MIL-STD Data Modem Terminal (MS-DMT)
non-MARS User Guide

Support via:

OVERVIEW

This document serves to provide an introduction and basic user documentation for the non-MARS user of the developing MS-DMT v2.00 software tool. Herein sufficient information is provided in a top/down order of importance to achieve the proper configuration of MS-DMT on a supported MS-Windows host environment and HF SSB radio equipment.

MS-DMT is developed in C++ as a Microsoft Foundation Class (MFC) based multi-threaded application and compiled using the latest Microsoft Visual Studio 2017 compiler to build 32-bit and 64-bit versions of application. MS-DMT requires the installation of the proper VS2017 C++ runtime redistribution libraries which are part of the full MS-DMT install distribution only. It is recommended that MS-DMT be run under an MS-Windows 7 SP1 or later operating system on computer hardware that is no more than one generation older that the version of Windows is was designed to run. For example, a computer shipped with Windows Vista can be used to run Windows 7 SP1 and MS-DMT, but not the Windows 8 or newer.

The MS-DMT software was developed to provide MARS member an alternative to expensive MIL-STD hardware solutions. MS-MDT has been tested against various make/model MIL-STD hardware data modems and HF-ALE Tactical radios using both dumb ASCII terminals, secure terminal and tactical chat software. In all cases MS-DMT has been found to be 100% compatible with hardware modem solutions.

The integrated terminal capability of MS-DMT was developed for ASCII messaging only, which is now only accessible in "LOCAL CONTROL" operation. The default configuration when MS-DMT is started for the first time is LOCAL mode. The ASCII terminal also supports sending messages from ASCII based files via GUI file folder navigation and selection.

The focus in MARS application of MS-DMT has shifted to using MS-DMT with external terminal applications in REMOTE mode operation. The non-MARS user of MS-DMT when tasked to support MARS or a MARS customer may or may not be provided an external terminal application tool. In which case LOCAL mode operation in Plain Text (PT) will be used.

The act of entering a legitimate com port for the "Data Port" will automatically place MS-DMT into "REMOTE CONTROL" operation where an external terminal tool is required. Do not use MS-DMT with a com port entered if there is no external terminal in use.

In REMOTE mode operation MS-DMT provides a "High Speed 8 bit ASYNC" Data Port for RS-232C Asynchronous interfacing with the same external terminal applications used with MIL-STD hardware modems. The Data Port supports binary data streams in either Synchronous (SYNC) or Asynchronous (ASYNC) over-the-air communications modes in support of Data Link Protocol (DLP) layers and or Crypto processing. In addition the Data Port supports in-line Remote Control Commands for the remote control of MS-DMT by the terminal application verses the need of a dedicated remote control port.

Military Serial Tone (ST) Phase Shift Keying (PSK) waveforms defined in a number of Military standards have various roles in Military HF NVIS and Beyond Line-Of-Sight (BLOS) communications. MS-DMT provides a software defined Modulator-Demodulator (Modem) approach which makes use of a standard AC'97 compliant PC sound device as its hardware modem component that support MIL-STD-188-110A (MS110A) PSK waveforms from 75bps to 4800bps to include 2400bps VOICE (2400V) mode and Robust STANDARD NATO (STANAG) 4415 (S4415) at 75bps. The MS110A/S4415 software modems in MS-DMT not only meet, but exceed most of the minimum performance requirements as verified on Rockwell MDM-3001 and MDM-Q9604 hardware modems operating in HF Channel Simulator (HFCHANSIM) mode for verification and validation testing.

The MIL-STD-188-110A standard has been superseded by MIL-STD-188-110B and MIL-STD-188-110C and the new MIL-STD-188-110D is close to debut, however the legacy 75..4800bps PSK waveforms have been retained due to their durability. Additional Military waveforms of interest and currently under development for MS-DMT inclusion are MIL-STD-188-110B Appendix C and STANAG S4285.

The MS-DMT software is much more demanding of the PC Sound Device, the MS-Windows operating system and the HF SSB radio equipment than is Amateur Radio digital communications applications. Amateur Radio applications that make use of the PC Sound Device as the modem hardware component only support low symbol rate data modes.

However the complex Military serial tone PSK waveforms have a much higher 2400 baud symbol rate, wider 3.0kHz bandwidth and higher data rates than do the Amateur Radio, Commercial and Military FSK (RTTY) digital modes commonly used by Amateur Radio and MARS in the past. **Much more care and attention must be taken in the configuration and thereafter configuration management of the PC operating system for latency and the radio settings for the best and consistent results to be achieved when using MS-DMT**.

MS-WINDOWS

An MS-Windows x86 or x64 host computer system with low DPC Latency that supports "Streaming Audio" is required to achieve the best results from the use of MS-DMT. The Windows 10 operating system is recommend for running MS-DMT. However at present Windows 7 SP1 or later version are currently still supported by MS-DMT.

HF SSB TRANSCEIVER

The HF SSB transceiver required for use with MS-DMT must have a Temperature Compensated Oscillator (TXCO) for best results if more than occasional short data transmissions are going sent or received. In addition, along the same lines of use, any transmission of a message longer than a few lines is going to require fan cooling in addition to a transceiver with a good size heat sink. If the transceiver being used for broadcast duty or message center operation then a heavy duty radio with external fan cooling for a constant heavy air flow will be required.

The required IF passband for Military ST waveforms is specified as 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) which specify the properties of military radios which receives the baseband audio signal (3 kHz bandwidth) from the modem and modulates it onto a an 1800hz carrier.

The normal 1500hz passband center of Amateur Radio grade SSB transceiver filters needs to be raised using IF Passband tuning to at least 1650hz if not the full 1800hz when not using a 2.8kHz filter and often when doing so.

The use of an SDR transceiver and typical SDR IF BW filtering will require greater than 2.8kHz on RX due to the brick wall DSP filters in most cases.

PC SOUND DEVICE

The PC Sound Device used as the hardware modem (PCSDM) component is a critical component in achieving the full serial tone modem performance MS-DMT is capable of providing.

The MS-DMT v2.00 MIL-STD-188-110A (MS110A) modem to include the Robust STANAG 4415 (S4415) performance at 75bps not only meet but exceed most of the minimum performance requirements as verified on the Rockwell MDM-3001 and MDM-Q9604 modems operating in HF Channel Simulator (HFCHANSIM) mode. All verification testing was performed using the analog MIL-STD PCSDM (MS-PCSDM) as the MS-DMT hardware modem component which is based on the $100USD TI C5535 ezDSP board (https://store.ti.com/TMDX5535EZDSP-C5535-eZdsp-USB-Stick-Development-Kit-P2615.aspx) using the v1.01 beta firmware.

In addition side-by-side comparison testing has been performed within the MDM-3001 HFCHANSIM environment with the MDM-3001 and MDM-Q9604 modems interfaced using a Pricom passive mixer board (http://www.pricom.com/Trains/PassiveMixer.shtml) for controlled testing. MS-DMT v2.00 when using the MS-PCSDM as the hardware modem component was found to exceed the performance capabilities of the MDM-3001, especially at 75bps. MS-DMT compares very favorably with the MDM-Q9604 modem performance at all data rates.

PCSDM options for MS-DMT are ranked as:

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

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

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

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

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

NOTE: Stations that do NOT have an HF SSB transceiver with a TXCO installed or less than a 2.75kHz SSB passband filter or have sound device sample rate error of greater than 10ppm should **NOT** be transmitting with MS110A PSK for anything but short order wire or "Through Me" partial fill messages.

STARTING MS-DMT

MS-DMT v2.00 supports "License Validation" where at each start of the tool a missing "license.dat" file will at present cause a pop up screen in addition to a failed license validation message in the "Status Window" when active. A license.dat file is required for full access to all features of MS-DMT. Placement of a valid license file in the folder where the "MS-DMT_nn.EXE" file resides will prevent the "License Validation" pop up screen seen below from being displayed.
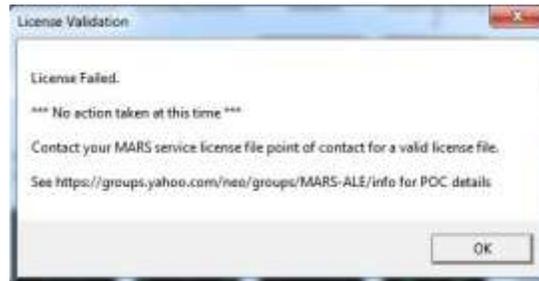

The license pop up dialog will go away at some point during the beta testing phase of development. At which point restriction of features will commence should the validation process fail. The POC information to acquire a license.dat file for those authorized is posted and updated as required at: https://groups.yahoo.com/neo/groups/MARS-ALE/info

MS-DMT will always function properly for MS110A/S4415 ASYNC or SYNC use in both LOCAL and REMOTE control operation without the presence of a license file or with a corrupted license file. However other modems and features yet to debut will be restricted to those with validated license file.

STARTING THE FIRST TIME EVER

The very first time MS-DMT v2.00 is started the experienced MS-DMT v1.nn user will notice a number of changes to the Graphical User Interface (GUI) where the most apparent is the added multi-purpose Graphical Display tool and the reduced foot print of the "Outgoing Message Window", both within the "Receive" panel as seen below. Also within the receive panel are operations options implemented as check box selections have been slightly re-arranged with the new options of AGC, AGC-2 and PMAG (Preamble Magnitude) having been added.
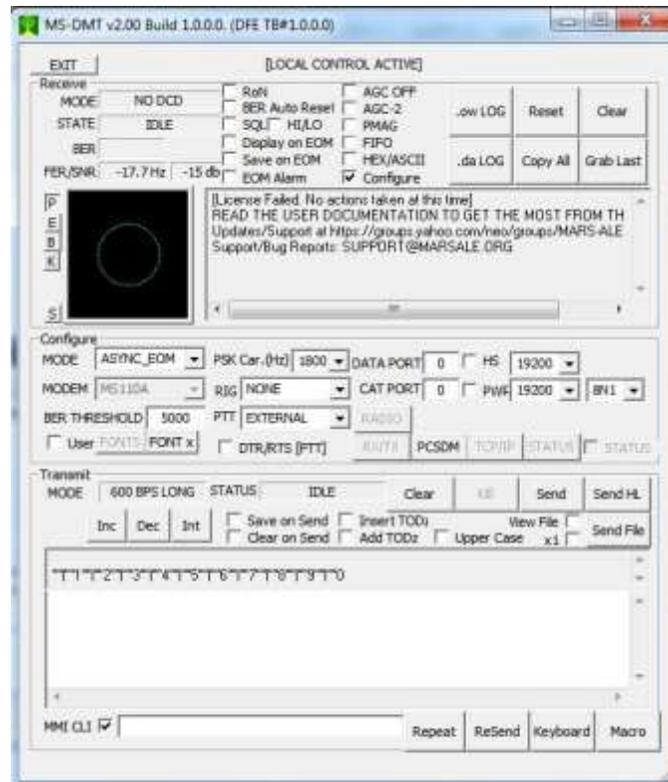
The banner just above the "Receive" panel is also new and very important. It will display the operational state of the tool as "LOCAL CONTROL ACTIVE" on the first start. This means the internal terminal is being used for all messaging and that there is no active external terminal application connected. The operational state change to the tool commenced with ALPHA builds near the end of MS-DMT v1.01 development however a formal build containing this feature was never released. The "Configure" panel, selected by the state of the "Configure" check box, will also be enabled the first time the program is started

Should an active com port value be entered into the "DATA PORT" field on the "Configure" panel the tool will immediately switch to "REMOTE CONTROL ACTIVE" and automatically close the "Configure" panel. At that point the size of the "Graphical Tool will increase and the "Incoming Message" window, "Outgoing Message" window and "Ruler Bar" will all be hidden as seen further below.

The other significant change is that no incoming message data is displayed on the local terminal (or logged) when in REMOTE CONTROL, which actually improves the modem receiver performance of the tool a bit.

The most striking visual difference when the GUI is compared to the previous MS-DMT v1.01 builds is the new "Graphical Tool", which operates as both a "Polar Plot" and "Constellation Diagram" display automatically.

As evidenced by the Polar Plot being displayed and the fact that the MODE is "NO DCD" and the STATE is "IDLE" we know the tool as seen below in REMOTE CONTROL mode is "Hunting Preamble" detection.

NOTE: The "Status Window" in LOCAL mode can be enabled by checking the MMI/CLI box and entering ENABLE STATUS in the data window next to the check box. DISABLE STATUS provides the opposite effect. In REMOTE mode the Status Window is always active.
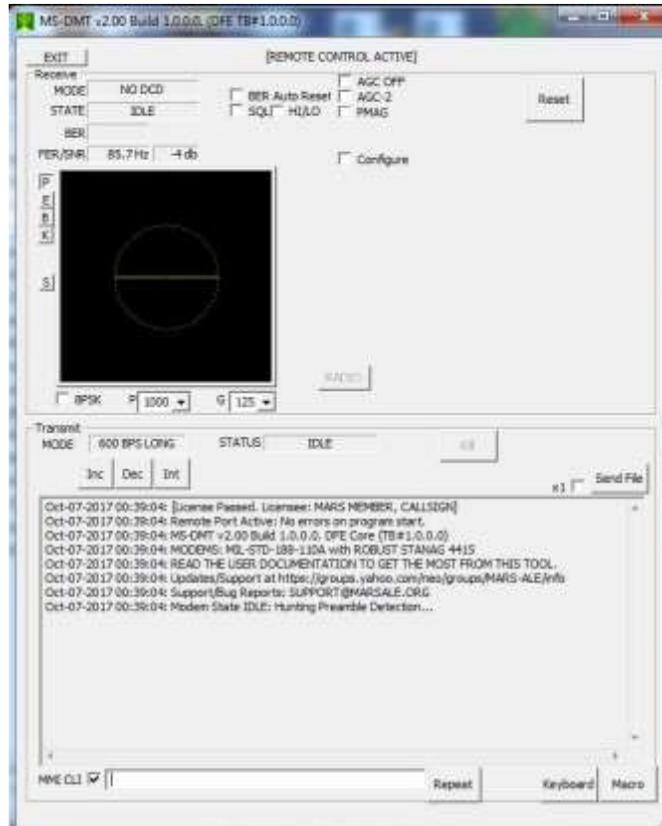
The other noticeable new GUI feature that automatically appears in REMOTE CONTROL mode is the presence of the ever developing "Status Window" within the "Transmit" panel. The Status Window can be enabled or disabled when in LOCAL CONTROL only, the MMI commands "ENABLE STATUS" and "DISABLE STATUS" respectfully. The Status Window began to appear near the end of MS-DMT v1.01 development, however it was never provided in a full release build.

LOCAL CONTROL

The basic "ASCII" terminal operation in LOCAL CONTROL is the default configuration when MS-DMT is started for the very first time. Its use only provides for Plain Text (PT) operation as there is no crypto support provided.

The biggest new features when in LOCAL CONTROL are the "Graphical Display" tool and "Status Window". The Graphical Display tool has a small foot print by default but can be enlarged by clicking the "S" button to the left which will then hide the incoming message window. When "S" is pressed again to return the Graphical Display to its smaller size, the Message Window will re-appear, along with any received messages being displayed.

NOTE: When in "REMOTE CONTROL" the Graphical Display tool will be large by default, again pressing the "S" button will change the size to the opposite state.

There are many features of the tool that are enabled when in LOCAL CONTROL that are not enabled during REMOTE CONTROL that are specific to the integral ASCII terminal support.

MS-DMT GUI INTERFACE

MS-DMT on install by default will first start in "LOCAL CONTROL" mode operation as stated at center screen top by "LOCAL CONTROL ACTIVE". The "Configure" panel is active for configuration purposes on first start and its status is controlled via the "Configure" check box being checked. When a legitimate com port is entered for the "DATA PORT" on the Configure panel, the program will automatically switch to "REMOTE CONTROL" operation, however many aspects of the GUI remain active in remote control, to include being able to access the Configure panel.

In "LOCAL CONTROL" the user interface consists of three panels from top to bottom; "Receive", "Configure" and "Transmit". This separates the GUI into a clean user interface. The "Configure" panel is only displayed when the "Configure" checkbox on the "Receive" panel is checked. When the Configure checkbox is not checked the Graphical Display can be enlarged and the Configure panel is hidden. The "Receive" and "Transmit" panels are the focus for all ASCII terminal communications.

All user selected parameters are saved to the DMT.DAT database file which resides in the same directory as the MSDMT_32.EXE file. MS-DMT creates a default DMT.DAT file at program start and when one is outdated, missing or corrupt. All user selected settings as well as the current GUI size and screen location of the application are retained for use each time program is terminated. The "EXIT" button is the ONLY proper way to terminate the application.

The GUI has two large windows that provide display of incoming and outgoing ASCII message text which will scroll when required. Any intercepted that is not ASCII shall being displayed in ASCII aside from non-printable characters when in LOCAL CONTROL operation. The HEX/ASCII check box when checked, will displayed all incoming data to the "Status Window" when enabled.

The top incoming message window is the largest when the Configure panel is not active. It displays the startup information received messages when using the internal terminal. It also displays some status messages when the Data Port is enabled in support of external terminal use.

The bottom outgoing message window seen in Figure 3. Below, supports entering or pasting up to a 32kb ASCII text message for sending.

There is also third single line transmit window at the bottom for up to a 1kb (1024 bytes) messages can sent on the "Enter" key stroke intended for rapid Orderwire communications in both LOCAL CONTROL or REMOTE CONTROL operation. It also doubles as the Man Machine Interface (MMI) Command Line Interpreter (CLI) input when the MMI/CLI box is checked, which is the case by the default.

The outgoing message window and ruler are hidden when the "Status Window" seen in figure 4. below, is activated which in LOCAL CONTROL is accomplished by entering "ENABLE STATUS" via the MMI/CLI and "DISABLE STATUS" to disable. The Status Window provides real time status data and error messages on the modems operation, MMI and remote control command requests.

CONFIGURE PANEL

The main MS-DMT GUI provides a number of options on both the "Receive" and "Transmit" panels for LOCAL CONTROL and REMOTE CONTROL which may change frequently out of need. However the Configure panel provides access to all configuration parameters that a user is unlikely to change frequently, if at all after the initial setup.

The Panel approach speeds the access process verses navigating conventional menu's to find the needed selection in the heat of 2-way communications. Placing lessor used parameters the Configure panel and sub configuration dialogs selected from buttons on the Configure panel, such as the "PCSDM" button, further separates those selections.
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DATA PORT

If MS-DMT is to be used with a provided external terminal application then a legitimate com port needs to be entered on the "Configure" panel for the "Data Port" entry, otherwise it is to be left set to zero (0).

MS-DMT and the given external terminal application being used are both executed on the same host computer usually. In which case a Virtual Serial Port (VSP) Null Modem is normally utilized for the serial connection between the MS-DMT "Data Port" and the external terminal tool. The recommended free VSP for use with MS-DMT is VspMgr which can be used on both 32-bit and 64-bit Windows.

However a physical Null Modem cable using a pair of real physical RS-232 serial ports can be utilized if the terminal application is running on a second computer. When doing so the required port parameters are 19,200 baud 8N1 which cannot be changed. When using a physical Null Modem cable MS-DMT cannot be remote commanded to send messages from a file.

PCSDM

The PCSDM button opens the "PC Sound Device Setup" dialog as seen in Figure 2. The PC Sound Devices selected as the Input and Output sound devices are used as the PC Sound Device Modem. These selections almost never change once made.

NOTE: The system "Default Device" should NEVER be used as the PCSDM, however should it be used, all system sounds MUST be disabled.

The "PC Sound Device Setup" dialog provides a clean interface to select your **Input Sound Device** (RX) and **Output Sound Device** (TX). Depending on the sound device and its driver it may be necessary to check the "**By Number/By Name**" box. The selection of the device by "Name" is default, if after selection the device is not retained, then try doing so by "Number".

"Line In" is recommended if available, if "Mic In" must be used be sure no enhanced boost features are enabled via the device driver in Windows. Today most sound devices in use are USB port types where "Mic In" must be selected.

All levels are currently selected via the Windows sound panel for the device being used. Do NOT change the **MOD** value, it should remain at 75% unless all other means of adjusting the drive level for no ALC on TX fail. Please refer to the "MS-DMT User Guide" for further details.

When done, click "OK".

NOTE: If using a USB or other interface port, external portable sound device, be sure to test each port with the device for the lowest sample clock error.

NOTE: If using an on-board sound device, especially on a laptop, the newer versions of Windows since Vista will not display the external mic port for selection unless a connector is plugged into the port.

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..255 must be entered. The com port parameters are user selectable for baud rate and framing. For each radio type coded, default values are provided.

The user may change the value for each radio type selected. 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.

PTT	EXTERNAL	▼
	CAT ONLY	▲
	CAT&RS232	
	RS232	▼

PTT TYPE	COMMENTS
CAT ONLY	Sends CAT PTT ON and CAT PTT OFF
CAT&RS232	As above plus either DTR or RTS as below.
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 based external units.

DTR/RTS AND RS232 PWR

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.

CAT Radio Type

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.

The 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 for hard code radios selections. The use of DMT-RADIO or DMT-RADIO_HS supports users creating custom radio control classes. The details of DMT-RADIO are found in Appendix N the "MS-DMT User Guide".

If the given hard coded 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. The details of all the radio type selections are found in Appendix G the "MSDMT User Guide".

REMOTE CONTROL

At this point virtually all use of MS-DMT by MARS members at this point is in REMOTE CONTROL mode with an external terminal application.

When in REMOTE CONTROL all of the GUI features found in LOCAL CONTROL that have no use in REMOTE CONTROL are hidden on the main GUI. The Graphical display tool by default in REMOTE CONROL mode is larger and the Status Window is automatically enabled.

In addition all Outgoing message generation and Incoming message data display is handled by the external terminal software that must be running when the data port is enabled for MS-DMT to function properly on receive. This is true even if MS-DMT is just being used for is new Graphical Tool along with a hardware modem. If an external terminal tool is not connected when in REMOTE CONTROL any intercepted transmissions will cause run on to occur as the output buffer cannot empty into the Data Port without an external terminal running.

When in REMOTE CONTROL mode the Orderwire message bar for un-encrypted message generation at the bottom of the GUI which doubles as a Man Machine Interface (MMI) "Command Line Interface" when MMI/CLI is checked remains available for command and control via user entered MMI commands and message generation.

In REMOTE CONTROL the tool can be resized so as to have a very small foot print when the Graphical Tool is in its small state as seen below.
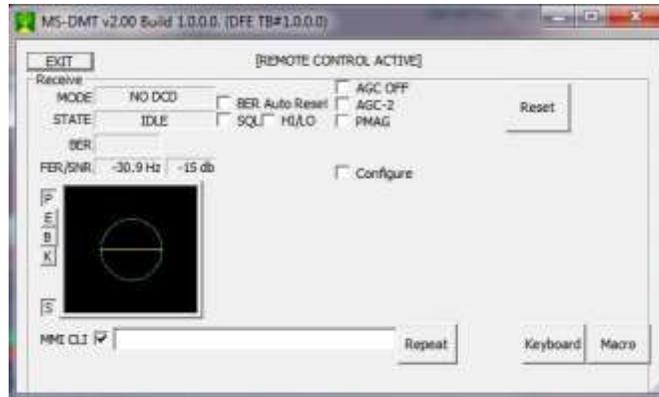
The benefit of resizing the graphical tool is that the foot print of the GUI can be reduced to take up less of the video display area when using an external terminal tool if monitoring the Status Window all the time is not a consideration. This makes the user of external terminal tools that don't resize or only partially resize easier to deal with and still allow for easy monitoring of the informative "Receive" panel tools during a signal intercept. The resize information and screen location is saved on proper program termination so as to return the last state upon program restart.

EOM DETECTION

The EOM detection has been improved, especially as to dealing with EOM sequence detection when the EOM bytes have been damaged. Most of the time when the EOM is damaged, the EOM generates a "Post EOM Detected" event message to the Status Window. However other means of resetting the modem may take precedence.

The new "Post EOM" process effectively deals with a damaged or lost EOM as well as a False EOM Detection event when using encryption. It does NOT do so in a fixed amount of time however if we are talking a false Preamble detection situation. Also, I have no hook as to when the EOM should come about in the data stream or detection of the fact that an RF signal has been lost (however that is under development) or never existed (which is a more complicated issue). However it usually beats the "DCD DECISION/VITERBI STATE RESET REQUEST" event in providing a reset and will reset when that one won't on a False Detection.

SQUELCH

What is not obvious from a glance at the GUI is that the SQUELCH (SQL) selection has been substantially improved with a re-write of the Preamble detection function. The use of SQL LO requires an incoming signal 2db stronger where SQL HI requires a 5db stronger signal.

NOTE: ALL HANDS should start with SQUELCH (SQL) disabled to gauge the performance of the tool in their environment.

The use of SQUELCH may be required in the case of False detection events where local man made noise, especially at 75bps trips the Preamble detection in the Hunting Preamble process. The best cure for this is of course for the end user to mitigate their local source of RFI in or about their station.

Before making any use of SQUELCH the user should make use of "AGC" which is enabled by default and "PMAG" which when combined with AGC do a good job of dealing with rapidly changing signals strengths such as during 2G ALE scanning. Then too PMAG alone deals with such signals and RFI when the magnitude of the signal and the SNR is not within the proper range for the AUTOBAUD returned by Preamble detection.

When SQL is not checked and SQUELCH is OFF all signals will be processed for Preamble detection if the signal passes a signal strength trip point for Hunting Preamble.
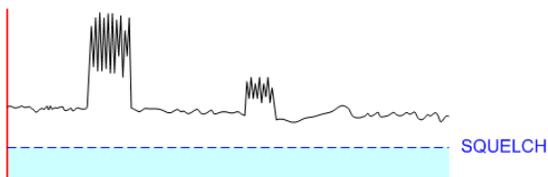

However if SQL is too high then no processing will take place.
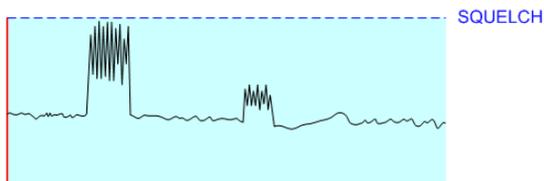
The ideal use of SQL is to mitigate any offending signal(s) that are causing a False detection to take place, especially during any unattended use of MS-DMT.

SQUELCH
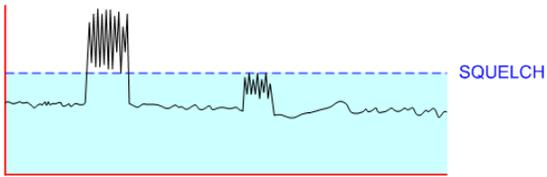
The use of SQL LO or SQL OFF in a situation where a False detect occurs now and then is preferable to too SQL HI that may keep real signals from being processed. MS-DMT will deal with many False detect events automatically in a rapid modem reset. This can be observed in the "Status Window" when a False detect occurs and an immediate NO DCD state results. However if the False detects occurring result in long periods of modem receiver run on generating gibberish then SQL HI may be required. But the use of "PMAG" alone or with SQL LO should be tried prior to going to SQL HI.

SQUELCH
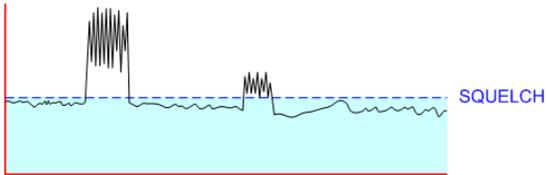
AGC OFF/AGC-1/AGC-2

The long ago disabled AGC function due to having extreme gain at over 30db which caused overloading issues with strong signals and noise has been re-written and is now very effective.

The AGC is user selectable as to ON/OFF state and AGC level.

When AGC OFF or AGC-2 are not checked, AGC-1 is enable. This is the default state the first time MS-DMT is started with a fresh DMT.DAT file.

AGC-1 provides minimal gain and makes a big difference on Multipath and Fading.

The SNR display is much more stable with AGC enabled.

When AGC OFF is checked there is no AGC or associated gain.

When AGC-2 is checked will see the difference in the SNR display when AGC2 is enabled as there is an overall signal improvement of about 10db. The use of the AGC-2 selection and SQL at the same time is counter productive.

Predicated on the user selection, on restart of MS-DMT AGC is either OFF or in AGC-1. The selection of AGC-2 is NOT saved as it is undesirable to restart the tool in AGC-2.

PMAG

The Preamble Magnitude (PMAG) is part of the Hunting Preamble process which where after AUTOBAUD detection its purpose is additional verification that the incoming signal is within the proper SNR and magnitude for the given data rate detection.

NOTE: ALL HANDS should start with PMAG disabled to gauge the performance of the tool in their environment.

Thus PMAG when enabled mitigates false detection events by some 95% based on testing where compared previous versions of MS-DMT under both HFCHANSIM and on-the-air conditions.

What is taking place when PMAG is enabled is a gating process that determines if the AUTOBAUD results are correct based on the best performance as to SNR and Preamble Magnitude of the incoming signal for each data rate along with the Frequency Error.

When PMAG is NOT enabled there are some new steps taken to mitigate False detection automatically during Hunting Preamble, but not as many as with PMAG enabled. The maximum Frequency Error of 81.1hz is in affect as when PMAG is enabled. Then too as with PMAG enabled, a two tier evaluation of the incoming signal strength for the Preamble processing trip point where the first stage based on the long standing algorithm that always existed and a new second stage is a fixed trip point.

Also, regardless of the PMAG state, the Preamble (PREAM) detection and validation code has been changed from that of MS-DMT v1.101 to where if LONG interleave is being used a detection and validation of 21 or greater PREAM states vs. all 24 will allow for decoding to start. This change was made as analysis revealed that prior build versions completely decoded messages without false detection and run on etc. when just 21 PREAM states were decoded. However all 3 PREAM states are still required for SHORT interleave PREAM validation.

NOTE: The Preamble states are now displayed to the "STATE" window in the "Receive" panel where there are 24 states for LONG and 3 for SHORT and NONE. Even at 75bps, the PREAMn..n go by fast in that State Window and are replaced by the next update to the window. The Preamble states count down from 23 to 0 and 2 to 0 in the displayed data. However in the new Status Window the data scrolls and is retained which when exposed for use as an ENABLE/DISABLE feature will allow scroll back.
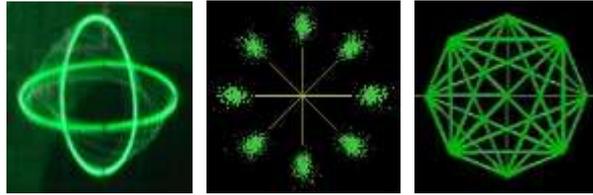
GRAPHICAL DISPLAY TOOL

The Graphical Display Tool in MS-DMT provides both Polar Plot and Constellation Diagram displays.

The Constellation Diagram displays the signal as a two dimensional X-Y plane scatter diagram in the complex plane at the symbol sampling rate instants. It provides a wealth of information regarding the MS110A transmission by rapid visual analysis of 8-ary IQ (I = Real and Q = Imagery) symbols transmitted in MS110A during the Data Phase which contains the KNOWN probe and UNKNOWN data symbols.

The custom Polar Plot is an effort to provide valuable information during Hunting Preamble, Processing Preamble and 75bps decoding where there is no symbol data as Walsh modulation is used in all cases. Polar plots are 2D plots, like X-Y plots. However instead of plotting X versus Y, we plot r (some length) at some angle, between 0 and 360 degrees.

Similar to the Lissajous phase pattern display for Radio Teletype, the X-Y Constellation displays symbols to observe when the symbols phase is negatively affected for interpretation of the channel conditions and radio equipment quality on transmit or receive. Below are a comparison of RTTY Lissajous 850hz shift phase pattern and MS110A at 2400bps LONG 8PSK I/Q phase pattern displayed in MS-DMT in both the normal Constellation Diagram and Constellation Differential Line display.

NOTE: The Constellation display persistence or hold time if you will of each pixel can be adjusted using the "P" (Persistence) drop down box below the Graphical Tool. The default "P" value is 1000 where 500, 1000 and 1500 is normally the best range to use. Selections range from 250..1500 in steps of 250 and 2000..5000 in steps of 1000.

The Constellation Differential Line mode display variation plots the 8-ary symbol transients and has been found to be of value for modem development and testing needs. However use of the Line mode on-the-air with disturbed channel conditions results in a mass of pixels verses anything useful being displayed over time during the Data Phase.
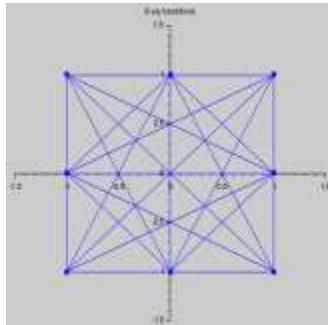
Thus given that absolutely perfect channel conditions required for the given data rate in use, further development of the Constellation Line mode was determined to be impractical for on-the-air use and put on the side. It is not currently a user selectable display mode. However further development and refinement may bring it online for all to use. Here are a pair of videos of this display in action:

www.n2ckh.com/MARS_ALE_FORUM/Constellation_Differential_Line2400bpsLONG.wmv

www.n2ckh.com/MARS_ALE_FORUM/MS-DMT_v200_2400bps_Line_Mode_Constellation_Test.wmv

POLAR PLOT

During Hunting Preamble, Preamble Processing and 75bps data rate operation custom Polar Plot displays are utilized to provide a visual representation of the effects of channel conditions. As WALSH modulation is used there are no Symbols to display as in the case of the Constellation display for 150bps operation and above.

When the tool is first started the Polar Plot is displayed while Hunting Preamble detection where a circle is displayed similar to two sine waves of equal frequency and 90 degrees out of-phase with a Lissajous pattern. However in our case the unit circle is the modem core looking for symbols to process and no legitimate MS110A signal being present and thus showing rotation of imaginary symbols due to the frequency offset and nothing being present as yet to correct. This remains the case during Preamble processing and 75bps intercept as there are no symbols then either as both use WALSH modulation BPSK.

In the image below the circle is brighter than in other such images in this document as there was a lot of Doppler on the channel at the time it was captured.
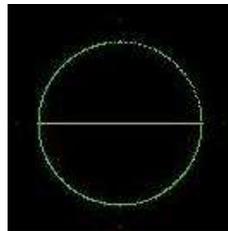
By default the single BPSK horizontal cross hair is displayed flashing as the Preamble is WALSH coded BPSK. There are BPSK, QPSK and 8PSK cross hairs that are displayed as soon as MS110A Autobaud detection is achieved during Preamble and then Data processing. The last Autobaud detection state of the cross hairs is retained when re-entering Hunting Preamble. This provides the user knowledge of what the last message data rate received in whole or part was intercepted.

At times during Hunting for Preamble the circle will be brighter and it will appear as a snake is zipping around the circle. The length of the brighter parts of the circle section (or the entire circle in the worst case) at times section will be longer and move faster as the sweep rate is higher in frequency from 0.0hz/sec to 3.5hz/sec or greater when there is Doppler on the channel.

I am still analyzing what I have created for use during Preamble decoding and at 75bps, which is an I/Q Time vs. Frequency Polar Plot vs. being as a true Constellation display is not possible as we are talking WALSH coding of BPSK signal.

The Preamble comes in at all the different data rates however and uses the same WALSH coding as does the 75bps data rate. At 75bps the Polar plot is an effort to provide some visualization of information during both the Preamble and Data phases. During the Preamble phase should part of the circle appear bright and appear to zip around the circle, the longer the bright part appears and the faster it moves, is an indication of Doppler Sweep Rate being high. The three times that the circle is displayed, Hunting Preamble, Preamble Decoding and 75bps DATA incoming are not text book items that any other software tool I have seen for Signal Analysis provide, thus I am in uncharted waters here.

The cross hair markers are provided for each data rate modulation used as seen from left to right below are the BPSK (2PSK), QPSK (4PSK) and 8PSK cross hairs.
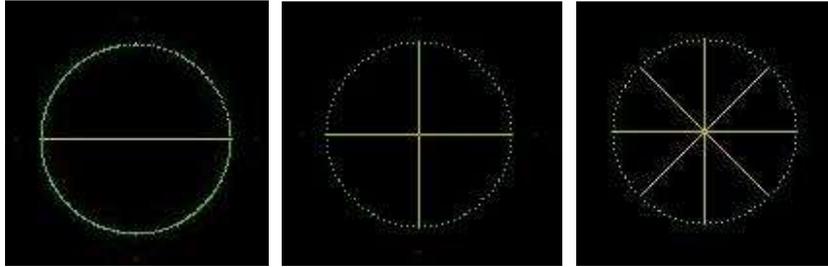

NOTE: The color is a bit washed out in these images when reloaded from saved files. As we are not viewing symbol data the persistence setting has no affect here as we are not dealing with symbols.

GRAPHICAL DISPLAY

The multi-purpose Graphical Display provides a Constellation Diagram and Polar Diagram display.

The Constellation Diagram provides the display of all data symbols during the DATA phase where MS110A 75, 150, 300 and 600bps data rates are BPSK, 1200bps is QPSK, 2400bps and 4800bps are 8PSK. The 2-point cross hairs are displayed for BPSK, 4-point cross hairs for QPSK and 8-point cross hairs for 8PSK as seen below.
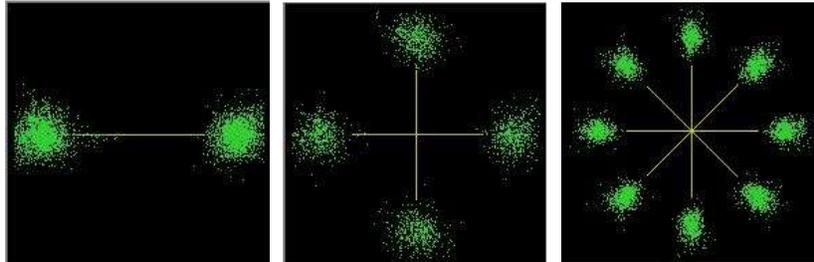
NOTE: I had to increase the persistence much higher than I normally have it set to enable capturing and saving screen captures suitable for inclusion in this document. I normally run 1000 for persistence as seen in the QPSK capture, the BPSK and 8PSK were made using a persistence of 5000.

As seen in the images above, when the constellation of symbol points displayed are Clear and Distinct at the ends of the cross hair points perfect signal copy all of the symbols is guaranteed.

All Constellation data can be displayed at 8PSK at all times by clicking the 8PSK box or the actual incoming data rate raw modulation. When this is the case the cross hairs will still be displayed for the actual BPSK, QPSK or 8PSK being used as seen below where a BPSK signal is being intercepted.
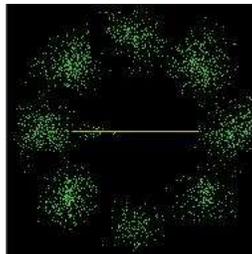
MS110A is sent over the air to always appears as 8PSK for all modes 150bps and higher. However as each mode uses different modulation, however the actual data payload modulation of BPSK, QPSK and 8PSK will provides more visual clarity as to how the symbols are being negatively impacted by the channel conditions when a perfect signal is not being received.

As the signal to noise ratio (SNR) decreases or other channel impairments arise, the constellation of symbols will become less distinct. When enough noise or interference is present received symbols will move across the boundary from one symbol to another, at some point bit errors (BER) will begin to be seen.

Most of the time the DFE modems Equalizer and Forward Error Correction (FEC) can compensate for the various channel conditions up until the point where the constellation is no longer recognizable at all for a period of time.

There are many causes that affect the Constellation Display visual effects, among them are:

- Multipath: Symbols will be seen breaking apart

- Fading: Causes Symbols to rotate in either or both directions and symbols breaking apart.

- Doppler: Causes symbols to rotate clockwise for negative doppler and counter clockwise for positive doppler and breaking apart

- Weak Signal: Symbols will be seen breaking apart

- Distortions: Radio induced distortions in the form of clipping or non-linearity may often be identified in the constellation as a radial smearing of the constellation points outward from their center. Very good channel conditions are required for such observations. 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, non-linearities tend to result in the constellation points appearing as ellipses, with the major axis radially outward from the center of the constellation.

Most of the time the modem Decision Feedback Equalization (DFE) and Forward Error Correction (FEC) can compensate for the various channel conditions up until the point where the constellation is no longer recognizable at all for some period of time and DCD is lost.

The 600bps LONG transmission that resulted in the Constellation display below actually resulted in completion with BER 4 and EOM detection and perfect copy on the message even though resemblance to a proper Constellation was no where to be seen. However it was just a case mostly of a weak signal vs. Multipath and Fading as can be seen both the symbols being spread out somewhat equally from the BPSK cross hairs verses rotating about in the first image.
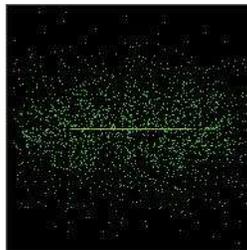
The images below are from the same HFCHANSIM test bed case seconds apart where lots of Multipath and Fading was present and the 1200bps LONG symbols are send rotating, smearing and fading.
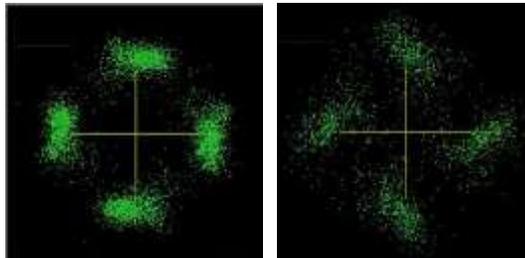
Switching from 8PSK display to the actual QPSK and changing the persistence improved the ability to view the constellation a can be seen in the videos of 1200bps testing from which above screen caps were taken which can be viewed at:

www.n2ckh.com/MARS_ALE_FORUM/1200bps_LBtestMsg_Heavy_Multipath_Fading.wmv

The constellation display can be configured to display the received symbols before or after equalization as well as an overlapping display of both. There are four Constellation mode buttons to the left of the graphical tool. Three of the four buttons labeled P, E and B from top to bottom select the three Constellation display modes of Pre-Equalization, Equalization or Both. When E or B are selected, the fourth button labeled K, selects to display the KNOWN symbols only vs. KNOWN and UNKNOWN symbols.

The "P mode" displays the raw incoming symbols Pre-Equalization. The symbols are displayed as GREEN pixels. In P mode all incoming Symbols, both the KNOWN probe (a.k.a. Training) symbols and the UNKOWN payload (message data content) symbols prior to the Equalizer during the DATA mode are displayed. At times the FLUSH bits at the end of the transmission may also be displayed, but not by desire.

The 8PSK check box selects between each data rates actual symbol display where 150-600bps is BPSK a.k.a. 2PSK, 1200bps is QPSK a.k.a. 4PSK and 2400-4800bps is 8PSK at all times.

The "E mode" will provide a view of the symbols post Equalization in the color ORANGE and always in an 8PSK representation as seen in the 1200bps LONG intercept below. The ORANGE pixels will have less movement than the GREEN pixels of P mode as E mode symbols have under gone initial equalization. The ORANGE pixels provide a real time visualization of how well the Equalization is dealing with the channel conditions depicted by the GREEN pixels that provide a visualization of how good or poor the channel conditions may be at the time. When E mode is selected and the tool returns to Hunting Preamble at the end of the transmission but the Polar Plot during hunting is not displayed.
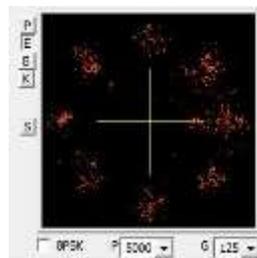

The "B mode" is a mix of both P and E modes with their GREEN and ORANGE color pixels are displayed at the same time. When the ORANGE and GREEN pixels are both displayed at the same time a real time visual comparison is provided, where as channel conditions to degrade we want to see far less effect on the ORANGE pixels if the Equalizer is doing its job well. As E mode is always 8PSK, if the 8PSK box is not checked, only the E mode symbols that are at the same phase of the raw mode selected will be directly in the mix for a very good signal. The remaining phase angle points for E mode will be displayed in the clear in ORANGE.

In the first image below a 1200bps LONG signal that was a bit weak but on a good channel is being displayed while the second image is a strong 2400bps LONG signal on a poor channel with Multipath and symbol rotation was captured, but yet perfect copy was had. The Equalizer performance is now so good that regardless as to how bad the incoming RAW symbols (as GREEN pixels) are prior to equalization and appear to spread, smear and or rotate, you will continue to get copy, possibly perfect or with lots of hits as conditions degrade to where finally DCD is lost.
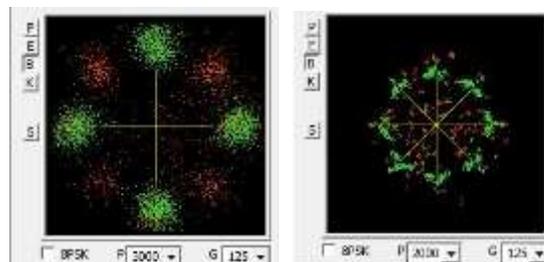
The buttons P, E, B are interactive, in other words if P the default mode is selected, clicking E will deselect P as will B, the selected button will appear indented. The K button only has an affect when E or B is selected where it when clicked on will be indented with one of the P, E or B buttons when K is active.
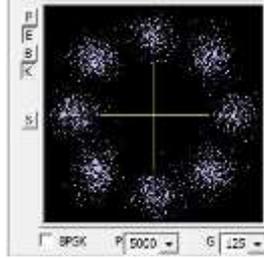
E mode can either display the UNKNOWN (message data payload) symbols or if K is selected, the KNOWN probe symbols, in both cases as being processed by the Equalizer. The symbols will appear as ORANGE pixels for UNKNOWN and WHITE pixels for KNOWN. The UNKNOWN systems are what the Equalizer uses to touch up equalization over the course the data transmission.

B mode is a combination of P and E at the same time with K being the wild card selection. E displays the Symbols as they have been processed by the Equalizer where K selects the KNOWN symbols when checked, otherwise the UNKNOWN symbols of the message payload. The KNOWN symbols are display as WHITE pixels and UNKONWN are in ORANGE and always in 8PSK.

B selects to display both the P and E modes where K selects between KNOWN and UNKNOWN.

There are more Symbols for UNKNOWN vs. KNOWN as the KNOWN Probe data for continued Synchronization. The amount of UNKNOWN data varies to a point between the selected data rate in use.

Thus the E selection always displays less symbols than does P selection.

The P selection is just displaying all the RAW symbols as they are being received and thus they really follow the changing channel conditions at all times.

The E selection allows one to observe the actual Equalization process at all times, something that will allow me to work on improving the Equalizer even more.

The B selection will provide a contrast between the RAW symbols and the Equalized KNOWN or UNKNOWN symbols as they are being processed.

The 8 boundary symbols displayed in RED when P is selected are not displayed when E or B is selected. Those 8 single RED pixels represent 8 symbols that are the boundary points for the 8PSK over-the-air Constellation taken from final equalization processing. Below is the best image that could be captured and used in this document to highlight the 8 RED pixels representing the boundary points can be seen outside the green circle.

In a perfect world the GREEN pixels or when E mode is enabled the ORANGE pixels would be directly over the RED pixels in a tight cluster so much so the RED pixels would not be seen. The boundary pixels are almost never going to rotate or otherwise move until we reach the point in the equalizer when things fall apart so bad and so fast you lose DCD and even then you won't often see them change with the naked eye.

The E mode for my needs, provides a means to observe the Equalizer so as to make code changes to improve its operation. In E with K unchecked, the processing of the UNKNOWN will display symbols as pixels that should be more stable than P mode as they are equalized. However they too will be negatively impacted by channel conditions. When K is checked it is just the KNOWN data symbols, where there are less symbols and where they will be even more stable.

75BPS POLAR PLOT

At 75bps we only use the "P mode" selection as things are quite different at 75bps due to the WALSH modulated BPSK as there are no symbols per see as there are at 150bps and up. At 75bps is the 2-point cross hair is displayed as 75bps is BPSK.

NOTE: The Walsh modulation for 75bps uses the bits, in groups of two, coming from the coder and the block interleaver structure to select one of four orthogonal Walsh functions of length four. Then these Walsh functions are repeated eight times, resulting in a 32-symbol 8-PSK sequence. The interleaved data also decides which of the four Walsh functions is used to rotate 180 (in case of 1) or 0 (in case of 0) each of the 8-PSK symbols of the underlying PN sequence. Finally, the scrambled PN sequence is mapped to the in-phase and quadrature components of the carrier signal (1800 Hz) at a rate of 2400 symbols per second.

If the modem receiver is not having any real challenge there will not be any random pixels displayed during 75bps decoding. However, should there be interference on the channel that is strong or should the channel be severely disturbed with Multipath and Fading that even makes life difficult for the RAKE receiver used for 75bps decoding there will pixels displayed scattered about the polar plot as seen below.

There is no defined pattern to the pixels, they are just scattered about like bird shot on a target. The worst the channel conditions the more pixels that will be displayed and the possibility of hits in the data.

The first close up image below is that from the full screen capture, the second close up is near the end of the transmission which was received without errors to include the EOM. Should the circle completely disappear due to so many random pixels being displayed we can expects hits in the data payload and possible loss of EOM.
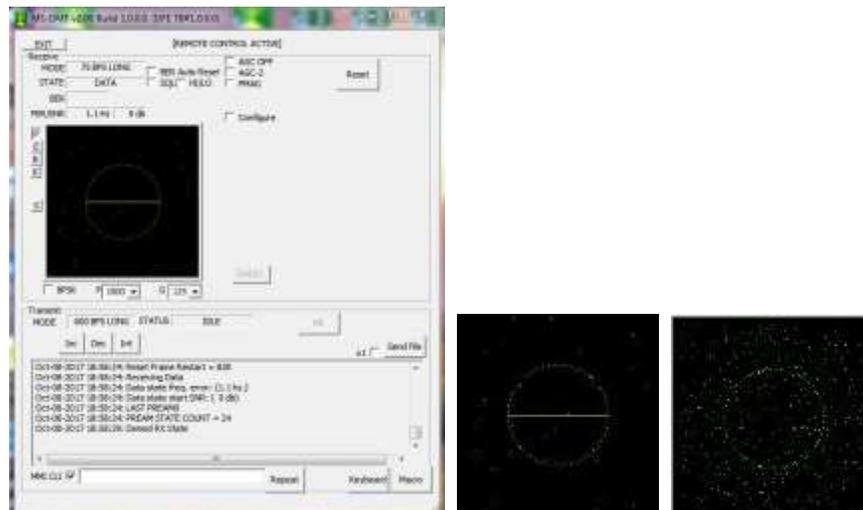
At times the circle may disappear during the FLUSH after the EOM phase if the signal is weak and the channel conditions are poor. Should the circle disappear during the data phase it indicates that the Equalizer is really losing the battle and big hits are taking place in the data payload.

The significance of all this is a heads up as to what to expect when the 75bps transmission is complete as in the past when we were not using TacChat and on-line encryption we could see hits in real time, now we need to wait until the end of the transmission.

STATUS WINDOW

The "Status Window" is a development in process that provides a great deal of information during the intercept and decoding of an MS110A intercept. However that is not the only purpose of the Status Window. Any information that needs to be conveyed to that user that they is not an existing means to display is piped to the Status Window.

The Status Window can be Enabled/Disabled in LOCAL CONTROL however it is active at all times in REMOTE CONTROL operation. The MMI commands ENABLE STATUS and DISABLE STATUS are entered into the Orderwire message window at GUI bottom when the MMI CLI box is checked.

At MS-DMT start to shutdown information accumulates in the Status Window, in time it will be logged to one or more files and the user will also have the option to clear the window. At present information pertaining to MS-DMT proper and user entered Man Machine Interface (MMI) commands and external terminals remote control command process are displayed.

In the future information from the HF SSB radio under control of MS-DMT will also be displayed, to include as much 2G ALE status information any supported ALE transceiver may provide if a separate window is not created for such support.

NOTE: There is a "STATUS" added to the "Configure" panel that when enabled will provide for configuration as to what all will be displayed to the Status Window.

There is an awful lot to document regarding the Status Window already and its development is perhaps only 50% complete, for now this document is only going to touch on a few examples pertaining to MS110A intercepts.

Any false detection or failed intercept that results in a failed DCD event will display in the status window similar to this post where the incoming 2400bps LONG was too weak.

Oct-08-2017 21:57:11: Preamble Found
Oct-08-2017 21:57:11: Preamble Autobaud: 2400 BPS LONG
Oct-08-2017 21:57:11: SQUELCH OFF
Oct-08-2017 21:57:11: Preamble Freq. Error: (-1.1 hz.)
Oct-08-2017 21:57:11: Preamble SNR: (1 db)
Oct-08-2017 21:57:11: PREAM21
Oct-08-2017 21:57:11: Preamble errors: 1
Oct-08-2017 21:57:11: PREAM20
Oct-08-2017 21:57:11: Preamble errors: 2
Oct-08-2017 21:57:11: PREAM19
Oct-08-2017 21:57:11: Preamble errors: 3
Oct-08-2017 21:57:11: Preamble Restart
Oct-08-2017 21:57:12: PREAM18
Oct-08-2017 21:57:12: Preamble errors: 4
Oct-08-2017 21:57:12: PREAM17
Oct-08-2017 21:57:12: Preamble errors: 5
Oct-08-2017 21:57:12: PREAM16
Oct-08-2017 21:57:12: Preamble errors: 6
Oct-08-2017 21:57:12: PREAM15
Oct-08-2017 21:57:12: Preamble errors: 7
Oct-08-2017 21:57:12: Preamble errors: 7
Oct-08-2017 21:57:12: Preamble errors: NO DCD

Here for example is the information displayed for a 150bps LONG intercept that was without an errors:

Oct-08-2017 21:44:57: Demod IDLE State
Oct-08-2017 21:44:57: Frame Start Position = 0
Oct-08-2017 21:44:57: Preamble Found
Oct-08-2017 21:44:57: Preamble Autobaud: 150 BPS LONG

Oct-08-2017 21:44:57: SQUELCH OFF
Oct-08-2017 21:44:57: Preamble Freq. Error: (-0.0 hz.)
Oct-08-2017 21:44:57: Preamble SNR: (9 db)
Oct-08-2017 21:44:57: PREAM23
Oct-08-2017 21:44:57: PREAM22
Oct-08-2017 21:44:57: PREAM21
Oct-08-2017 21:44:57: PREAM20
Oct-08-2017 21:44:57: PREAM19
Oct-08-2017 21:44:58: PREAM18
Oct-08-2017 21:44:58: PREAM17
Oct-08-2017 21:44:58: PREAM16
Oct-08-2017 21:44:58: PREAM15
Oct-08-2017 21:44:58: PREAM14
Oct-08-2017 21:44:59: PREAM13
Oct-08-2017 21:44:59: PREAM12
Oct-08-2017 21:44:59: PREAM11
Oct-08-2017 21:44:59: PREAM10
Oct-08-2017 21:44:59: PREAM9
Oct-08-2017 21:45:00: PREAM8
Oct-08-2017 21:45:00: PREAM7
Oct-08-2017 21:45:00: PREAM6
Oct-08-2017 21:45:00: PREAM5
Oct-08-2017 21:45:00: PREAM4
Oct-08-2017 21:45:01: PREAM3
Oct-08-2017 21:45:01: PREAM2
Oct-08-2017 21:45:01: PREAM1
Oct-08-2017 21:45:01: Reset Frame Restart = 671
Oct-08-2017 21:45:01: Receiving Data
Oct-08-2017 21:45:01: Data state freq. error: (-0.0 hz.)
Oct-08-2017 21:45:01: Data state start SNR: (0 db)
Oct-08-2017 21:45:01: LAST PREAM0
Oct-08-2017 21:45:01: PREAM STATE COUNT = 24
Oct-08-2017 21:45:06: Demod RX State
Oct-08-2017 21:45:08: EOM Detected SNR: (-1 db)
Oct-08-2017 21:45:08: EOM Detected Modem Reset

NOTE: The Preamble (PREAMn…nn) states are also displayed to the "STATE" window on the "Receive" panel, however other information associated with the Preamble, such as a Preamble processing errors and restart is only displayed to the Status Window.

Oct-08-2017 21:58:27: Preamble Found
Oct-08-2017 21:58:27: Preamble Autobaud: 2400 BPS LONG
Oct-08-2017 21:58:27: SQUELCH OFF
Oct-08-2017 21:58:27: Preamble Freq. Error: (0.9 hz.)
Oct-08-2017 21:58:27: Preamble SNR: (7 db)
Oct-08-2017 21:58:28: PREAM23
Oct-08-2017 21:58:28: PREAM22
Oct-08-2017 21:58:28: PREAM21
Oct-08-2017 21:58:28: PREAM20
Oct-08-2017 21:58:28: PREAM19
Oct-08-2017 21:58:28: PREAM18
Oct-08-2017 21:58:29: PREAM17
Oct-08-2017 21:58:29: PREAM16
Oct-08-2017 21:58:29: PREAM15
Oct-08-2017 21:58:29: PREAM14
Oct-08-2017 21:58:29: PREAM13
Oct-08-2017 21:58:30: PREAM12
Oct-08-2017 21:58:30: PREAM11
Oct-08-2017 21:58:30: PREAM10
Oct-08-2017 21:58:30: PREAM9
Oct-08-2017 21:58:30: PREAM8
Oct-08-2017 21:58:31: PREAM7

Oct-08-2017 21:58:31: PREAM6
Oct-08-2017 21:58:31: PREAM5
Oct-08-2017 21:58:31: PREAM4
Oct-08-2017 21:58:31: Preamble errors: 1
Oct-08-2017 21:58:31: PREAM3
Oct-08-2017 21:58:31: Preamble errors: 2
Oct-08-2017 21:58:32: PREAM2
Oct-08-2017 21:58:32: Preamble errors: 3
Oct-08-2017 21:58:32: Preamble errors: 4
Oct-08-2017 21:58:32: PREAM1
Oct-08-2017 21:58:32: Preamble errors: 5
Oct-08-2017 21:58:32: Preamble errors: 6
Oct-08-2017 21:58:32: Reset Frame Restart = 684
Oct-08-2017 21:58:32: Receiving Data
Oct-08-2017 21:58:32: Data state freq. error: (0.9 hz.)
Oct-08-2017 21:58:32: Data state start SNR: (-1 db)
Oct-08-2017 21:58:32: LAST PREAM0
Oct-08-2017 21:58:32: PREAM STATE COUNT = 24
Oct-08-2017 21:58:37: Demod RX State
Oct-08-2017 21:58:38: Partial EOM Detected
Oct-08-2017 21:58:38: EOM Detected SNR: (-1 db)
Oct-08-2017 21:58:38: EOM Detected Modem Reset