no external terminal tool running, the internal display of incoming data would display very slowly and the tool would appear to crash. As of MS-DMT v1.00 Build 1.0.0.0 the Data Port can now be active without the need of an external terminal being active, however "enable buffer overrun" must be enable if a VCP port is being used and the external terminal flow control must not being using any handshaking or asserting the RTS line for PTT.

The MS-DMT tool should always be started with the Data Port enabled before any external terminal application is started.

The Data Port supports COM port selections between 1..16 to activate and 0 to disable. For additional details see Appendix F.

If "RoN" which stands for "Reset on Null", is checked in addition to "TRANS" being checked, then in addition to resetting on the EOM, the modem will reset on "Null", this provides for modem reset in case the EOM is corrupted, missed or not sent. However, RoN cannot be used if any binary data is being sent that contains even one ASCII value 0x00 Null character or else the null character in the message will prematurely cause a modem reset.

RECEIVE PANEL

NOTE: MS-DMT v1.01 B1.0.1.3. GUI has changed and this section has not yet been updated to completely reflect those changes.
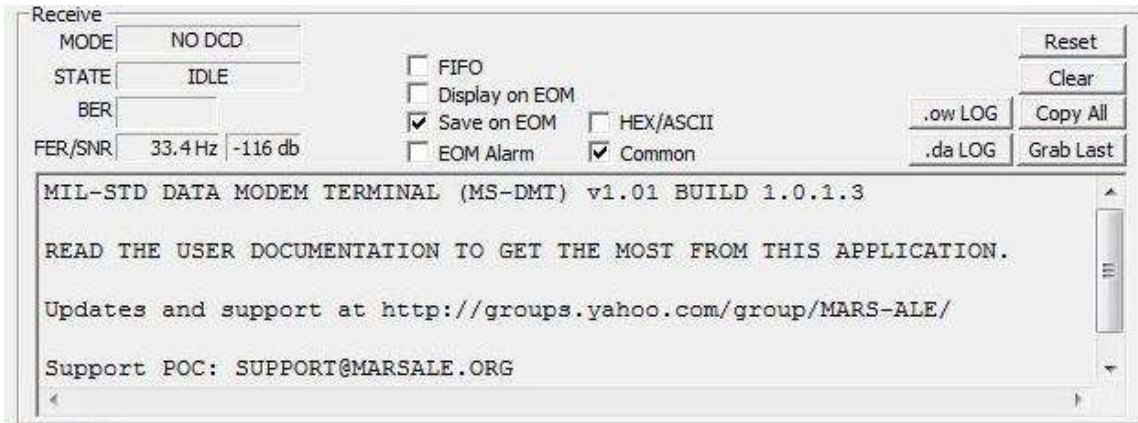
Buttons

"ow. Log" - Displays the .ow log for the current Zulu day by launching an instance of MS-Notepad with the .ow log, if no messages have been sent during the current Zulu data a message box is displayed attesting to that fact.

"da. Log" - Displays the .da log for the current Zulu day by launching an instance of MS-Notepad with the .da log, if no messages have been received during the current Zulu data a message box is displayed attesting to that fact.

NOTE: Additional logging events an take place during the log file being opened, however at this time the log being displayed in Notepad is not updated, only the log file itself is updated. At this time the ".da Log" button will launch as many copies of Notepad loading the then current .da log file for review as the user may initiate.

"Reset" - Resets the Data Carrier Detect (DCD) state of the modem and STATE to IDLE which resets the Viterbi algorithm for decoding a bit stream and clears the ERROR field. The MODE will indicate "NO DCD" and the STATE will indicate "IDLE". The modem receiver will return to hunting for a preamble stream to sync on. The use of this hard reset vs. a soft reset should be made when sync is lost during the Preamble or start of Data where nothing but gibberish is displayed, the displayed STATE will usually be "NO EOM" when this occurs. That way we are sure all aspects of the modem are 100% reset after the dramatic loss of sync.

"Clear" - Clears the Incoming Message Window and resets the scroll bars if they were automatically enabled on a received message due to size.

"Copy All" - A single click copy of the entire contents of the Incoming Message Window to the Windows Clipboard for pasting its contents into another application. This saves the right click menu selections or manual high lighting steps to copy from the message window.

"Grab Last" - Grabs the last message received and clears and replaces the outgoing message window contents. The grabbed message can then be edited for relay or highlighted for sending fills using "Send HL" as needed as rapidly as possible over other copying and pasting methods. Should there be no message to grab a message box is displayed to the user. The last received message is always available until another message is received no matter how many times "Grab Last" is used.

Status

"MODE" - Displays the Data Rate and Interleave settings of the incoming data while data is being received and NO DCD when incoming data stops.

"STATE" - This is a work in progress, it displays the various states while awaiting detection of preamble sync, decoding data probes and payload data and completely decoding the payload through to the completion of the End Of Message (EOM) indicator. The current STATES that are displayed and there meaning are:

- IDLE: The modem receiver is hunting for a legitimate signal and PREAMBLE data to decode.

- DATA: The PREAMBLE has been found and is decoding as seen by the ERROR window values still changing, when frequency error values lock, the KNOWN/PROBE data and PAYLOAD data (consisting of the message) decoding starts taking place and the message (payload data if any) is then available.

- NO EOM: The message has been decoded through the EOM. This is displayed so fast and immediately switches back to IDLE that it will often not be caught by the naked eye. However, if it remains displayed then DCD has likely been lost and gibberish displayed to the Incoming Message Window if Display on EOM is not checked and the RESET button should be pressed for a hard reset to place the modem back into a known IDLE state.

Metric Display Tools

BER - The Bit Error Count starts at zero with each message frame and the errors in the KNOWN probe data block and UNKNOWN message data block are displayed as an indication of how hard the Forward Error Correction is working to correct the bit errors for proper ASCII character display. When the BER remains at 0 during the length of the transmission the FEC is doing nothing and the currently selected data rate and interleave setting are proper for the channel conditions. It is actually an indication that a higher data rate selection can be supported. On the other hand, high bit error counts on each frame indicates the need to reduce the data rate and or change to LONG if SHORT is being used. For more information see Appendix A herein.

FER - The Doppler Spread or Frequency Error has a display range of -999.99 to 999.99hz where the modem must properly decode an incoming signal that is off frequency by as much as +/- 75Hz (due to transmitting and receiving frequency variations and doppler spread). The modems RF frequency

error correction in this software exceeds that requirement of the standard. The sample clock error does not enter into this error correction. The frequency error display during the hunting for a signal will periodically jump about with significant numbers, however when a legitimate signal is detected the display will be constantly changing and displaying lower and lower values as the preamble is being decoded and frequency error correction is being applied until the completion of that task and then it will lock onto displaying the last frequency error value until DCD is reset.

SNR - The Signal to Noise Ratio (SNR) of the largely influences the proper data rate and interleave selection being made to support low bit error rate communications. For more information see Appendix A herein.

NOTE: There no need to touch up the RX frequency to deal with the error unless the error far exceeds 75Hz and DCD is being consistently lost and then is must be done between rather than during data transmissions.

NOTE: Any tuning of frequency must be done prior to MS110A transmissions when an actual transmission is being made where the purpose is to pass traffic vs. tuning receiver audio levels. Do not try to tune in MS110A as you would RTTY and other modes. You must be setup on the correct frequency at MS110A transmit start. When a station is transmitting MS110A and you touch up your RX frequency during the message being sent you will cause the software to work harder and you will likely loose DCD.

Incoming Message Window

Any received message is displayed in the upper window of the Receive panel in the "Incoming Message Window". The selection of "Display on EOM" determines if received messages are displayed continuously or one at a time and automatically cleared on the next message EOM received.

The RX message buffer has been set to the maximum of 2GB of system and virtual memory. This may present a problem for some Vista users if the buffer is allowed to get to full before hitting "Clear" based on some of the things I have read on issues with CEdit controls and Vista. Should the message buffer ever hit the limit a message box will display an error message.

Check Boxes

"Display on EOM" - When "Display on EOM" is checked, only the last message received that will be displayed, and done so all at one time on receipt of the End of Message (EOM) indicator. When "Display on EOM" is not checked, each character is displayed as received and scrolls smoothly line by during reception of the entire message. Even though the scroll bars are currently active during this process, they really should not be used until the entire message has been displayed.

NOTE: Selecting "Display on EOM" will automatically disables "HEX Eng. View" if enabled.

NOTE: Display on EOM does not support the use of MS110A 4800bps uncoded.

"FIFO" - When "Display on EOM" is not checked and "FIFO" is checked, the latest message received shall be inserted at the top of the messages displayed buffer and done so character by character

during decoding. Other, when "FIFO" is not checked, each message will be appended to the message buffer.

"Save on EOM" - When "Save on EOM" is checked, regardless of whether "Display on EOM" is checked or not, all messages received shall be saved to the "../dalog/" sub directory using a file naming convention of mmddyyyy.da in an ASCII text file that can only be read from start to end when MS110A is not running. The file contents can be read at any time as the file is opened, written to and then closed. However if the file is opened for reading during incoming data, the file must be closed and reopened to see all the data written to file since it was opened for reading. See Appendix D for more details on the .da file.

"EOM Alarm" - When "Display on EOM" and "EOM Alarm" are both checked, the receipt of an EOM will cause an audio alarm to sound on the systems default sound device. This feature should not be enabled if the default sound device is actually being used as the PC sound device modem.

"Common" - When checked the "Common" panel is always displayed.

"HEX/ASCII" – When "HEX/ASCII" is checked all data displayed in the Message Window and logged will be the HEX byte value for each data byte received. This feature for the user is of the most interest when monitoring binary data streams in SYNC or SYNC_EOM mode, which cannot be displayed as pure ASCII characters correctly or for third party developers. A good reference for the full ASCII character set is: http://www.ascii-code.com/

NOTE: Selecting "HEX/ASCII" will not be permitted if "Display on EOM" is enabled. A message box will be displayed alerting the user that "Display on EOM" needs to be un-selected.

NOTE: The use of "HEX/ASCII" requires that "RoN" always be checked. If "RoN" is not checked then the manual use of the RESET button will be required after the sending station has stopped transmitting.

TRANSMIT PANEL
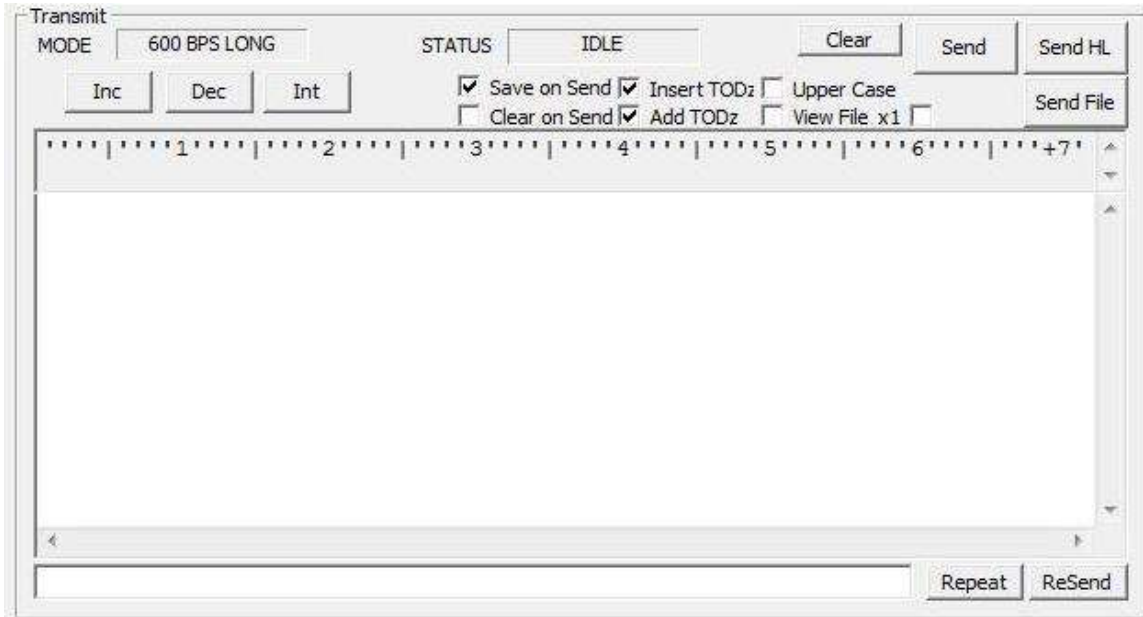
Buttons

"Inc" - This button increments the data rate.

"Dec" - This button decrements the data rate.

NOTE: 600bps LONG is the default the first time the program is run as it will handle average channel conditions with the use of LONG interleave. However the data rate needs to be user selected based on the prevailing channel conditions.

"Int' - This button toggles the Interleave between SHORT or LONG.

NOTE: The use of SHORT speeds processing of a message due to less data spreading. However LONG is more robust in the face of Noise bursts, Multipath and Fading channel conditions.

NOTE: There is no need for stations to be set to the same Data Rate or Interleave for RX as the MS110A preamble tells all receiving terminals what mode is being sent for automatic configuration. Each side in two-way exchanges can make use of different data rate and interleave setting with no coordination.

"Send" - Sends the message located in the "Outgoing Message Window" if any message is present. The "Send" and "Send HL" buttons and other selections are disabled during transmitting as seen in the screen capture at the end of this section. The EXIT button is active during transmitting should the transmission require termination.

"Send HL" - Supports resending any part of a multi-line message in the Outgoing Message Window where for whatever reason, it is desired to only send part of the message. The user must highlight

that portion of the message of interest as if to copy, once highlighted, clicking on "Send HL" instead of "Send" will transmit the highlighted part of the message as seen below.
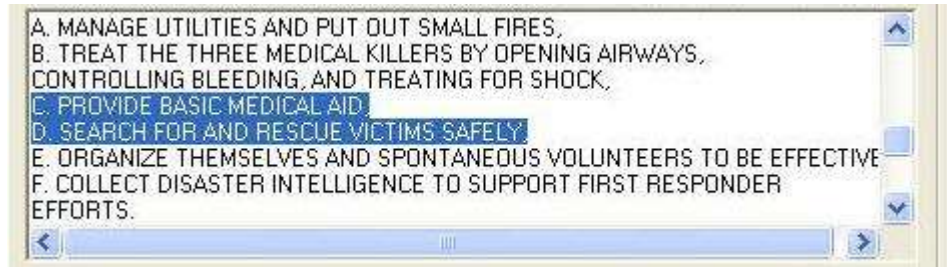
"Send File" - Supports the selection of an ASCII file to send its contents as the message or to view its contents in the "Outgoing Message Window" when "View File" is checked, for more details see Appendix C herein.

"Clear" - Clears the Outgoing Message Window and resets the scroll bars.

"Kill" - This button will only be displayed when the tool is in transmit and clicking it will stop the current transmission and clear all transmit buffers.

NOTE: Kill button is currently disabled while still under going further development.

"Repeat" - When clicked the last keyboard message sent during the current session will be pasted back to the keyboard message window for editing or immediate resending.

"ReSend" - Grabs the last message sent using by the 3 party software via the Data Port and paste is into the Outgoing Message window for editing and resending.

Status

"MODE" – This status window displays the current selected transmit mode is displayed. It follows the mode selected in the Common panel. For MS110A the default TX mode when the program is run for the first time or when the DMT.DAT file is missing or corrupted is 600BPS LONG. The range of MS110A TX data rates are: 75bps (compatible with S4415 Robust), 150bps, 300bps, 600bps, 1200bps, 2400bps coded for FEC and SHORT or LONG interleave and 4800bps uncoded, which has **NO** FEC or interleave support.

"STATUS" – This status window displays the current transmit state, at present for MS110A the states displayed are IDLE or TRANSMIT and BUFFERING. When the Data Port is active and receiving a message to transmit BUFFERING with flashing arrows ">" will be displayed as data is being buffered to send, as all data must be buffered before sending, this can take some amount of time when exceeding 1K message packets. If use of an external terminal is made that does not break up the message into packets, the buffering time will encompass the entire message.

NOTE: It is planned to undertake a rewrite of the modem interface in support of data port operation whereas all data is buffered into packets with the unknown sync data for transmit in real time in the same way as with hardware modems vs. all the data requiring buffering before sending.

MS-DMT Guide v1.06

Released 10-31-2015

Outgoing Message Window

The "Outgoing Message Window" supports entering or pasting of printable ASCII characters only. A message can be typed or pasted into the bottom "Outgoing Message Window" and is then sent by clicking on the "Send" button. When pasting messages be sure that the content has no non-printable characters (below ASCII 32) or extended characters (above ASCII 127). It is best to only copy and paste from an ASCII editor such as Notepad or Wordpad. All messages must be formatted using hard carriage return/line feed insertion in the body of the message by use of the ENTER key as the Word Wrap feature of those editors is a visual within those programs only and does not insert the required control characters in the text. Anything being copied from another source should first be pasted into Notepad and saved and then reopened to strip any undesirable content.

The main outgoing message buffer size is limited to 32k (32,378) at this time. If a message is entered that exceeds the limit an error message will be displayed. If a message is entered that is longer than will display in the window at one time, vertical scroll bars will automatically turn on for scrolling and will turn off when the "Clear" button is used. There is no LINE WRAP taking place, thus long lines will not wrap on the RX end.

NOTE: If any message content requires data encryption, the use of an authorized off line encryption methods that produce ASCII output must be used where the resulting data is pasted into the "Outgoing Message Window" for transmission. In addition, should the sending of any files be required, the use of an authorized Binary to ASCII file conversion tools must be used where the resulting output is pasted into "Outgoing Message Window" for transmission. It is recommended that any data which requires off line processing to recover its meaning be sent three times as the FEC although robust, is not error free, thus the user will need to verify proper data receipt by comparison prior to additional processing of the off line data content. The use of the Data Port with external 3rd party terminals for error free transmission negates the need to duplicate the data content.

Check Boxes

"Save on Send" - When "Save on Send" is checked, all messages sent shall be saved to the "../owlog/" sub directory in the format mmddyyyy.ow as an ASCII text file that can only be read from start to end when MS110A is not running, else only up the last time the program was run for the current Zulu Date shall be displayed. See Appendix E for more details on the .ow file.

"Clear on Send" - When "Clear on Send" is checked the outgoing message window will be cleared after the message has been sent.

"Insert TODz" - Per ACP-126 requirement "302. TIME OF TRANSMISSION INDICATOR - All transmissions are to include a time of transmission indicator. This is expressed as a time group in ZULU time and is to be the time the transmission commenced."

Example A: Call

(5 SPACES) (2CR) (LF)

1234Z (2CR) (LF)"

Thus there is now a selection check box of "Insert TODz" which will upon sending the message insert the TOD in Zulu time. This selection and "Add TODz" can both be active at the same time and work with all available means of sending a message.

"Add TODz" - When "Add TOD" is checked, the Zulu time shall be appended to the outgoing message sent.

"Upper Case" - When checked any text typed or pasted, either manually or when using the "Grab Last" feature will be converted to upper case. Any existing text prior for all but "Grad Last" will remain in lower case.

"View File" - When checked, any file selected using the "Send File" button or the Drag & Drop method (see Appendix C for details) will be displayed in the Outgoing Message window for reviewed or editing prior to sending.

"x1" - When checked, the Drag & Drop method for Displaying or Sending files is limited to one file and the one on which the mouse cursor is on regardless of how many files were selected.

Keyboarding Message Window

For Peer-to-Peer rapid keyboarding vs. formal message traffic, this window supports the sending of up to a 1024 (1Kb) ASCII character message on the ENTER key stroke. At 600bps or greater this makes for fast turnaround keyboarding interface capability. This window is not grayed out during TX as are other sending features are as seen below, this allows typing ahead with the next message to send as soon as the tool returns to receive.

The pasting of data is also supported, however whatever is pasted is limited to 1024 characters and will terminate on any embedded carriage returns or line feeds. All entered or pasted text is always converted to Upper Case.

There is no LINE WRAP taking place, thus long lines will not wrap on the RX end. When the 1Kb limit has been reached with an entered message prior to sending, a message box warning will display, at which point hitting enter will allow sending what has been entered, or the message can be trimmed down to convey all of the information with edited wording. The same rules when pasting apply as to legitimate ASCII character range of 32-132.

"Save on Send" and "Add and Insert TOD" features do not apply to use of this message window. A carriage return and line feed is inserted and appended to what is sent.

The "Clear on Send" is not supported as the keyboard message window automatically clears on sending the message when Enter is pressed.

The "Repeat" button will refill the window with the last sent message for reediting or resending immediately.

APPENDIX A: Data Rate and Interleave Selection

STANAG 4415 which only supports one data rate (75bps) makes life simpler for the user and provides very robust operation under all channel conditions (mandated for disadvantaged HF users, e.g. air-to-ground, low-power, auroral region communications). However it is slow and thus not the best choice if the channel will support faster data rates. S4285 and S4529 which are faster and rather robust broadcast modes which are not autobaud compliant (requiring that both the TX and RX stations to be configured to the same data rate and interleave settings in advance) and thus do not support ease of use for FEC RATT or support Adaptive ARQ. However due to their constant known probe synchronization data transmitted with the payload of unknown message data alternating in each frame, it makes them the better suited for FEC RATT and Broadcast applications.

Having the STANAG modems and MS110A in MS-DTM would make for a versatile capability for long as well as short haul HF communications. However all but use of MS110A and S4415 requires a lot of pre-coordination as to settings due to the lack of autobaud. As use the of STANAG 4285 or narrow band STANAG 4529 the user must select the proper data rate and interleave for FEC RATT operation based on channel conditions manually unless 75bps LONG is the starting point SOP or the only used mode. The use of serial tone modem waveforms in FEC modes by stations in attended operation, unlike in unattended guard channel operations permits a voice exchange to determine receive conditions on both ends, this holds true for Regional Broadcast use as well, as the NCS or directed sending station can poll the net for signal report. However in CONUS wide broadcast this is not possible, here 75bps LONG should be an SOP where additional modes can be used first to allow any stations who can copy to get the traffic and move along to other tasks.

Below is the section from MIL-STD-188-110B pertaining to MS110A standards "Minimum Performance Requirements" taking into account the use of an S4203 compliant HF SSB radio and use of LONG Interleave for the coded waveforms 75-2400bps.

The use of MS110A waveforms requires an understanding of the "MIL-STD-188-110B section 5.3.2.5 Performance requirements" as depicted below and correlated to current channel conditions in application due to HF channel variations, poor signal-to-noise ratio (SNR), and interference. As such many hardware modems provide visual tools for an idea of how the selected data rate is performing taking into consideration prevailing and changing channel conditions.

MIL-STD-188-110B, 5.3.2.5 Performance requirements: The measured performance of the serial (single-tone) mode, using fixed-frequency operation and employing the maximum interleaving period, shall be equal to or better than the coded BER performance in table XX. Performance verification shall be tested using a baseband HF simulator patterned after the Watterson Model in accordance with International Telecommunications Union (ITU) Recommendation ITU-R F.520-2. The modeled multipath spread values and fading (two sigma) bandwidth (BW) values in table XX shall consist of two independent but equal average power Rayleigh paths. For frequency-hopping operation, an additional 2 dB in signal-to-noise ratio (SNR) shall be allowed.

User bit rate	Channel Paths	Multipath (ms)	Fading (Note 1) BW (Hz)	SNR (Note 2) (dB)	Coded BER
4800	1 Fixed	-	-	17	1.0 E-3
4800	2 Fading	2	0.5	27	1.0 E-3
2400	1 Fixed	-	-	10	1.0 E-5
2400	2 Fading	2	1	18	1.0 E-5
2400	2 Fading	2	5	30	1.0 E-3
2400	2 Fading	5	1	30	1.0 E-5
1200	2 Fading	2	1	11	1.0 E-5
600	2 Fading	2	1	7	1.0 E-5
300	2 Fading	5	5	7	1.0 E-5
150	2 Fading	5	5	5	1.0 E-5
75	2 Fading	5	5	2	1.0 E-5

TABLE XX. Serial (single-tone) mode minimum performance.

NOTES:

1. Per ITU-R F520-2.

2. Both signal and noise powers are measured in a 3-kHz bandwidth.

The number of paths specified where modem performance is concerned are from one to two. Where two can even occur within NVIS taking into account ground wave and thus having to deal with multipath components. Multipath is much more common on Skywave paths. Fading can occur on any path. For mid-latitude HF circuits, the amount of multi-path (often called delay spread) can range up to 6 Milliseconds (ms) and the fading rate (often called Doppler spread) can be as high as 5 Hz. However, more typical values are 2 ms and 1 Hz, respectively, which are the basic parameters of the standardized CCIR Poor HF channel defined in ITU-R F520-2. Northern trans-auroral paths, of great interest to NATO worldwide and CFARS our counterpart in Canada, can be significantly more challenging with up to 10 ms of delay spread and 50 Hz of Doppler spread which S4415 has been designed to deal with.

The channel Signal to Noise Radio (SNR) and Bit Error Rate (BER) are key metrics that apply equally to both single and double hop paths as to modem performance. Signal to Noise Ratio (SNR) is defined as the ratio between the signal and noise levels, and is usually expressed in decibels (dB). There MUST be an actual MS110A signal present with MS-DMT to provide an accurate SNR reading. At SNR = 0 dB the ratio is 1, the signal and noise power levels are the same. A 10 dB SNR means the signal power is 10 times that of the noise power. At 20 dB the signal is 100 times (it is a log based scale) as strong as the noise. A SNR of 0 dB would just be barely detectable, in practice you need a few dBs' for a weak signal to be an audible by ear signal whereas a SNR of 30 or 40 dB is considered an excellent quality signal.

HF Channel Bit Error Rate (BER) is a simple concept in that its definition is simply:

BER = Bit Errors Total/Total Number of Bits

With a high SNR (regardless of signal strength) and an unperturbed signal path, BER will be so small as to be insignificant. However the BER value becomes significant when SNR decreases in the presence of imperfect channel conditions. The more rapidly the channel degrades the more rapidly the BER increases and the harder the modem receiver FEC most work at correcting error and the equalizer must work to maintain synchronization.

Harris Radio Corporation has publish data as replicated in the chart below whereby they have categorized the channel by estimated SNR for the given coded data rates listed to achieve 10E-4 BER (not Bit Error Count currently displayed in MS-DMT). It must be noted that the MIL-STD performance characteristics does not list BER 10E-4 as criteria for each data rate.

Data Rate (bps)	Signal-To-Noise (dB) Ratio Required for 10E-4 BER	
	Sky Wave Channel (CCIR Poor)	Surface Wave Channel (Gaussian)
9600	28	20
8000	24	17
6400	20	14
4800	17	12
3200	13	8
2400	14	9
1200	9	5
600	5	2
300	3	0
150	0	−2
75	−3	−5
75 (NATO Robust)	−3	−8

An HF channel is characterized as a multipath time-varying environment that produces time and frequency dispersion as represented in the image below that was captured with Spectrum Lab about 20 meters. Multipath fading can affect radio communications channels in two main ways; Flat or Selective Fading.

Flat fading: This form of multipath fading affects all the frequencies across a given channel either equally or almost equally. When flat multipath fading is experienced, the signal will just change in amplitude, rising and falling over a period of time, or with movement from one position to another. Selective fading:

Selective fading occurs when the multipath fading affects different frequencies across the channel to different degrees. It will mean that the phases and amplitudes of the signal will vary across the channel. Sometimes relatively deep nulls may be experienced, and this can give rise to some reception problems. Simply maintaining the overall amplitude of the received signal will not overcome the effects of selective fading, and some form of equalization may be needed. MS110A spreads the data over the channel using Interleaving selections of SHORT or LONG so that only a portion of the data is lost by any deep nulls. This allows the data to be reconstituted using Forward

Error Correction (FEC) techniques and in this way it can mitigate the effects of selective multipath fading.
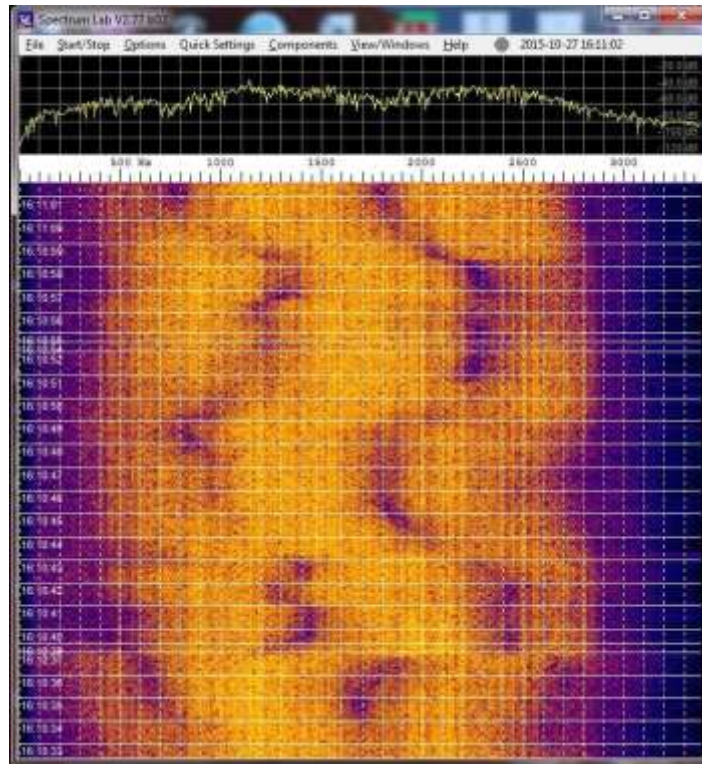
The sources of multipath are the reflections of radio signals from different layers in the ionosphere. In addition, multiple reflections can occur between the earth's surface and the ionosphere, giving rise to multi-hop propagation. Thus, the received signal can contain several "echoes" or modes, separated in time by a matter of milliseconds (i.e. time spread). The source of frequency spread is that each mode is itself fading due to the specular nature of the ionospheric reflection. Then too with ground wave distance between stations there exists an additional path.

Recently on TRANS GLOBAL the multipath on Skywave was awful one day and appeared as seen in the image above at the authors' location. MS-DMT was consistently approaching the maximum number of bit errors per frame while decoding at 600bps LONG. Another station working along with the author at another location a few hundred miles further east was also consistently registering close to the maximum number of bit errors. However at the authors' location in the mountains at 2200ft. ABSL the sync was often lost. However when the sending station reduced power to 8 watts perfect copy was had, even at a 1200bps LONG transmission as the SNR was strong enough. Upon returning to the higher RF power level once again sync was at times lost. **The only way to mitigate multipath components is to reduce transmitted RF power**. There are too many MARS members running power levels that are too much for MS110A to deal with over Skywave paths and at times on NVIS when multipath is involved. It does not really matter if we are talking the software defined modem in MS-DMT or a hardware modem, they will both fail depending on the channel conditions and RF power level.

MS-DMT Guide v1.06

Released 10-31-2015

MS-DMT now provides addition tools in both an SNR display and an actual Bit Error Count displayed labeled as BER at this time. In addition there is the long standing Frequency Error (FER) display. These displays are accurate when actually decoding MS110A PSK incoming signals only.

The FER display provides the difference in Hz. between the transmitting and receiving station during the PREAMBLE decoding and synchronization and equalization phrase. This difference in frequency is the sum of sample clock error, radio frequency error and channel Doppler (QSB in HAM terms). That could be all positive or all negative or a combination of frequency offsets per category. At the initial PREAMBLE data decoding the error will be the highest and then by the start of the Data phase it will be displayed as corrected by the modems equalizer. At that point the FER display will hold during the Data phase and be saved to the log with the message data if logging is enabled. An ongoing FER display during the Data phase and continued equalization as provided by some MIL-STD hardware modems is planned. When FER is displayed during the Data phase it will add insight into the ongoing equalization which if fails to deal with doppler will cause a loss of DCD.

The SNR display provides an instantaneous update verses an averaged over some time period and thus smoothed SNR display common to MIL-STD hardware modems that provide for SNR display. It is planned to provide for a user selectable instantaneous vs. averaged display. The instantaneous display when dipping rapidly and much lower than the average being seen will immediately correlate to an increase in the current Bit Error Count.

The BER display at this time provides a "Bit Error Count" total for the current packet frame being decoded verses the MIL-STD hardware common "BER = Bit Errors Total/Total Number of Bits" as an ongoing average during the entire transmission being decoded by the receiver. When the selected data rate and interleave has no issues with dealing with the channel conditions the current BER display will sit at 0. Any reading that is under 100 means the FEC is starting to get some exercise but is not working very hard at all. It however indicate imperfections in the decoded data stream that are being correct. If one were using SHORT interleave and seeing bit errors then on the next transmission a change to LONG would decrease the bit errors due to the increased spreading of the bits in the message stream bandwidth. Between up to about 500 errors means the FEC is now getting a workout, however along a equalization is keeping pace with FEC all will be fine. As we exceed 500 bit errors during the processing the FEC is starting to work hard, again if the equalization continues to hold all will be fine. Each additional 100 bits errors above 500, e.g. 600, 700 etc. as we approach the point of no return is stressing the FEC, however this is usually only going to occur with severe Multipath and Fading and or large amounts of Doppler that the FEC and equalization is about to lose the battle against. However even within 1 bit error of maximum for the current selected parameters, as long as equalization can manage to hold through the message up to the EOM you will get the message. Quite often under such conditions you may lose the EOM being decoded and either need to rely on automatic resetting or manually click RESET.

It you are consistently see high levels of bit error count then its best to use LONG interleave. If high bit error count persists or if you are already using LONG (which is SOP in Army MARS for FEC RATT) then it's time to decrease the data rate. If the bit error count just keeps sitting at 0 or below 100 or not to much beyond 100 you can assume the next higher data rate can be used to push the traffic along at a quicker pace.

Keep in mind that when you can tell Multipath is an issue, an alternate approach to reducing the data rate is to have the sending station reduce their RF output power. This is more prevalent on Skywave than on NVIS paths (aside from daily multipath interference at sunrise and sundown) unless their good ground wave between the stations involved and/or mountainous terrain and/or the sending station is running an external PA. I have witnessed countless cases on MARS NVIS circuits of strong station that I could not decode at all or lose DCD on fast that is solely due to the POWER mentality factor in running their external PA. Then too some stations have radios capable of in excess of 100w output with MS110A where it's actually too much power and needs to be cut back. There will be Multipath tools added to MS-DMT in time that will take the guess work out of this issue.

Also keep in mind that the two-way use of MS110A serial tone FEC modes being autobaud easily provide for two stations in contact to send at the same or at different data rates (and even Interleave) settings. It is best to just make use of the LONG interleave all the time to deal with any channel issues, however SHORT will speed things along for good channels. Thus the split mode capability allows station 1 to send at the fastest data rate station 2 can receive at due to their channel conditions and station 2 to send at the fastest data rate station 1 can receive at. Any 3rd parties to the circuit will intercept easily due to autobaud should their conditions be suitable for the data rates in use.

For guard channel operations the broadcast station can only to take into account TOD propagation characteristics for the wavelength being used, seasonal effects and minimum performance characteristics of the waveform data rates, thus 75-300bps should be used for CONUS wide or OCONUS broadcasts and 75-600bps for regional broadcasts. The use of serial tone modem waveforms in FEC modes by stations in attended operation, unlike in unattended guard channel operations permits a voice exchange to determine receive conditions on both ends. This holds true for Regional Broadcast use as well, as the NCS or directed sending station can poll the net for signal report.

Most MARS-to-MARS peer-to-peer and regional broadcast communications takes place within 2-12Mhz where the 3-7Mhz range sees the most use and where the 3 and 5Mhz range sees the bulk of the use and which has the highest noise levels and fading conditions next to 2Mhz. As such the recommended Interleave setting is always LONG as previously stated, it can't overstated that LONG is the best setting for FEC RATT. Data rates beyond 600bps will not yield reliable results even if one has an S4203 compliant radio system and hardware modem unless very good to excellent channel conditions exist, which can be more readily determined if two-way contact with the audience stations are part of the scenario.

APPENDIX B: Resizing the MS-DMT GUI

NOTE: MS-DMT v1.01 B1.0.1.3. GUI has changed and this section has not yet been updated to reflect those changes.

Below are screen shots dealing with the features in support of "Resizing" the tool were the first new feature is the presence of the Maximize box as seen circled in red below.
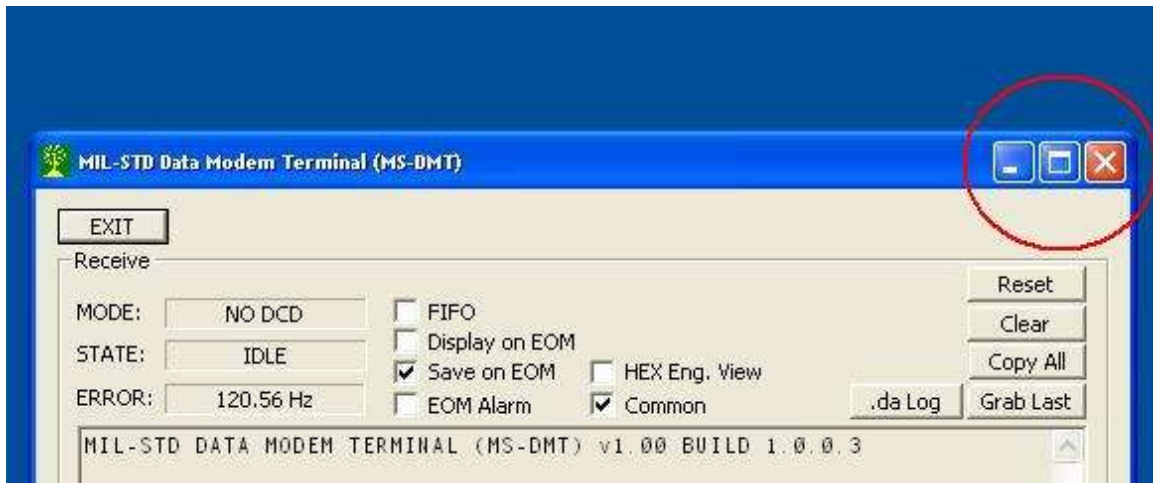
There has also been a Resizing Grip Anchor added at the lower right corner which can be seen a below circled in red.
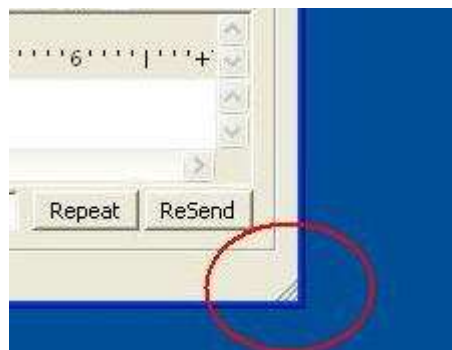
However resizing via dragging can be achieved by left clicking on any border and releasing the button and dragging via the mouse vs. needing to hold the button. Thus resizing will automatically remain active from the first click point and drag until another left click and release is made to disconnect from resizing. This approach mitigates issues with RX during resize dragging caused by the larger amount of windows messages being sent otherwise. Also, for less interrupts just click on the anchor with the mouse and then you the Left/Right and Up/Dn keys on the keyboard to resize and then click the anchor to release.

Below is the tool resized full screen by use of the single click of the new maximize button where the font is Letter Gothic MT size 14 and the display configuration is 1024x768 96dpi.
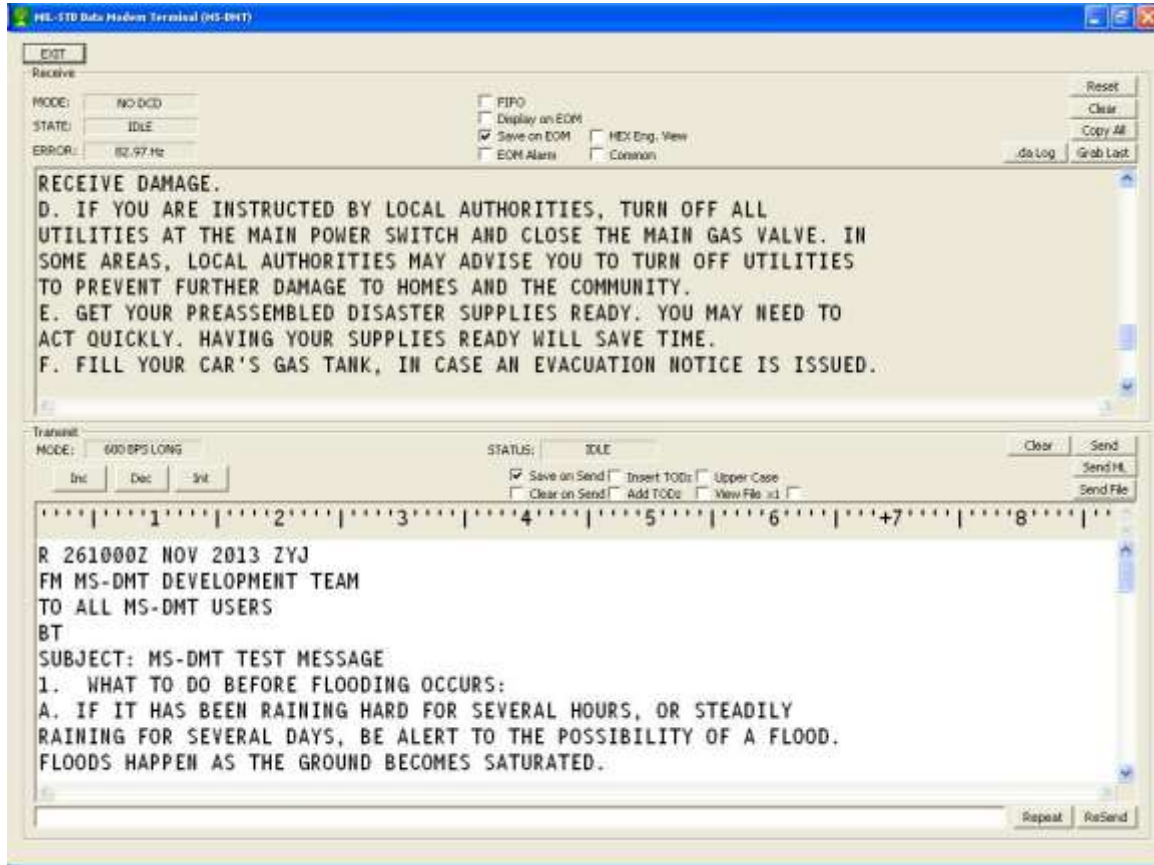
At present there is no minimum resize point being set, thus a ridiculous under size resize can be made as seen below (which can be resized even smaller) which was the condition prior to clicking on the Maximize button to create the screen cap above and upon clicking again, it is the size that the tool will return to, the Grip Anchor when this small cannot been seen, but it's there to click on to resize to usable dimensions.

Resizing is enabled at all times, to include during transmitting, in testing during receiving and transmitting a normal amount of resizing does not seem to be a problem but it cannot be ruled it out if over used.

The layout that everyone is used to has been preserved, however being as MS-DMT is an MFC Dialog based application, where everything involving resizing requires custom code development. The current layout limits certain aspects of resizing. As the TX windows are on the bottom part of the GUI, I have configured the main TX window to be resized horizontally and vertically while only allowing horizontal resizing of the peer2peer window. As the RX window is on the top half of the GUI it can only be resized horizontally without overlapping the common frame, thus the vertical resize is not enabled for the RX window.

The Maximize/Restore button does not seem to have any negative impact if used during RX or TX. The normal use of Click and Drag Resizing also seems to have little or no impact if performed during RX or TX. However, if one were to constantly resize the tool during RX, the overly large amount of windows messages and constant repainting of the tool to the display can at times impact RX decoding.

For those who are always resizing the MS-DMT and forget to click to drag and resize and then click again to disable resizing, you may be interested in the extra step required to get rid of the need to make that last click to disengage resizing? Then start your process by right clicking on the top title bar and click on "Size", see the screen cap below.
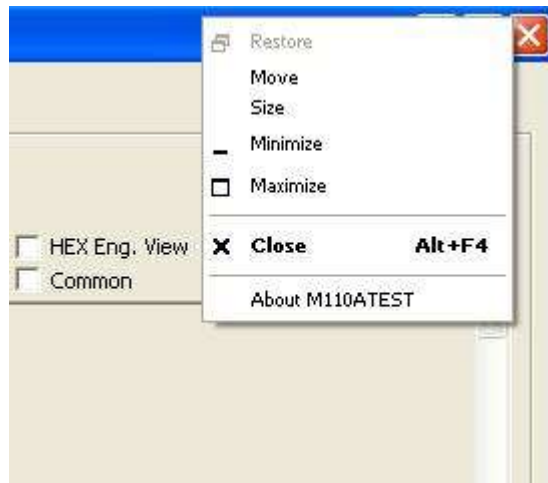
The cursor will change and you can then resize without the need to make that final click to disengage.

Save/Restore of MS-DMT Position, Size and State has been implemented. When the program is run for the first time it will be at its default size and centered in the middle of the screen. Thereafter, it will be at whatever location and size the user last resized and positioned it. Furthermore, if the program was reduced to the Task Bar when terminated, it will restart reduced to the Task Bar, and when re-enlarged off the Task Bar, it will resume its size and location prior to being reduced to the Task Bar before being terminated in that state.

The above Save/Restore is independent of the DMT.DAT file as well, thus even a new update or trashed DMT.DAT file will have no effect on the next restart as the information is being saved to the Windows Registry Database as the structures required to bring this all about just would not store to the .DAT file and retrieve fast and smoothly enough at program termination and start. If you ever has cause to restore the registry prior in date and time to the first use of MS-DMT with this new support, then and only then will your saved coordinates be lost, but upon the first start and reposition and program termination they will once again be saved.

However, for the Save/Restore to work under Vista and later it is required that the user check the "Run this program as an Administrator" box at the bottom of the compatibility page. Do NOT check the box to run in any XP compatibility mode however that doing so causes memory leaks. Also, at

present there will be a message regarding "unknown publisher" when MS-DMT is started until such time as the .EXE assemblies are signed if you have not disabled that feature by setting the UAC (Control Panel/User Accounts/Change User Accounts Settings) to "Never Notify".

APPENDIX C: Send File and Drag & Drop

NOTE: MS-DMT v1.01 B1.0.1.3. GUI has changed and this section has not yet been updated to reflect those changes.

The screen shots and text herein detail the use of the "Send File" button and the "Drag & Drop" method for loading messages from a file to view, edit and send or just sending directly from a file.

Send File
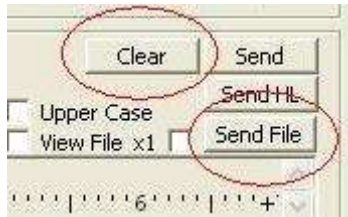
The "Send File" button takes the previous position of the "Clear" button which has been relocated to the left of the "Send" button.

The use of "Send File" follows the selected MODE pull down choice in the Common panel. As such the current modes provided will send the contents of the selected file and not an image of the file as would be the case with the FS-1052DLP FTP selection found in the MARS-ALE application.

When/If there are selections that would support binary file transfer the use of "Send File" when such a MODE is selected would send the file itself to the other party who would need to be in the same MODE where the file would end up in the sub directory designated for the reception of files.

The use of "Send File" presently supports the sending of ASCII file contents where the default sub directory coded is \FILES\ which the user can optionally create under where the MSDMT_32.EXE resides. The choice is the users as to whether or not it is desired to create the \FILES\ sub directory.

If there is no \FILES\ sub directory and it is the first time the tool is executed and "Send File" is used, then the sub directory where MSDMT_32.EXE resides will be the target directory and at that point should there be navigation to another directory for file selection, it will be the directory opened on the next use of the "Send File" feature during that session or the next session until another directory is selected or a \FILES\ is created. The use of a cleaning utility that wipes out files and last used information may negate this in practice.
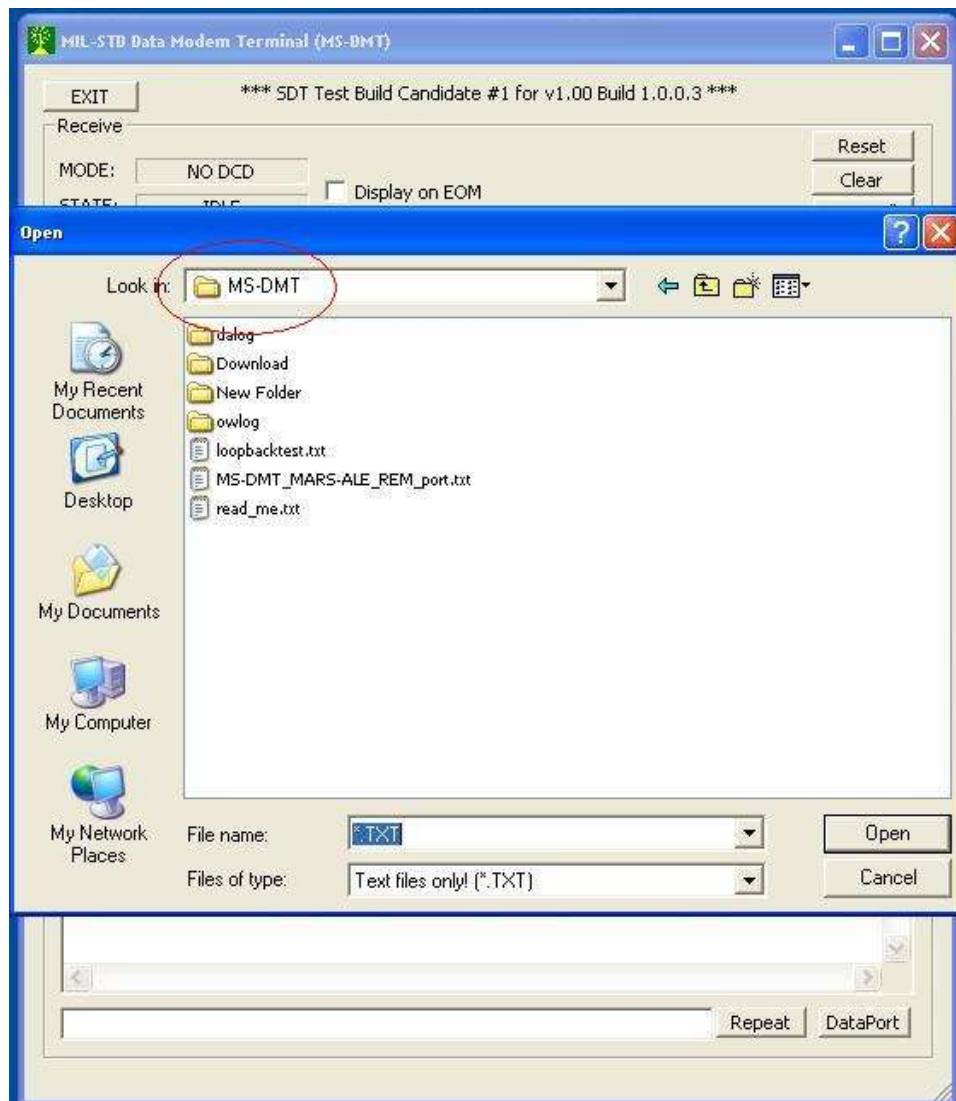
However, if at any time the \FILES\ directory is created under where MSDMT_32.EXE resides, it will always be the directory opened by the use of "Send File", at least that is the intent, it may or may not work out that way under all versions of Windows and of course the use of Wine etc. under other operating systems.
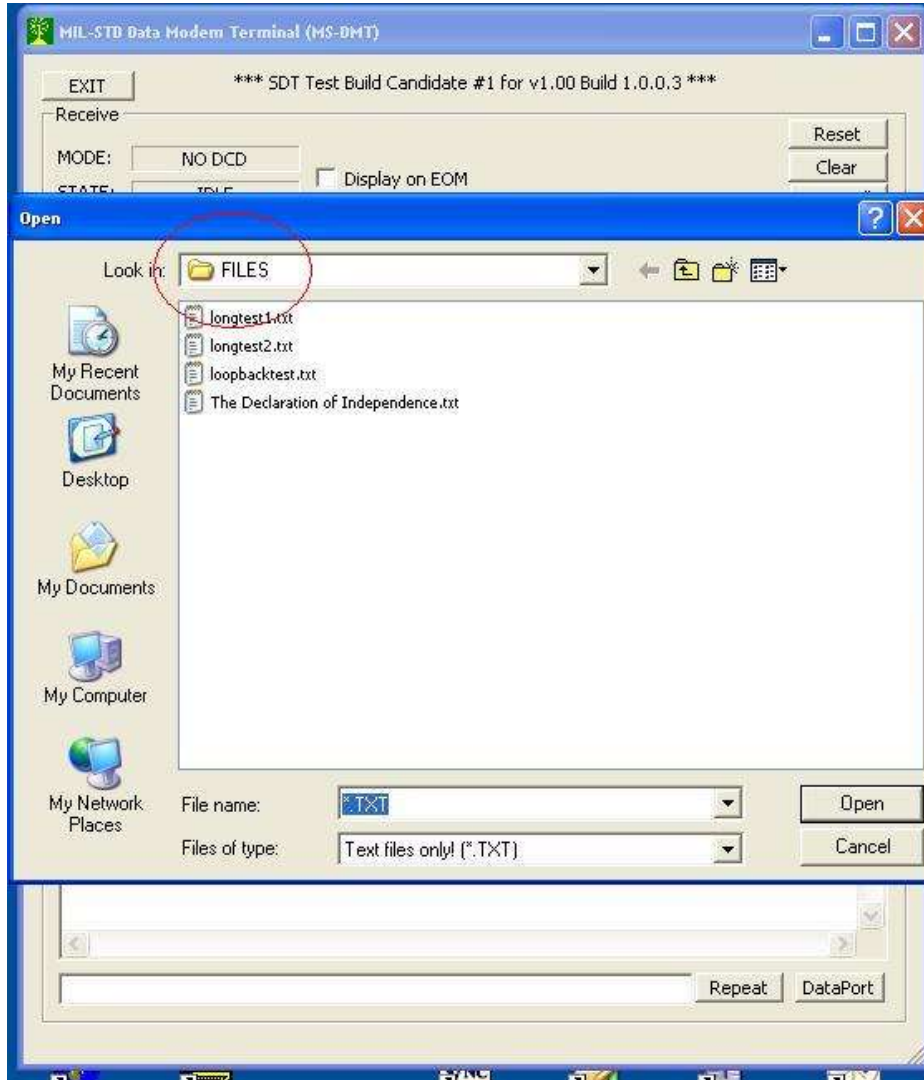
By default files with the extension of .TXT are listed, however the user can change that to files with any other extension or all files by using *.[extension] or *.* or any wildcard a position filler combinations on each use of "Send File".

When a file is single clicked it's displayed for use, another click on OPEN sends it. If the file is double clicked on then the file is sent immediately.

The selection of any file that contains other than pure ASCII content between the range of ASCII 32 and ASCII 127 and to include ASCII 10 and ASCII 13 will result in an undesirable display of garbage characters by receiving stations as well as premature end of file contents being displayed. It will not however cause any issues with the applications function in the sending of the file selected.

There is also an option to view the contents of the file by checking the "View File" box where the selected file will be loaded into the outgoing message box where any existing contents will be cleared. So rather than just sending from the file immediately this option allows the user to review

the file contents first in case they may have selected the wrong file At this point the file can be reviewed and edited as any pasted message and then sent.

Should a file now be clicked on for selection but instead by manually entered by the user by any means or renamed after selection and the file not exist, then an error message will be displayed and there will be no transmission.

If the file selected is too large, then an error message will be displayed.
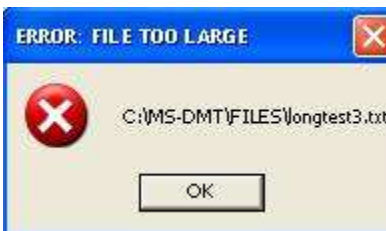
Drag & Drop

Drag & Drop file support has been added to the tool for the benefits if offers the user in rapidly grabbing one or more files for use as the message for transmission to either be sent immediately for viewed prior to sending.

ASCII files only are the desired file type for Drag & Drop operation at this time. However there is currently no mechanism in place to alert the user that a file contains non-printable characters.

The Drag & Drop File support that follows the state of the "View File" check box in that if checked, files are displayed in the Outgoing Message window for user processing and if not checked a single file selected is just sent and multiple files are queued for sending by user authorizing them one by one.

Any area of the program at the Outgoing Message Window and above can have the file dropped onto it with proper results, below that window nothing will happen.

When "View File" is checked, one or more files can be highlighted for selection and then dragged and dropped onto the MS-DMT where the files will be displayed in the Outgoing Message window. As printable ASCII content files can only have all of their contents properly displayed on either end of the equation, and null characters will cause undesired issues, the user should be careful in file selection.

Any pre-existing contents of the Outgoing Message Window will automatically be cleared by design, if you want the content of more than one then on file to display then you use multi-file selection, if

you want something else added or changed to it that you have elsewhere, you need to paste it after the drop.

The first file that is processed when multiple files are selected is one that the mouse is actually clicked on for the drag & drop process. The remaining files are then processed in their visual order.

When "View File" is NOT checked, if a single file is dragged and dropped it will immediately start a transmission of the files contents.

When "View File" is NOT checked, if more than one file is selected, then the user will be presented with a message dialog and YES/NO/CANCEL choice regarding the processing of the files that were dropped onto MS-DMT.
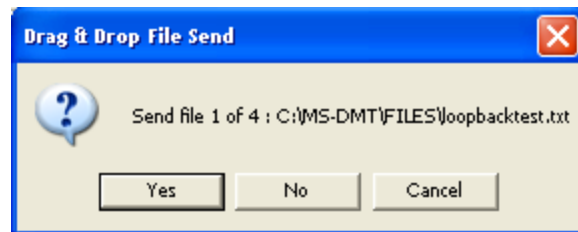
For each file the dialog which lists that files ranking and the number of files selected beginning with a file "1 of x" statement and the full path and file name of the current file being presented for sending. The user can choose one by one to send by clicking YES or to pass on sending by clicking NO until file "x of x" files has been reached or exit the entire process by clicking CANCEL. During the sending of multiple files, after the first one is done sending, you can click YES to send the next one. You can of course click NO or CANCEL while the tool is transmitting, but you should not click YES when the tool is transmitting as the next file is not be sent and will be dropped from the queue. Thus if you are going to send a number of messages from files you can queue them all up at one time to send them one by one and even change your mind as to get to each on or exit the entire process, which for a traffic rep is a time and effort saving feature.

You can also move the "Drag & Drop Send File" dialog to the side or just click on the MS-DMT main GUI and change data rate and or interleave settings in between clicking YES to send a file. The "Drag & Drop Send File" dialog will re-center automatically after you click a selection on it again. You can also repeat the sending of a file once sent by pressing the "ReSend" (DataPort renamed) button which ReSends the last messages sent by Drag & Drop (as well as Send File and use of the DataPort with an external terminal) by pasting the previously sent message into the outgoing message window where you can then hit Send, whenever you are done resending, you can then refocus on the Drag & Drop File dialog and the next dropped file for sending or exit the process.

All files that are not ASCII will be processed for sending which is not desired as they will terminate prematurely depending on the characters contained and will not display properly on the receiving end.

If a file selected is too large then an error message only will be displayed listing the file as being too large, if "View File" is selected and multiple files are selected then the file that fills the TX buffer will generate a Buffer Full error message and any subsequent file selected will do the same.

If any selected file is empty of any character, it will be processed in that it will be opened, but nothing will transpire, it will be listed as a file to send if multiple files are dropped, but it will not result in a transmission.

The added "x1" checkbox works in conjunction with the state of the "View File" checkbox as applied to Drag & Drop of files as detailed above. If the x1 checkbox is checked, then regardless of the number of files dropped, only 1 will be acted upon. That one will be the one that the mouse is actually clicked on for the drag & drop process.
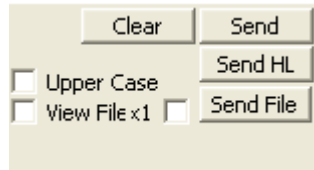
Renamed "DataPort" button to "ReSend" to support resending the last sent message via the Drag & Drop, Send File or DataPort streams.

.ow Logging Changes

Added support to log to current .ow file when "Save on Send" is checked, the details of the full path and file name and file contents sent as the message when "Send File" or Drag & Drop methods are used to send from a file.

FILE OPENED Nov-16-2013 17:45 Greenwich Mean Time

Transmitted using Mode: ASYNC_EOM

Transmitted using: 2400 BPS LONG

***Sent File: C:\MS-DMT\FILES\loopbacktest.txt

***Sent File Contents As Message Starts Here:

snip....

***Sent File Contents As Message Ends Here:

==

FILE CLOSED Nov-16-2013 17:45 Greenwich Mean Time

APPENDIX D: Received Data Logging

NOTE: In MS-DMT v1.01 B1.0.1.3. the saving of the peak SNR during the PREAMLE was added to the .da log output.

For "Save on EOM" to work properly, the Data Logging directory, "..\dalog\" must exist, else a warning message will be displayed if it is missing and "Save on EOM" is checked when a message is received and no log will be created.

Name	Size	Type	Date Modified
dalog		File Folder	4/15/2013 7:00 PM
Download		File Folder	4/15/2013 7:00 PM
owlog		File Folder	4/15/2013 7:00 PM

The file naming convention for data log files is "MMDDYYYY.da", for example:

06082012.da

When "Save on EOM" is checked, all messages that come in with a legitimate EOM at the end will be saved to the current log file.

A log file is created or if existing for the current date opened when the program has received a message and the file is closed immediately after the data is saved.

The same log file will be used until the program allowed to run beyond the Zulu date, then a new log file is will be created at the next message received when logging is enable.

Each time the log file is opened during its life, the following statement is written to it:

FILE OPENED xxx-xx-xxxx xx:xx Greenwich Mean Time

For example, today's files first entry is:

FILE OPENED Jun-08-2012 02:12 Greenwich Mean Time

Then later when the next message was received the entry is:

FILE OPENED Jun-08-2012 02:12 Greenwich Mean Time

For each "FILE OPENED" entry there should always be as corresponding "FILE CLOSED" entry, which should always be the last entry to a log file, such as:

FILE CLOSED Jun-08-2012 02:12 Greenwich Mean Time

In between "FILE OPENED" and "FILE CLOSED" entries with the same date/time stamps will be the message received, as the file is opened and written to and then closed, the date/time for these two events will most likely always be the same except for long messages, for example here is a complete example of a test message being received:

==

FILE OPENED Jun-08-2012 02:12 Greenwich Mean Time

==

Received using Mode: SYNC_EOM

Received at Data Rate: 600 BPS LONG

Received at Freq. Error: 0.04 Hz

***Received Message Starts Here:

0202Z

THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG'S BACK 1234567890 TIMES. RYRYRYRYRYRYRYRYRYRYRYRY

NNNN

SENT AT: 02:02:00z

***Received Message Ends Here:

==

FILE CLOSED Jun-08-2012 02:12 Greenwich Mean Time

==

If the End of Message (EOM) indicator is displayed in the log as the three characters "iZ›" prior to the line "***Received Message Ends Here:" the user is using an old Alpha build or Beta #1 and NEEDS TO UPGRADE.

In testing during numerous HF Channel Simulator sessions and real world testing to date, to include when stations were setup with the incorrect mode, such as ASYNC and SYNC, if the incoming signal is recognized as being a legitimate Preamble, when data starts, even if we immediately lose sync (NO DCD) and even if NO EOM is printed to the STATE display and the three EOM characters are not displayed, the log file has always properly closed for example here is a case where the sending station was using SYNC which resulted in NO DCD and NO EOM:

==

FILE OPENED Jun-08-2012 04:32 Greenwich Mean Time

==

Received using Mode: SYNC_EOM

Received at Data Rate: 600 BPS LONG

Received at Freq. Error: -0.06 Hz

***Received Message Starts Here:

This is a test.

NNNN

***Received Message Ends Here:

==

FILE CLOSED Jun-08-2012 04:32 Greenwich Mean Time

==

If the sending station has either or both "Insert TOD" or "Add TOD" enabled using MS110A-DMT then each message received will have the Zulu TOD that the sending station sent the message inserted and or appended to the body of the message. The difference in time between the Zulu TOD in the body of the message if present and the FILE CLOSED Zulu TOD, assuming both stations have accurate TOD is a relative indicator of the duration of the message transmission time, but is not exact as time is only recorded down to minutes and not seconds.

As the log file is an ASCII file rather than a binary file, you can open them to access the information using Notepad or just about anything. Having the file open when the software writes to it does not cause any issues under MS Windows, running the software under a Windows emulation such as Wine may be another matter.

APPENDIX E: Sent Data Logging

When "Save on Send" is checked, each message sent using the "Send", "Send HL" or "Send File" buttons or the "Drag & Drop" method will save message text sent is saved to the current log file.

For "Save on Send" to work properly, the Outgoing Message Logging directory, "..\owlog\" must exist, else a warning message will be displayed if it is missing and "Save on EOM" is checked when a message is received and no log will be created.

Name	Size	Type	Date Modified ▲
dalog		File Folder	4/15/2013 7:00 PM
Download		File Folder	4/15/2013 7:00 PM
owlog		File Folder	4/15/2013 7:00 PM

The file naming convention for data log files is "MMDDYYYY.ow", for example:

06082012.ow

The log will contain two types of sent messages, those sent normally and those sent as fill using the Send Highlighted feature, which will be labeled as "***Sent Highlighed Message Starts Here:", followed by the message sent and then "***Sent Highlighed Message Endss Here:"

Here are some examples during testing.

===

FILE OPENED Jun-07-2012 22:28 Greenwich Mean Time

Transmitted using ASYNC_EOM

Transmitted using: 600 BPS LONG

***Sent Message Starts Here:

2228Z

This is a test message

BT

NNNN

SENT AT: 22:28:00z

***Sent Message Ends Here:

==

FILE OPENED Jun-07-2012 04:44 Greenwich Mean Time

Transmitted using ASYNC_EOM

Transmitted using: 4800 BPS UNCODED

***Sent Highlighted Message Starts Here:

THE COMMUNITY EMERGENCY RESPONSE TEAM (CERT) PROGRAM IS AN

ALL-RISK, ALL-HAZARD TRAINING. THIS VALUABLE COURSE IS DESIGNED

TO HELP YOU PROTECT YOURSELF, YOUR FAMILY, YOUR NEIGHBORS AND

YOUR NEIGHBORHOOD IN AN EMERGENCY SITUATION.

SENT AT: 04:44:00z

***Sent Highlighted Message Ends Here:

When "Save on Send" is checked, the details of the full path and file name and file contents sent as the message when "Send File" or Drag & Drop methods are used to send from a file.

FILE OPENED Nov-16-2013 17:45 Greenwich Mean Time

Transmitted using Mode: ASYNC_EOM

Transmitted using: 2400 BPS LONG

***Sent File: C:\MS-DMT\FILES\loopbacktest.txt

***Sent File Contents As Message Starts Here:

snip....

***Sent File Contents As Message Ends Here:

===

FILE CLOSED Nov-16-2013 17:45 Greenwich Mean Time

APPENDIX F: Data Port

The Data Port parameters are locked to 8 data bits, no parity and 1 stop bit and No Handshaking. The DTR line is asserted to indicate a high PTT state for any applications that requires the monitoring of the PTT state.

The Data Port support is either accomplished by a paired (null modem) set of Virtual Serial Ports (VCP) where a server application such as the recommended use of com0com (http://sourceforge.net/projects/com0com/files/com0com/) or other (32 and 64 bit) server tool is used with the 3rd party terminal software when running on the same PC as MS-DMT. The use of a signed VCP server is required for Windows 7 and later.

It is recommended that "enable buffer overrun" be selected on both sides of a VCP pair with com0com or any VCP server that supports this capability to mitigate issues when the terminal connects and to allow for the use of the MS-DMT tool when the Data Port is not set to 0 and there is no external terminal program running. VCP servers tested that offer baud rate emulation do not seem to work, thus the selected baud rates between the MS-DMT and external software do not seem to matter when using VCP ports as they do when using a physical RS-232 port. With com0com Microsoft .NET Framework 3.5 is required to use GUI setup seen below.
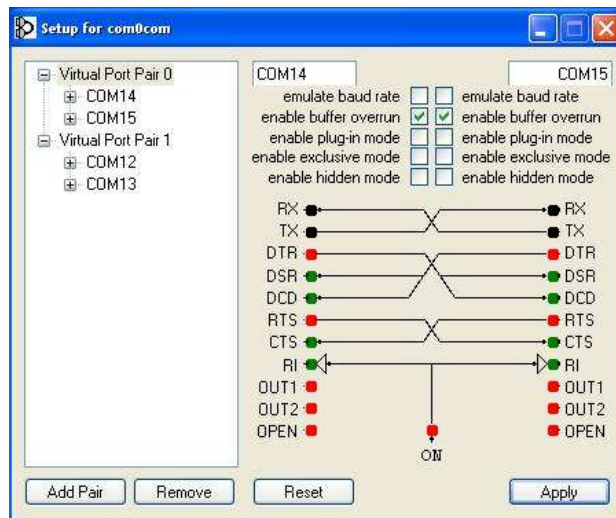
An option when the system resources are too low or DPC latency is too high on the same PC to support both the MS-DMT and external terminal or when the DMS-DMT is running under another operating from the external terminal application, real physical serial ports can be used along with a Null Modem. It is not recommended to use real serial ports on the same PC running both applications as the effects of RS-232 interrupts has on DPC latency. The selected port parameters much match between the MD-DMT and external software when using physical serial ports.

NOTE: With the trend of no physical hardware serial ports and the need to use device driven RS-232 adapters, another option would be to dedicate an older PC up to the task to MS-DMT and make use of com0com and the com2tcp tool to tie MS-DMT to a com0com virtual serial port and then to com2tcp

and via the PC's wired ethernet port to the home TCP/IP network to connect with a second machine running the external terminal application.

The MS-DMT Data Port is always opened in binary mode to support ASCII characters 0-255 as the modem itself will support passing binary range characters, however, at present the internal incoming data display will only display the normal printable range ASCII characters. In that regard, when "TRANS" in use by the sending station to transmit binary data, when SYNC_EOM is used, the monitoring of the non-ASCII can be achieved if "HEX Eng. View" is checked. However the intercept of content that contains a Null (0x00) character while just SYNC will cause a modem receiver will reset. The use of ASYNC_EOM will result in gibberish.

The Data Port follows the selection of ASYNC_EOM, SYNC_EOM and SYNC modes available for selection to process the data port data stream as ASCII range (decimal 20 through 128) characters. However, when "TRANS" is checked, the mode will be locked into a compatible SYNC with EOM mode coded to support passing a binary data stream, be it Binary, mixed Binary/ASCII or just ASCII.

If "RoN" which stands for "Reset on Null", is checked in addition to "TRANS", then in addition to resetting on the EOM, the modem will reset on "Null", this provides for modem reset in case the EOM is corrupted, missed or not sent. However, RoN cannot be used if any binary data is being sent that contains even one ASCII value 0x00 Null character or else the null character in the message will prematurely cause a modem reset.

When the data port is active, all data received is still displayed and treated the same within the MS-DMT application to include RX logging except when "TRANS" is checked. All data sent and received via the data port passes through MS-DMT application when the data port is active with no MS-DMT parameters selected effecting the sending of data or the display of received data via the 3rd party application. The most recent message sent via the 3rd party application is retained by the MS-DMT for later re-use by pressing the DataPort button, which pastes it into the MS-DMT Outgoing Message window. 3rd party terminal applications may send unprintable characters (between ASCII decimal 0-31) any such characters when pasted for sending or when received will be automatically displayed as a box () character within the MS-DMT display.

NOTE: When making use of the serial Data Port with external applications, modem performance may be adversely affected on older PC hardware and Operating Systems if the external application is run on the same computer. With MS-Windows XP and Vista, the better the class of CPU and more available RAM the better. The maximum amount of RAM the PC will support installed is recommend and if multi-processor or multi core PC's are being used, its best to dedicate one to the MS-DMT and the other to the external terminal application using Process Affinity of CPU Pinning as appropriate and setting the MS-DMT to operate at high priority. What is even better is to run both applications on different PC's using a null modem cable between two physical serial ports. For those running under emulations of Windows under other operating systems it's recommended that only the latest PC hardware, with maximum amount of RAM be used to run both applications at the same time.

APPENDIX G: CAT Radio Support

NOTE: MS-DMT v1.01 B1.0.1.3. GUI has changed and this section has not yet been updated to reflect those changes.

The list of supported computer controlled HF SSB transceivers and receivers herein is current as of this build. Additional make/model radio equipment are always being added. Should your make/model radio not be listed, please provide the any documentation you may have for computer control programming.

All CAT modes operation listed below require that the CAT COM port be set correctly and not 0.

PTT TYPE	COMMENTS
CAT ONLY	Sends CAT PTT ON and CAT PTT OFF
CAT&RS232	CAT is used for PTT as above plus either DTR or RTS as below. Supports signaling for auxiliary interfacing requirements.
RS232	Asserts and de-asserts either the DTR or RTS lines for PTT on the CAT port predicated on the DTR/RTS box being checked or not.
EXTERNAL	None of the above PTT methods are used which allows for the use of an external hardware PTT method based on the modem audio out from the PCSDM such as with VOX PTT based external units.

CAT PTT = Main SSB or only radio CAT PTT ON and OFF command sent and no other others if CAT ONLY or CAT&RS232 is selected.

CAT DATA = Dedicated Data Port CAT PTT ON and OFF command sent if one exists for the RADIO MODEL and no other CAT PTT command if CAT ONLY or CAT&RS232 is selected.

CAT D/V = Radio DATA mode selection CAT command sent prior to PTT ON and is taken out of DATA mode after PTT OFF in support of Data/Voice SSB USB operation. Either the radios only CAT PTT command or its DATA port CAT PTT commands are sent. The DATA commands are sent but no CAT PTT commands are sent if RS232 or EXTERNAL is selected as the PTT TYPE.

REMOTE = The Radio requires Remote Enable and Remote Disable CAT commands, thus the radio must be powered and properly connected to the PC before the software is started and the software must terminate normally via EXIT for the radio to exit Remote configuration.

RADIO MODEL	STATUS	COMMENTS
NONE		Select when RS-232 PTT is desired by not CAT commands are desired to be sent over the port.
B2050	**CAT PTT**	Use for Barrett 20xx series and perhaps other models.
DATRON	**CAT PTT**	Use for 7000 series transceivers.
DATRON_DV	**CAT PTT**	Use for 7000 series transceivers for USB Data mode operation in transmit if the option is installed in the radio where upon return to receive USB is automatically selected for Voice operation.
DX-SR8	**CAT PTT** `9600,N,8,1`	Use for DX-SR8-T, DX-SR8-E, DX-SR8-J, SR9-E NOTE: I have been informed that "Donners Country Crafts" makes an interface for the DX-SR8 that has been tested. Hamersville, OH 45130 Phone 513-783-8148 http://www.donnerstore.org Remote Control interfacing options: 1. This method is standard as used for firmware updates and cloning. It requires an optional ERW-7(USB) or ERW-4C(Serial) or compatible cable plugged into radio speaker jack "SP" on the front panel of radio, therefore during the PC

		control you must an external speaker connected to the phone jack but the AF power is very low so a use of commonly available PC speaker with internal amplifier. Takes 8 to 16 ohm impedance speakers. 2. This method is more complicated and not tested. Pins 1, 2 and 6 of the 8-pin Modular RJ45 jack may possibly be used if the control panel is separated from the radio and a Y splitter cable is used. 1. TXD data from radio to control panel 2. RXD data from control panel to radio 3. 8V power to control panel (when radio is switched on) 4. Not in use 5. Mic signal / PWR On/Off button 6. GND 7. AF - Audio to speaker. 8. SPK GND- Speaker ground
FLEX	**CAT PTT** `9600,N,8,2`	Supports all FLEX models, Apache Labs ANAN-10 and possibly the Sunair RT-8100
FT817	**CAT PTT** **REMOTE** **38400, 8N2**	Also FT-650, FT-655, FT-817ND, FT-857x, FT-897x, FT-847, VX1700 Radios must be turned on before software is started else the radio will not respond to CAT commands. **NOTE:** For FT-847 Requires the use of Null Modem cable. **NOTE:** FT-650, FT-655 works at 4800 baud only. They support 24-56Mhz coverage within our support window of 1.5-88Mhz. An external TTL level converter is required using a 1/8 inch 3 conductor stereo plug where tip is Serial Data Out from the PC and shield is ground is required from the external level converter. The ring should only be connected if the RxD line will be monitor for Squelch status for scanning applications.

FT890	**CAT PTT** **4800, 8N2**	This supports FT-100, FT-600, FT-747, FT-80C, FT-840, FT-890, FT-900, FT920, FT-990, FT1000D, FT1000MP, SB-140, Vertex System 600. **NOTE:** FT-920 PTT works even though not documented. **NOTE:** FT-990 requires ROM version 1.2 or later. **NOTE:** FT-1000D requires ROM version 6.0 or later.
FT2000	**CAT PTT** **38400, 8N2**	Also for FT-2000D, FT-450, FT-950, FTDX3000, FTDX5000, FTDX9000
ICOM	**CAT PTT** **19200, 8N1**	Supports any ICOM model that supports CAT PTT for use with MIC port or on really older rigs, any port where you need to be sure not to use a Mic wired for VOX. NOTE: Broadcast Radio Address 00h is sent which all radios respond to regardless of actually address.
ICOM_DV1	**CAT D/V** **19200, 8N1**	Supports IC746PRO, IC756PRO, IC756PROII, IC756PROIII and Signal One Milspec 1030E-DSP NOTE: Broadcast Radio Address 00h is sent which all radios respond to regardless of actually address. NOTE: ACC port RX BW may be too narrow in DATA mode for MS110A and other 2400baud waveforms, but should suffice for S4529 1200 baud requirement of 1.24Khz BW.
ICOM_DV2	**CAT D/V** **19200, 8N1**	Supports IC7700, IC7800 DATA Mode with Wide Filter NOTE: Broadcast Radio Address 00h is sent which all radios respond to regardless of actually address.
IC703_DV	**CAT D/V** **19200, 8N1**	Supports IC703 NOTE: Radio Address: 68h

IC7100_DV	**CAT D/V** **19200, 8N1**	Supports IC7100 for DATA Mode with filter FIL1 designated for USB port. NOTE: Radio Address: 88h
IC7200_DV	**CAT D/V** **19200, 8N1**	Supports IC7200 DATA Mode with wide filter FIL1 designated for ACC and USB port. NOTE: Radio Address: 76h
IC7410_DV1	**CAT D/V** **19200, 8N1**	Supports IC-7410 for ACC port NOTE: Radio Address: 80h
IC7600_DV1	**CAT D/V** **19200, 8N1**	Supports IC-7600 for ACC port NOTE: Radio Address: 7Ah
IC9100_DV1	**CAT D/V** **19200, 8N1**	Supports IC-9100 for ACC port NOTE: Radio Address: 7Ch
IC7410_DV2	**CAT D/V** **19200, 8N1**	Supports IC-7410 for USB port NOTE: Radio Address: 80h
IC7600_DV2	**CAT D/V** **19200, 8N1**	Supports IC-7600 for USB port NOTE: Radio Address: 7Ah
IC9100_DV2	**CAT D/V** **19200, 8N1**	Supports IC-9100 for USB port NOTE: Radio Address: 7Ch
ICOMNMEA	**CAT PTT** **4800, 8N1**	Supports all current ICOM Commercial Land Mobile/ALE and HF MARINE radio models: ICM700PRO, ICM710, ICM710RT, ICM801E, ICM802, ICF7000. May support ICF8100.

		NOTE: ICM801E Remote connector must be set to NMEA. NOTE: Broadcast Radio Address 00h is sent which all radios respond to regardless of actually address.
JSB176	**CAT PTT** **REMOTE** **1200, 8N1**	Also supports Raytheon RAY 152 and possibly RAY 150. **NOTE:** Optional RS232C unit CMM-741 must be installed piggyback on the CPU Unit CDC-493R. The radio must be in RMT via the front panel. A straight RS-232 cable is required.
JSB196	**CAT PTT** **REMOTE** **9600,7E1**	JRC JSB-196 and JSB-196GM Marine SSB radios using firmware older than v1.7 that requires data string checksum support. **NOTE:** Null modem cable required.
JST245	**CAT PTT** **REMOTE** **4800, 8N1**	Also select for JST-145 and JST-135 operation. **NOTE:** For JST-135 1200 baud must be selected.
K3_DV	**CAT D/V** **38400, 8N1**	Supports K3 data port for PTT where the radio is switched into DATA mode for TX and to USB on RX for Voice comms. For basic K3 CAT PTT use selection KNWD450. K3 directly supports RS232 RTS line for PTT if enabled.
KNWD450	**CAT PTT** **4800, 8N2**	Sends TX; for PTT ON and RX; for PTT OFF, supports Kenwood legacy radio models and many other manufacturers models that have adopted the Kenwood command protocol. NOTE: Use this selection for older firmware TS-2000
KNWD480	**CAT PTT** **9600, 8N2**	Sends TX1; for PTT ON and RX; for PTT OFF in support of 480 ANI port and 590 USB port.

KNWD590	**CAT PTT** **9600, 8N2**	Sends TX0; for PTT ON and RX; for PTT OFF in support of TS-590 NOTE: Use this selection for newer firmware TS-2000
MICOM	**CAT PTT** **9600, 8O1**	Supports models MICOM-1, 2E, 2B, 2BF, 2BT, 2EF, 2ES, 2ET-RDP, 2ET-RDP2, 2MF, 2R, 2RS, 2TS, RM125, RM125R, RM500, RM500E, RM500R, RM1000, 3F, 3R, 3T, RDP3-DHS, MICOM-H, MICOM-Z and perhaps others. To use a radio with no control head Short pins 13 and 14. Either the MIC or AUX port of the radio using TXD, RXD and GND will work. Refer to your radios manual. Interfacing to the PC is standard RS-232 levels with straight wiring. If using the rear J3 Accessory connector the RX and TX audio lines are differential and must be wired using 600 or 1,000 ohm isolation transformers. Ready to go J3 cables complete with RS-232 DTR line opto isolated PTT are available from Bill Holland, KC2CNB, (http://hollandelectronics.net/ or 1-609-693-7281) at a reasonable cost. Just tell him it's for MARS-ALE and if you want a DB9 or DB25 on the PC side and the cable length you require between the PC and radio. **NOTE:** CAT PTT can be used when interface via either the MIC port or rear J3 Accessory port. **NOTE:** The DATA filter of 3300 only works if programmed into a memory channel. **NOTE:** The MICOM-2BF, MICOM-2MF and MICOM-H Amateur Radio band version and perhaps others require the FLN2423 RS-232 option installed for computer control via J3,

		however the MIC port TXD, RXD, GND lines can be used for CAT control without the FLN2423.
PRC1099A	**CAT PTT**	Use for DATRON PRC1099A.
SIENNA	**CAT PTT** 9600, 8N1	SIENNA directly supports RS232 RTS line for PTT if enabled.
SIENNA_DV1	**CAT D/V** 9600, 8N1	Supports SIENNA with External PC/sound device for digital comms using LINE input. The radio is switched to LINE input for TX and to Mic input on RX for Voice comms using extended Atx; commands.
SIENNA_DV2	**CAT D/V** 9600, 8N1	Supports SIENNA with for Internal to Sienna PC digital comms. The radio is switched to DIGUSB mode for TX and to USB mode for input on RX for Voice comms using MDx; commands.
TK90	**CAT PTT** **9600, 8N1**	Supports TK90 Mic Port and USB only. **NOTE:** Kenwood TK-90 HF radio with the KCT-31 interface cable option for PC control installed per the documentation found in the TK90 Modification Information (MOD) publication version 2.0 date March 2007 or later. In the setup software under COM port settings for the KCT-31 select "PC Command" for the operating mode rather than GPS. **NOTE:** If an external ATU is connected to the TK90 for use then CAT PTT can not be used.
TK90J2B	**CAT DATA** **CAT PTT** **9600, 8N1**	Supports TK90 J2B data port by placing the radio into DATA mode at program start or this selection. Uses the proper CAT PTT ON and OFF commands for the DATA port if CAT PTT is selected vs. Pins 6 (DPTT) and 8

		(GND) of the KCT-39 cable for hardware PTT. Upon normal shutdown the radio is placed into USB.
TK90J2B_DV	**CAT D/V** **9600, 8N1**	Supports TK90 data port for PTT where the radio is switched into J2B DATA mode for TX and back to USB on RX for any use of Voice communications. Uses the proper CAT PTT ON and OFF commands for the DATA port if CAT PTT is selected vs. Pins 6 (DPTT) and 8 (GND) of the KCT-39 cable for hardware PTT.
TT538	**CAT PTT** **57600, 8N1**	Requires the "Enhanced PC Control" firmware v1.32 update or later. The radio is being controlled in Jupiter mode, thus full manual control is available.
TT538_DV	**CAT PTT** **57600, 8N1**	Sent test build to AAM4SC. LINE selected for DATA TX and back to MIC on RX, has potential of working.
TT563	**CAT PTT** **CPP – 19200, 8N1**	Omni VI PTT is supported via Ten Tec extended command. Radio Address is factory 0xE0h
TT564	**CAT PTT** **CPP – 19200, 8N1**	Omni VI Plus. PTT is supported via Ten Tec extended command. Radio Address is factory 0x04h
TT586	**CAT PTT**	Paragon II. PTT is supported via Ten Tec extended command. Radio Address is factory 0x2Ch
TT588	**CAT PTT** **57600 8N1**	For use for OMNI VII TT588 and TT588AT in REMOTE MODE, a new protocol that places the TT588 series radio into a hands off operation by the user. OMNI VII REMOTE MODE as documented in Model 588 Programmers Reference Guide Rev 1.0. To enter REMOTE MODE hold down digit 2 on the band stack keyboard until

		the firmware version string and REMOTE appears on the display.
TT588_DV	**CAT D/V** **57600 8N1**	Line Port selected before TX and MIC on RX
TT599	**CAT PTT** **57600 8N1**	Also use for TT599AT and TT539.
XK2100	**CAT PTT** **2400, 7E1**	Rohde & Schwarz XK2000 family of transceivers, XK2100, XK2500 and XK2900. NOTE: Requires null modem cabling where pins 1 and 9 are not used.

WHAT TO DO WHEN YOUR RADIO TYPE IS NOT LISTED?

If your CAT radio is not listed by its model number under the **RADIO TYPE** column in the above chart, check to see if it's listed in the **COMMENTS** column as being in the same family as the one listed. For example, under FT890 there are a number of Yaseu models as well as OEM models under other brand names that are all supported by the FT890 selection. Many make/model Amateur grade radios for basic PTT will work using Kenwood commands. If you do not find your make/model radio anywhere, then send the required radio remote information in .pdf format for review as to the possibility of inclusion in a future build.

APPENDIX H: STANAG 4203

STANAG 4203, "Technical standards for single channel HF radio equipment", in summary specifies properties of the radio which receives the audio signal (3 kHz bandwidth) from the modem and modulates it onto the PSK carrier. STANAG 4203 contains the minimum interoperability standards for single channel HF radio equipment. It does not contain performance specifications. For performance specifications reference should be made to other standards such as MIL-STD-188-141C, Section 5.

Technical parameters specified in STANAG 4203 Edition 3 are:

- Radio frequency range

- Tuning

- Frequency accuracy and stability

- Frequency response and group delay time over a 3 kHz frequency band

- Phase noise

- Linearity

- Random emissions outside the frequency band and inter modulation products

- Operation mode (simplex/half-duplex)

- Switching time between transmitting and receiving

- Gain control

- Modulation of carrier wave

S4203 in particular specifies:

The base-band frequency response of the transmitter and of the receiver over the range 300Hz to 3050Hz shall be within ±2dB of the response at 1000Hz for manpack equipment and within ±1.5dB for all other equipment. The group delay shall not vary by more than 0.5 ms over 80% of the pass-band of 300Hz to 3050Hz. The maximum time delay measured between the input and the output of either the transmitter or the receiver shall be less than 10 ms (design objective 5ms) over this pass-band.

The radio frequency accuracy shall be within ±30Hz for manpack equipment and within ±10Hz for all other equipment. The frequency stability of the transmitter carrier frequency shall be 1 x 10-8 per day or better (± 10Hz in 30 days).

The transmitter ALC action shall be implemented in such a way as to not degrade waveform performance e.g. switch-off and/or set very slow in data mode.

The change-over time between transmit and receive modes shall meet the following requirements:

(a) Transmit to receive changeover time shall not be greater than 15ms from keying-off for the receiver to achieve 90% of full specified sensitivity.

(b) Receive to transmit changeover time shall not be greater than 25ms (10ms highly desirable) from keying-on for the transmitter to achieve 90% of full specified output power.

The Receiver Automatic Gain Control requirements apply to receivers that employ AGC. Any change in input level above the receiver AGC threshold shall produce an output change of less than ±3dB.

The AGC time constants during non-data operating modes shall be as follows:

a. Attack: <30ms

b. Decay: between 500ms and 1.5sec.

The AGC time constants during single channel (not Link 11) data communications shall be as follows:

a. Attack: <10ms

b. Decay: <25ms (modes not employing amplitude modulation, e.g. PSK)

c. Decay: between 500ms and 1sec. (modes employing amplitude modulation, e.g. QAM).

APPENDIX I: MARS-ALE Radio Emulation

The use the MS-DMT with the MARS-ALE Radio Emulation (REM) provides for PTT access for any make/model radio supported by MARS-ALE that provides for CAT PTT (as detailed in MARS-ALE RHUG Appendix A) as well as the other PTT methods supported.

The steps for using MARS-ALE REM are detailed in see RHUG Appendix C, in brief:

1. Install MARS-ALE, the LICENSE.DAT file and setup a scan group of channels from either an edited .QRG file or manually, at least one channel setup for TX/RX is required for PTT to work.

NOTE: For radios like IC-7200 and TS-590 if their digital ports are being used, the mode must be USB-D instead of USB, see MARS-ALE RHUG Appendix A. for details. When such radios are being used the REM port commands must be those for the IC-746PRO to select ICOM DATA mode if non-ALE follow on CAT Radio Server control is configured.

2. Install a VCP server to setup a pair of paired VCP ports, e,g. COM12 and COM13. Such as Com0Com or other VPC driver. You will need to use a VCP server that works with your Windows OS, the VCOM one seems to have issues with newer versions of MS-Windows I am told whereas Com0Com does not.

3. Configure MARS-ALE for either MS-DMT use after and ALE inlink where ALE is not used at all, per the MARS-ALE RHUG Appendix C where you will either setup MS-DMT for KENWOOD or ICOM CAT PTT as detailed there in.

4. Execute the MMI commands DISABLE RADIOSERVER and ENABLE RMSBLOCK via the DataBar MMI interface for ALE follow on use.

NOTE: As MARS-ALE v3.00 supports MS110A ASYNC directly for basic communications, the use of MS-DMT in conjunction with MARS-ALE REM port is only required if MS-DMT use is a must for optional features it supports.

APPENDIX J: Software Portability

This application is developed solely as a Microsoft Foundation Class (MFC) mutlti-threaded baseline coded in C++ and built using the MS Visual Studio 2008 Professional compiler to build a 32 bit .EXE with WINVER targeted at the MS Windows 7 OS. The application runs on and has been tested on the following Windows OS versions common to MARS members use:

Windows XP Home SP3

Windows XP Pro SP3

Windows XP Pro 64 bit SP2

Windows Vista 32 bit SP2

Windows Vista 64 bit SP2

Windows 7 32 bit SP1

Windows 7 32 bit Starter Edition

Windows 7 64 bit SP1

Windows 8 32 bit

Windows 8 64 bit

Windows 8.1 64 bit Tablet Edition

It is planned to migrate the existing MFC baseline to the MS Visual Studio 2010 Professional or newer compiler in the future.

At some point in the future an MFC 64 bit .EXE build of this application may also be made.

There are no plans to create native versions of this application for any operating system other than MS Windows at this time. The 32 bit MFC .EXE of this application has successfully been used under both Linux using Wine as seen below running on Zorin OS 8 and under Mac OS X Lion using both Wine and Winskin.

MS-DMT Guide v1.06

Released 10-31-2015
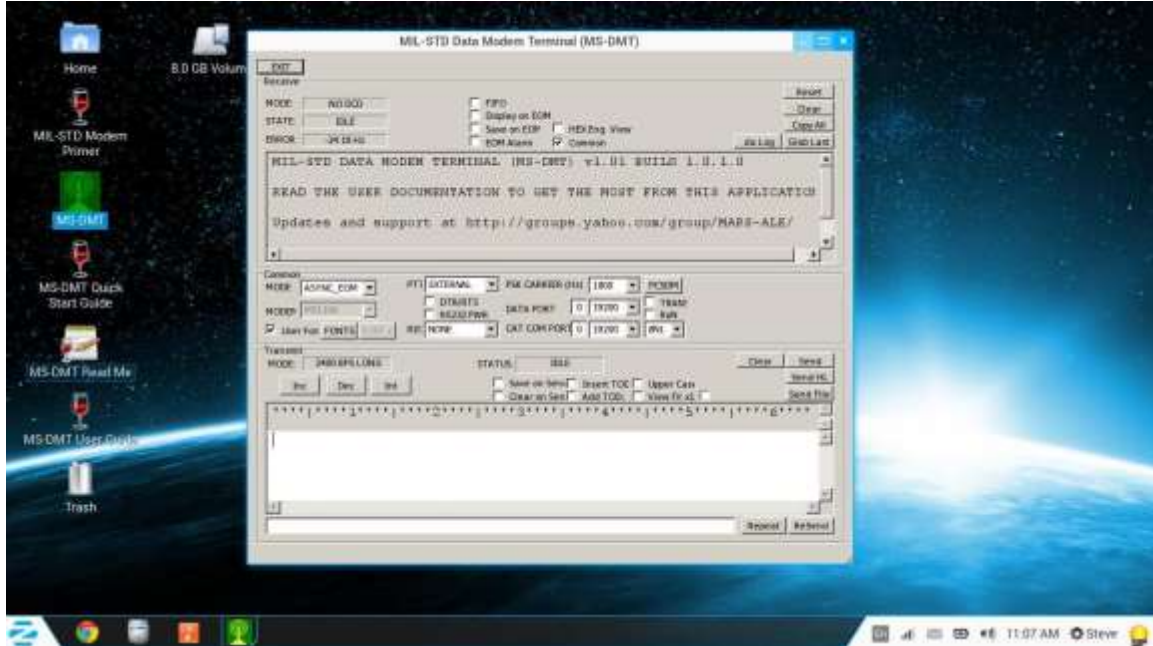
For Linux, using Wine, the incoming data logging seems to require that the programs executable (.EXE) file be located in the dalog sub directory, which leaves out the use of outgoing logging, as that logging will not work if the .EXE is separated from the log location. As we progress an effort will be made to improve the operation under Wine.

For Mac OS X the "Winskin" program at http://wineskin.doh123.com/ is required. Create a Wrapper (name it MS110A) that will run the application.

At some point the baseline may migrate away from MFC to using something like FLTK or WxWidgets for GUI and PortAudio for the PCM audio and perhaps other libraries for Serial I/O etc. if these developments take place then the application may become a cross platform portable baseline that will provide for native executables on other operating systems. However there are no real plans for Linux and Mac OS X support with the MS-DMT applications. However and more importantly, there are plans for a cross platform, virtual modem only version of the modem with no internal terminal capability which developers can then develop to support for all uses from FEC to Adaptive ARQ. There also exists the desire to port to a yet to be determined version of embedded Linux or perhaps other OS on an embedded board to bring about an inexpensive hardware modem.

All current 32 bit development is done on Windows XP Home SP3 and testing is performed on it and Windows XP Professional SP3 and Windows 7 Home Premium 64 bit. Testing is also performed under Wine on an Ubuntu 10.04 LTS 64 bit environment running on the same PC as Win 7. It is also desired to add a MAC OS X Lion and Winskin system to the mix for testing and perhaps future targeted development whenever a donation of a suitable MAC OS laptop comes along.

APPENDIX K: MS-DMT Remote Control

The Data Port can be used for Modem Remote Control by a dumb terminal or dedicated application in support of Data Link Protocol implementation.

The commands are simple ASCII based structures that provide for both control of modem parameters as well as query of parameters.

Full error checking of commands is provided where a minimum amount of each command must be correct for trapping purposes.

Commands sent to the modem do not require termination such as a Carriage Return and Line Feed.

When the Modem is sending the Data Port DTR line is held high. There is also a Remote control query of the current "TRANSMIT" state.

COMMANDS

SEND FILE:

The SEND FILE command provides the means for a cohosted external application running on the same computer.

Alternately an application running on another computer that has file system access to the computer running the modem can also be used. The speed of sending a message is increased exponentially sending from a file rather than buffered serial I/O using the Data Port.

The idea is that the external terminal application will place a file with the data to be sent on a drive of the host computer running the modem. Then the external terminal application will use the "SEND FILE" command to send the message content from that file.

The file can be located anywhere on the computer drive(s) using any file name and can be of any data type required, ASCII or BINARY as long as all stations are properly configured to support the file content. The file size cannot exceed 32kb.

The "SEND FILE" absolutely will not work properly if terminated.

Command syntax:

<<CMD:SEND FILE>>C:\\subdirectory\\filename.txt

Example:

<<CMD:SEND FILE>>C:\\TEMP\\message.txt

Note: The use of double back slashes (\\\\) verses a single back slash (\\) is required for all path level separation.

Note: The use of the same case in the path/filename as created when called is a good idea should it ever be mandated in future versions of Windows.

There is no query request. Errors that can be returned pertain to file missing or file too large or command syntax error.

<<CMD:ERROR: FILE NOT FOUND>[path/file name]

DATA RATE/INTERLEAVE:

Command syntax:

<<CMD:DATA RATE>>nU

or

<<CMD:DATA RATE>>nL

or

<<CMD:DATA RATE>>nS

The Data Rate and Interleave must always be provided at the same time.

Where for MS-110A the Data Rate provided (n) and Interleave choices of SHORT (S) or LONG (L) can be provided for n as 75, 150, 300, 600, 1200, 2400 or 4800 for Uncoded (U).

Examples when using MS110A:

<<CMD:DATA RATE>>4800U

<<CMD:DATA RATE>>75L

<<CMD:DATA RATE>>600S

Note: The range of arguments for the command <<CMD:DATA RATE>> shall be Modem specific. The addition of more Modem selections will bring about different choices. For example MS110B supports all but the 4800U as in MS110B 4800bps is coded and requires interleave settings. MS110B also adds a number of Data Rates as well as additional Interleave selections for those data rates.

Query the current TX Data Rate and Interleave setting:

<<CMD:DATA RATE?>>

Returns:

<<CMD:DATA RATE?>>nn..nnnnX

The returned data will terminate with a Carriage Return and Line feed.

RX DATA RATE:

Query the RX Data Rate for Auto Detect waveforms such as MS110A.

<CMD:RXDATARATE?>>

Returns:

<CMD:RXDATARATE?>>nn..nnnn BPS xxxx

Where nn.nnnn is the numeric data rate and where xxxx is the Interleave, i.e. SHORT or LONG, etc.

For example:

<<CMD:RXMODE?>>300 BPS LONG

This data is returned directly from the Modem core and is the same information that is displayed in the mode display during decoding of an incoming message.

NOTE: If <CMD:RXDATARATE?>> is issued during an incoming message it will provide the current incoming data rate and interleave setting. If <CMD:RXDATARATE?>> issued at modem start it should always return the value of "75 BPS SHORT" for the MS110A modem. If <CMD:RXDATARATE?>> is issued after an incoming message it will return the parameters for the previous transmission.

MODE:

Command syntax:

<<CMD:MODE mode>>

Example:

<<CMD:MODE ASYNC_EOM>>

or

<<CMD:MODE SYNC_EOM>>

or

<<CMD:MODE SYNC_NOE>>

Query the current mode:

<<CMD:MODE?>>

Returns:

<<CMD:MODE?>>ASYNC_EOM

or

<CMD:MODE?>>SYNC_EOM

or

<<CMD:MODE?>>SYNC_NOE

The returned data will terminate with a Carriage Return and Line feed.

PSK CARRIER:

Command syntax:

<<CMD:PSK CAR>>n

Where n = 1800, 1650 or 1500

Example: <<CMD:PSK CAR>>1800

Note: For STANAG 4529 the standard defines a number of PSK Carrier selections which may be implemented when S4529 support is provided. If additional selections are implemented, they would only be exposed for selectin when S4529 is selected as the modem.

Query the current PSK Carrier:

<<CMD:PSK CAR?>>

Returns:

<<CMD:PSK CAR?>>nnnn

The returned data will terminate with a Carriage Return and Line feed.

RESET MODEM:

<<CMD:RESET MDM>>

This command has the same effect as clicking the RESET button to reset the receiver. It is provided for a third party application use when running a Data Link Protocol over the modem via the Data Port. This command would be used when the EOM for the DLP is decoded so that the DLP can reset the modem.

There is no query request for RESET MDM.

EXIT MODEM:

<<CMD:EXIT MDM>>

This command has the same effect as clicking the EXIT button.

There is no Query request for EXIT MDM.

RESET ON NULL (RoN):

<<CMD:RON ENABLE>>

or

<<CMD:RON DISABLE>>

Query the current RoN state:

<<CMD:RON?>>

Returns:

<<CMD:RON?>>ENABLED

or

<<CMD:RON?>>DISABLED

The returned data will terminate with a Carriage Return and Line feed.

EOM ALARM:

<<CMD:ALARM ENABLE>>

or

<<CMD:ALARM DISABLE>>

Query the current ALARM state:

<<CMD:ALARM?>>

Returns:

<<CMD:ALARM?>>ENABLED

or

<<CMD:ALARM?>>DISABLED

The returned data will terminate with a Carriage Return and Line feed.

TRANS:

<<CMD:TRANS ENABLE>>

or

<<CMD:TRANS DISABLE>>

Query the current TRANS state:

<<CMD:TRANS?>>

Returns:

<CMD:TRANS?>>ENABLED

or

<<CMD:TRANS?>>DISABLED

The returned data will terminate with a Carriage Return and Line feed.

TRANSMIT State:

<<CMD:TX?>>

Returns:

<<CMD:TX?>>TX

or

<<CMD:TX?>>RX

The returned data will terminate with a Carriage Return and Line feed.

NOTE: When the Modem is sending the Data Port DTR line is held high to indicate the modem is in TX and DTR is low to indicate RX.

ERROR:

A message will be returned where the first 11 characters will always be: <<CMD:ERROR

The error message may be <<CMD:ERROR>> with and echo the erroneous command received.

In addition in the case of the command "SEND FILE", the error message may be <<CMD:ERROR: xxx>> where the xxx is pertinent information regarding the error predicated on the command that was received. For example:

<<CMD:ERROR: FILE NOT FOUND>>

or

<<CMD:ERROR: FILE TOO LARGE>>

The returned data will terminate with a Carriage Return and Line feed.

APPENDIX L: COM1..16 Management

Ghosts in the Machine? Do you find your PC's automatic allocation of serial port numbers challenging and perhaps a bit confusing? Perhaps the serial port for your radio CAT control me less than 16 but for your external USB sound device interface it may be greater than 16. Yet you don't currently have any other serial devices plugged in and only say 1 or 2 system devices with low COM port numbers? As MS-DMT requires all serial ports be between COM1..COM16 and herein we shall explain why and what you can do to address the issues involved.

Recent versions of MS-Windows support 255 serial ports. However MS-DMT is limited to the first 16 serial ports as MS-DMT makes use of the old Microsoft MSCOMM32.OCX for its serial I/O which at most will support 16 com ports. The Microsoft Visual Studio C++ compiler supports all 255 serial ports, Microsoft depreciated the MSCOMM32.OCX in later versions of Visual Studio to force the use of their .NET for serial I/O. The MS-DMT and MARS-ALE however are Microsoft Foundation Class (MFC) based applications verses .NET developments.

Should you have a device that installs as greater than COM16 you can simply re-assign the device to a lower COM port number that is not being used. The drill is to open Windows Device Manager and select the serial device of interest "Port Settings" as seen below.

Then click on "Advanced" which leads to the following dialog below.
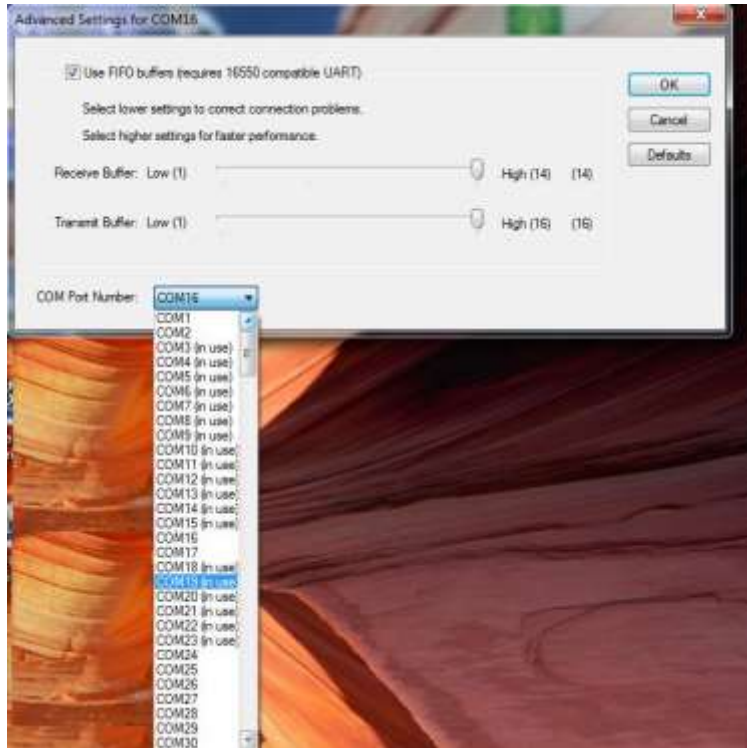
The "COM Port Number" pulldown will display which ports are in use vs. free. However something appears to be wrong as there are many more than the 4 ports listed as seen below on that system. Can there really be that many port in use?
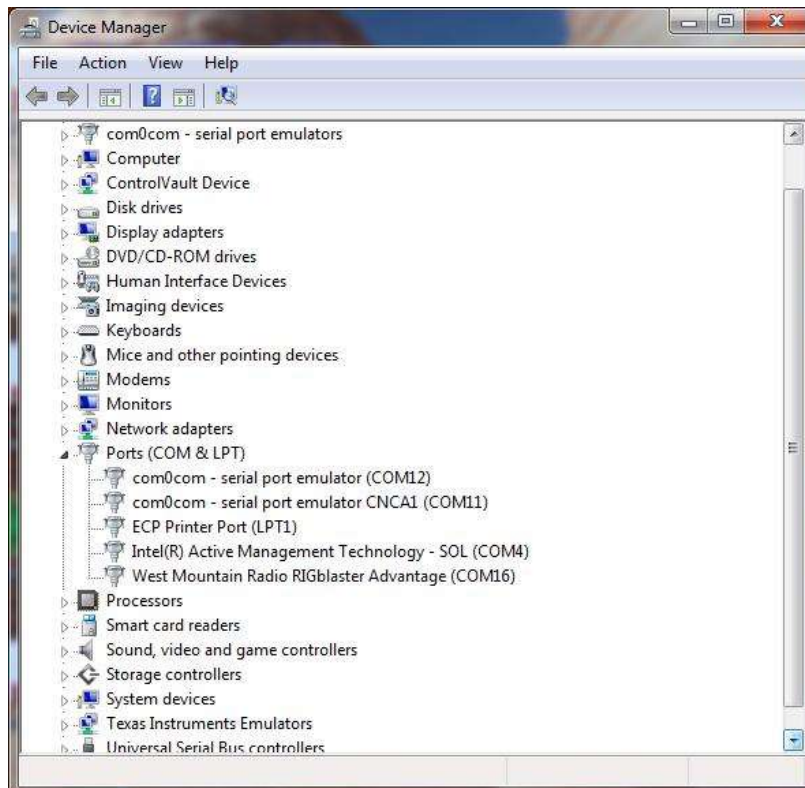
The answer is Yes! The reason is due to hidden ports for past devices that were plugged in previously.

When Windows installs a new plug 'n play device and assigns resources, such as COM port number, it retains those assignments. Thus although may currently appear to have free ports below COM16, you don't as you have "ghost devices" in the system. If you do many things with devices that make use of COM port designations eventually you can get into pretty high COM port numbers and that can be really annoying, especially with the use of MSCOMM32.

At some point you may want to figure out what were all those other COM ports and perhaps uninstall the ghost devices. Under windows this isn't particularly easy unless you know how. First up, you'll have to open up a **Command Prompt** and in Windows 7 later it has to be run as administrator. Open up the start menu and start typing in "Command" until the black C:\ icon appears. Right click and select **Run as Administrator**.
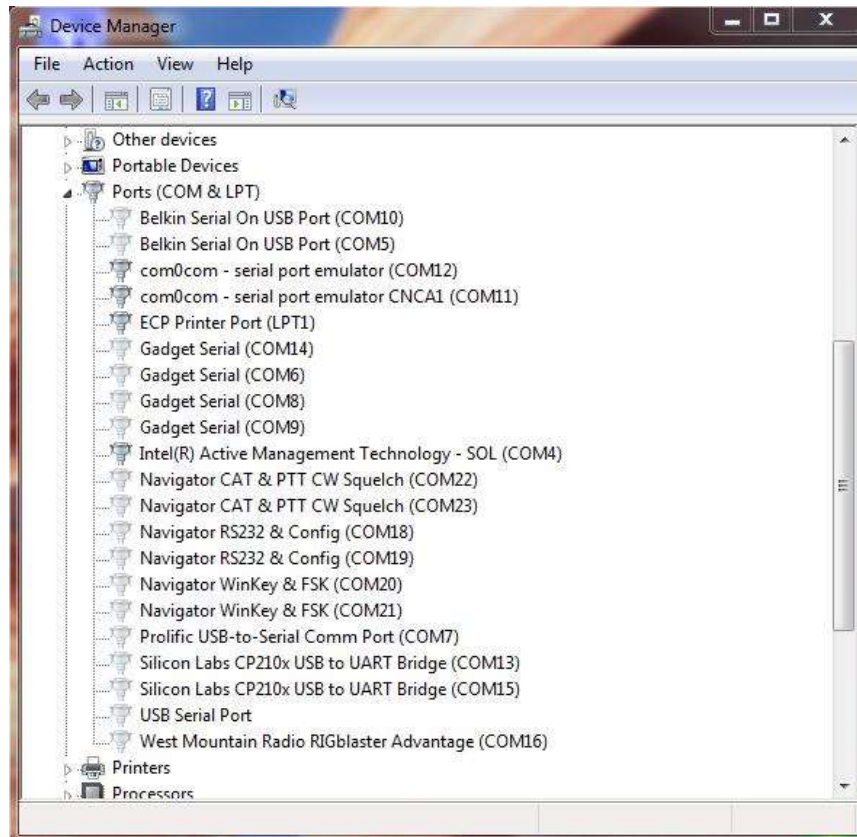

Now type in set "devmgr_show_nonpresent_devices=1" as seen below which is the command to show ghost devices followed by start "devmgmt.msc" which starts up the device manager.

Then once device manager is up and running click on "View" then "Show Hidden Devices" as seen below.
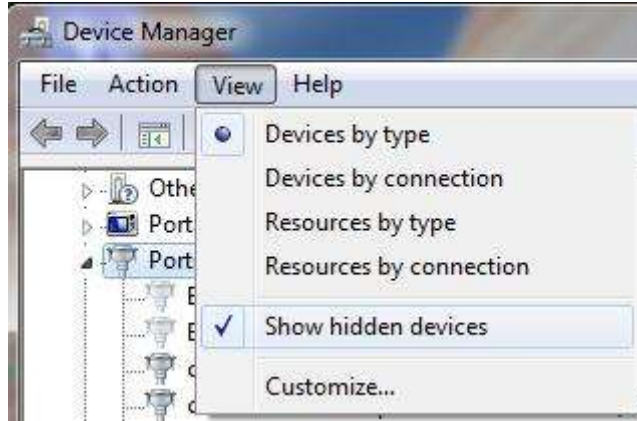
Now all your serial devices in use will be displayed to include all hidden devices as seen below.

Now with the big picture of your serial devices you can select which ones you may want to uninstall so the COM port number can be recycled or reset the COM port number to get what you require at this time at COM16 of lower for MS-DMT use. Whenever you want to display hidden devices the previously steps will need to be repeated.

The above screen shot was taken from my Windows 7 Professional laptop used for development where you can see the Navigator listed which is just being used on that system for base band audio testing with the HF Channel Simulator and thus always has its serial ports assigned above COM16.

Whereas the RigBlaster Advantage is sitting at COM16 for its PTT port. The Silicon Labs CP210x is for the ICOM IC-7200 radio USB interface by the way on COM15.