Messenger 2 Transmitter
MODEL M2T – D3
OPERATIONS MANUAL

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1.0 Important Warning and General Safety Information

The following information is presented to the operator to ensure awareness of **potential harmful RF (**radio frequency**) exposure** and general hazards. With regards to potential harmful RF electromagnetic fields the text below is only a brief summary highlighting the possible risks and how to minimize exposure. The summary is based on OET Bulletin 65 "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields" [(1)]. The user should carefully read and comprehend the following before operating the equipment and for additional in depth information refer to OET Bulletin 65.

1. FCC has set guidelines [(1)] for evaluating exposure to RF emissions that the user must be aware of when operating GMS's M2T microwave transmitter. The maximum power density allowed at 2025-2110 MHz & 2450-2483.5 MHZ is **5mW/cm^2** for occupational/controlled exposure* and **1mW/cm^2** for general population/uncontrolled exposure**. These are the limits for maximum permissible exposure (MPE) as called out in the FCC guidelines (for the above mentioned frequencies).

2. Exposure is based on upon the average time spent within the RF field with a given intensity (field units in mW/cm^2). Hence it may be controlled (or at least minimized) by observing the safe distances and time exposed as shown in Table 1. These safe distances are calculated from equations predicting RF Fields [(3)] with the following assumptions:

    - The transmitter maximum power is 23dBm (0.2W)
    - The antenna used has a 2dBi gain
    - The transmitter is used in a fixed location

* "*Occupational /controlled exposure limits apply to situations in which persons are exposed as a consequence of their employment and in which those persons who are exposed have been made fully aware of the potential for exposure and can exercise control over their exposure. Occupational/controlled exposure limits also apply where exposure is of a transient nature as a result of incidental passage through a location where exposure levels may be above general population/uncontrolled limits (see below), as long as the exposed person has been made fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means. ……."* [(2)]

** *"General population/uncontrolled exposure limits apply to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Therefore, members of the general public would always be considered under this category when exposure is not employment-related, for example, in the case of a telecommunications tower that exposes persons in a nearby residential area."* [(2)]

[(1)] OET Bulletin 65, Appendix A Table 1 Limits for MPE
http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65.pdf
[(2)] OET Bulletin 65, page 9, definitions of types of exposure
http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65.pdf
[(3)] OET Bulletin 65, page 19, Equations for predicting RF Fields
http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65.pdf

The user (and bystanders) should remain beyond the distances from the antenna at all times as stated in Table 1 when the transmitter is operating for no longer than the time periods indicated (keeping in mind this is the average time).

If any of the above variables change, such as a higher gain antenna, less or more power output from the transmitter, additional transmitters used, etc. then the safe distances would need to be recalculated. The user can either refer to the equations predicting RF Fields as noted in the above section or call contact GMS for advice at (760)-496-0055.

Table 1 – Safe distances

Frequency = 2025-2110 MHZ 2450-2483.5 MHZ	M2T Transmitter Power = 0.2W (+23 dBm)		Antenna Gain = +2dbi
Occupational /controlled exposure (5mW/cm^2)		*General population/uncontrolled exposure (1mW/cm^2)*	
Safe Distance	Average Time	Safe Distance	Average Time
2.2 cm	**6 minutes**	**5 cm**	**30 minutes**

3. The transmitter, which can be operated in fixed or mobile applications, is rated at 0.2W (+23dBm) RF power and is capable of harmful radiation if safe operating practices are not observed (see sections 1 & 2 above).

4. It should be noted that this device is an intentional radiator, hence:

   Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

   NOTE: The manufacturer is not responsible for any radio or TV interference caused by unauthorized modifications to this equipment. Such modifications could void the user's authority to operate the equipment.

5. Do not substitute any antenna for the one supplied or recommended by the manufacturer. The installer is responsible for ensuring that the proper antenna is installed.

6. Antenna minimum safe operating distances should be observed as stated in section 2 above. It is the responsibility of the qualified end-user of this intentional radiator to control the safe distances and exposure limits to bystanders.

7. DC power (+12VDC) to the unit should never be applied until the antenna (or other suitable load) has been attached to the device SMA RF output connector. Safe operating procedures must be observed when unit is transmitting into an antenna (see sections 1 & 2 above).

8. Electro-Static Discharge (ESD) precautions should be observed as a safe practice.

9. The transmitter will generate considerable heat and is the responsibility of the end user to properly heat sink the device before using.

2.0 Acronyms

This section lists and describes the various acronyms used in this document.

Name	Meaning
16QAM	16-state Quadrature Amplitude Modulation
64QAM	64-state Quadrature Amplitude Modulation
A/V	Audio/Video
AES	Advanced Encryption System (32 bit)
ASI	Asynchronous Serial Interface
BDC or BDCC	Block down converter
C-OFDM	Coded Orthogonal Frequency Division Multiplexing
CVBS/Y	Composite video/Luminance with S-video
C	Chroma video
D/C	Down-Converter
FEC	Forward Error Correction
GUI	Graphical User Interface
HD	High Definition
I/O	Input/ Output
Kbaud	Kilobaud per second
Kbps	Kilobits per second
Mbps	Megabits per second
MER	Modulation Error Rate
MPEG	Moving Picture Experts Group
MSR	Messenger Smart Receiver
M2T	Messenger Two Transmitter
M2L	Messenger Two Link
NTSC	National Television System Committee
PAL	Phase Alternation Line
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RX	Receiver
S/N	Signal-to-Noise Ratio
THD	Total Harmonic Distortion
SD	Standard Definition
SDI	Serial Digital Interface
TX	Transmitter
VDC	Volts (Direct Current)

3.0 Introduction

GMS introduces the Broadcast industry's first AVC / h.264 C-OFDM wireless transmitter for transport of Standard (SD) plus High Definition (HD) audio /video streams.

The Messenger 2 Series (M2) product line incorporates many of the original "Messenger" product line capabilities with two major upgrades. The M2 series incorporates the AVC compression technology with one frame delay which replaces the MPEG-2 compression, and they cover all the SD and HD formats up to 1080P.

One of the biggest problems encountered in the transition from an analog to a digital A/V platform has been the inherent digital coding delay that in some digital systems are 1.5 seconds or more for HD. The M2T employs a specially designed 'Ultra-Low Delay' coding technology, which provides 44mS (~ 1 frame) end-to-end system delay when using GMS's AVC Decoder. This ensures that the picture you see is what is happening now; crucial for applications such as sports and news coverage!

This manual provides information on how to operate the M2T as well as pertinent technical information related to the overall system. Refer to the model identifier (on-line document, 100-MNI0063 - latest revision) at GMS website, http://www.gmsinc.com/, for available frequency and power configurations along with options.

3.1 Key System Features

- Built–In AVC / h.264 Encoder
- SD and HD formats up to 1080p
- Low Power Consumption (~22 Watts)
- Low System Latency (~1 frame with GMS AVC Decoder)
- Local Control
- User Data Support
- AES 128 Bit Security
- C-OFDM Modulation
- Output Frequency: [2025-2110] – [2450-2483.5] MHz
- High-Throughput 4K option for maximum link performance
- Rugged and Compact Portable Design
- Companion C-OFDM receiver with Maximal-Ratio Pre-Detect Diversity reception

4.0 Theory of Operation

The Messenger 2 Transmitter (M2T) accepts Standard Definition (SD) or High Definition (HD) 4:2:2 digital video or analog SD video and analog stereo audio inputs (Mic or Line level). The video is compressed according to the Advanced Video Compression (AVC) /h.264 specifications. The low-latency AVC Encoder supports the Baseline Profiles with resolutions from 480 to 1080 with support for either interlaced or progressive formats. The audio is compressed using MPEG layer II compression. Low rate user data up to 38.4K Baud can be optionally supported. The audio, video and user data packets PES streams are multiplexed with basic service data to indicate the service name. The stream can be scrambled with AES scrambling system to provide protection in sensitive applications.

A complete GMS Messenger 2 Camera Link for wireless camera application includes the Messenger 2 Transmitter, the Messenger Smart Receiver (MSR), a SD/HD AVC Decoder and one or several external Block Down – Converters (BDC), as shown in the Figure 1 below. The M2T provides professional Audio/Video (A/V) interfaces and processing. All versions of the Messenger Digital Link family use a robust digital modulation system known as Coded Orthogonal Frequency Division Multiplexed (C-OFDM) that provides frequency diversity and powerful Forward Error Correction (FEC) algorithms.

The Messenger Smart Receiver (MSR) provides for *Spatial Pre-Detect Maximal-Ratio Diversity Combining* of up to six independent antennas per MSR to increase the Signal Strength, Signal-to-Noise Ratio and combat short delay spread multipath reflections found in indoor environments. There is a dramatic increase in the operating threshold when multiple high-gain antennas and Block Down-Converters (BDC) are used with the MSR, greatly enhancing link robustness when operating at the high data rates as required for HD transmission. The MDR outputs a transport stream simultaneously over ASI and SPI interfaces. External Audio/Video/Data MPEG Decoders are sold separately that support HD or SD AVC Decoding.

The 4K HIGH-THROUGHPUT OPTION enables user-selectable options to set bandwidths from 6 MHz to 16 MHz and to double the throughput of our standard M2T (Up to 63 Mbps!). Using 4K carriers and the 16 MHz bandwidth, the link can support HD operation with > 12 Mbps while running QPSK and ½ FEC. This increases link robustness and provides an additional 13.5 dB increase in link margin (>4.7 x increase in operating range!) for the same throughput rate in a standard HD MPEG-2 DVB-T system! With the HIGH-THROUGHPUT OPTION you can run with fully DVB-T compliant 2K carriers and bandwidths of 6, 7, or 8 MHz. When switched to 4K carriers user can select 12, 14 or 16 MHz bandwidth.

The 4K HIGH-THROUGHPUT OPTION is also useful when transmitting multiple video streams through one transmitter. This option requires a special receiver configuration. Please contact GMS Sales for additional information.

5.0 Getting Started

The standard M2T kit includes the following items:

- M2T unit
- M2T full breakout cable (GMS p/n 780-C0291)
  (Power, A/V input, User Data, Control interfaces)

NOTE: Based on customer application GMS may deliver a receiving system, additional cables and antennas. Contact GMS for further information.

The M2T is pre-configured by GMS prior to shipment (based on customer requirements), thus is ready to work “right out of the box”.

5.1 Initial Checkout

Prior to installing a M2T unit into the desired target environment, an initial checkout should be performed to ensure proper operation of the unit. The initial checkout consists of configuring a basic MT2 link.

Figure 1 shows a basic standard M2T wireless link configuration. (NOTE: MSR and D/C units and their associated hardware are sold separately). The steps necessary to setup the configuration shown in Figure1 are shown below. High throughput optional M2T require additional hardware (which includes two MSRs, a DDP plug in card and a combiner).

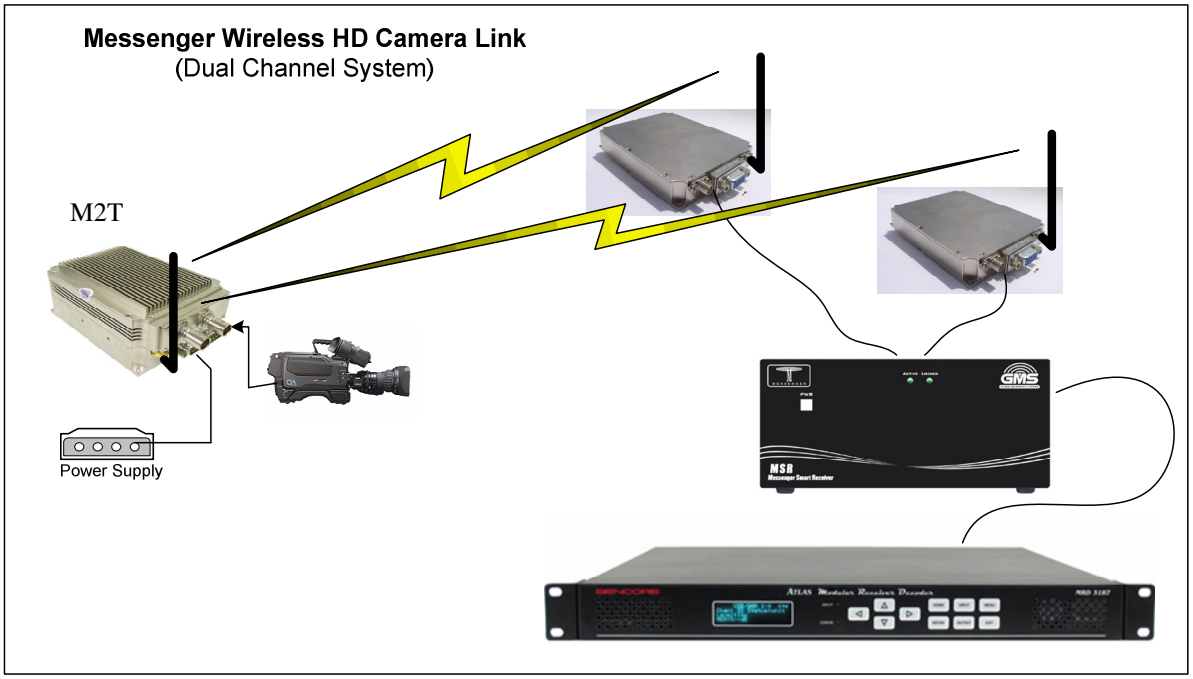


Figure 1 - Basic M2T Link Setup

1. Install omni-directional antennas onto the M2T transmitter RF output port and at the receiver end Down-Converter(s) RF input port. ***Note: Transmitters should not be powered on without a load attached to the RF output connector. The internal PA could be damaged.***
2. Attach an SDI video source to the M2T SDI BNC video input. A composite signal can also be applied to the M2T I/O DB-44 connector using GMS break out cable, however keep in mind that the video source must match the group setting of the transmitter. Refer to the software section 6.0 on the selection of the transmitter (M2T) video groups.
3. The MSR should be pre-configured from the factory (refer to the GMS web site for the online manual). In short ensure the MSR is powered, has a cable from the ASI out to the decoder ASI input, that each tuner has a RF cable which runs to each block down converter (each tuner is provided power either through the MSR or locally) and is set to the same RF frequency as the transmitter.
4. Attach a video cable from the video out of the decoder to a video monitor. Refer to the decoder's operational manual for proper setup.

   NOTE: Before providing power to the M2T in the following step ensure to use a proper heat sink with adequate air flow or equivalent heat sinking method.

5. Provide power to the M2T (+12 Volts) using GMS break out cable (780-C0291) which connects to the I/O DB-44 pin connector. Power supply should be able to source approximately 2 amps.
6. Turn on the video source and video monitor equipment.
7. After approximately 30 seconds the link should be established and video provided by the source should be displayed on the monitor. An optional computer with the MSR control software installed can be used to monitor the receive parameters such as BER, MER and Signal to Noise. This connection can be through the USB or RS232 port.

The initial checkout described above is simply to check the basic video operation of the M2T unit. For further details on monitoring and controlling the M2T using GMS' optional MS Windows-based M2T Configurator software program, see Section 6.0.

6.0 Hardware Overview

The basic M2T transmitter configuration is outlined in this section:

6.1 Standard M2T

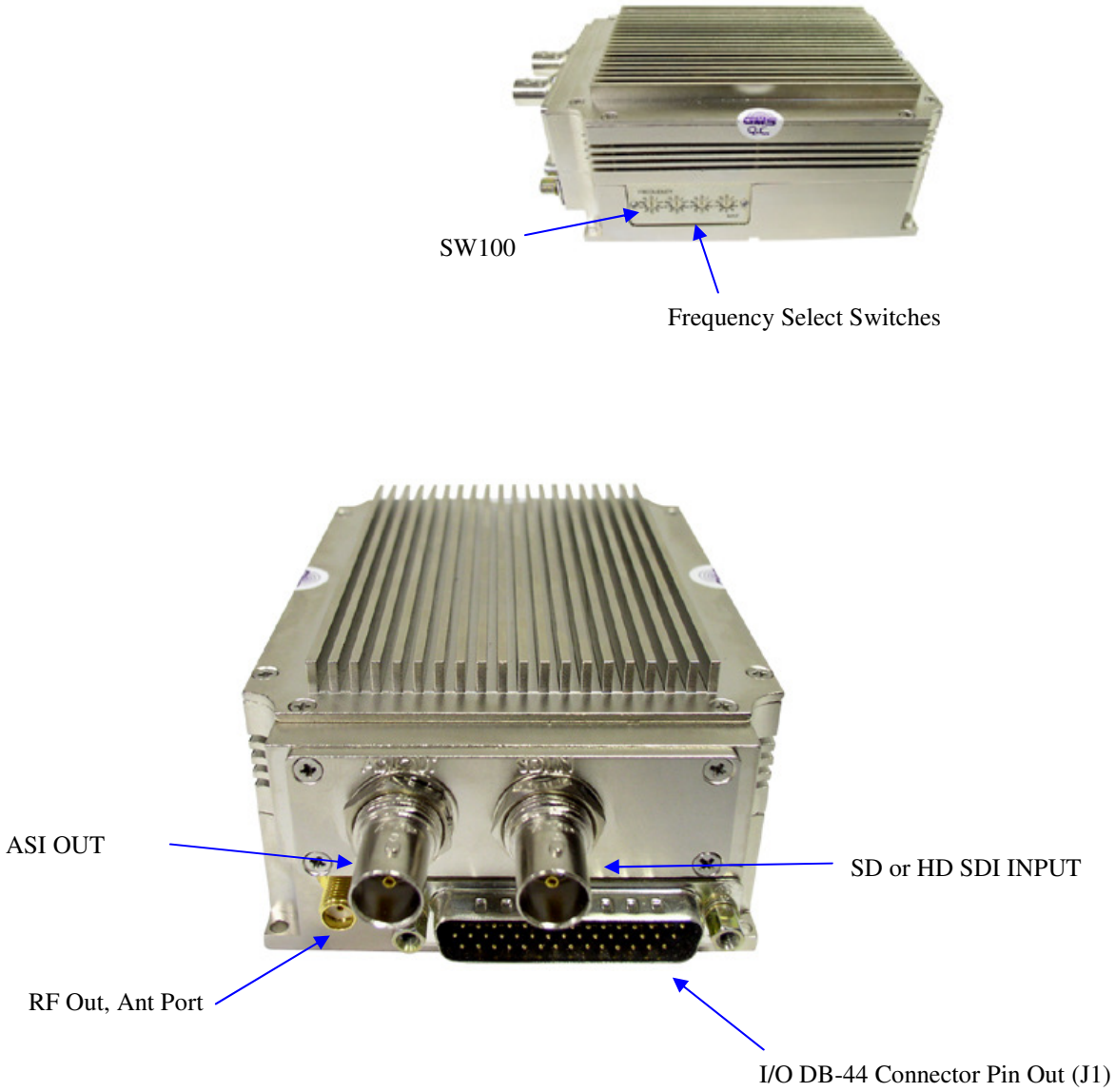


Figure 2 – M2T Connectors

6.1.1 M2T Connectors

There are four connectors located on the M2T unit as shown in Figure 2. They are for interfacing the RF, SD/HD SDI Video, ASI out, audio, component and composite video and Control signals. There are also frequency select switches located on the side of the transmitter also shown in Figure 2

6.1.1.1 RF Output, Ant Port

The M2T uses a female SMA connector for its 'RF Output' port. The antenna is attached here.

Note: Transmitters should not be powered on without a load attached to the RF output. Doing so could damage the internal Power Amplifier (PA).

6.1.1.2 SD/HD SDI

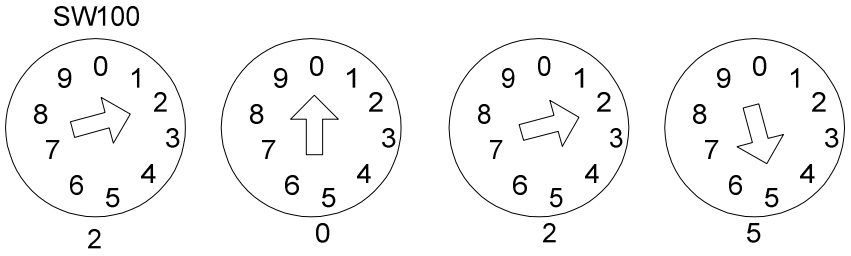
A female BNC connector is provided for SD-SDI or HD-SDI video input streams. The input bit rate is 270 Mbps for SD and 1.485 Gbps for HD.

6.1.1.3 ASI Out

A female BNC connector is provided for DVB-ASI Transport Stream Output. The output bit rate is 270 Mbps. This transport stream does not include the SI tables, User-Data, or AES encryption which is added later in the processing chain.

6.1.1.4 Frequency Select Switches

There are four external rotary switches mounted into the chassis of the M2T (reference Figure 2). They are used to control RF frequency selection. Frequency selection can also be controlled through GMS control software; see section 6. The most significant switch (SW100) represents 1000MHz (0-9) units, the second switch (SW101) represents 100MHz (0-9) units, the third switch (SW102) represents 10MHz (0-9) units and the fourth switch (SW103) represents 1MHz (0-9) units. Hence the highest switch selection can be 9999MHz and the lowest is 0000MHz. For example with the switches in the following positions, the frequency will read 2025MHz.



And with the switches in the following positions the frequency will read 2483 MHz.

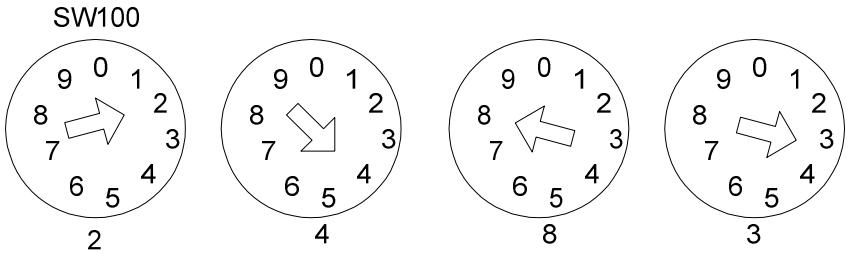


Figure 3 – Frequency Select Switches

6.1.1.5 I/O DB-44 Connector Pin Out (J1)

The 'I/O' connector is a male, high-density DB-44. It is used to provide the interface for external power, audio, analog video and RS-232 signals. The M2T has a separate RS232 channel (labeled "Control" on the external breakout cable) for control and monitoring the unit. GMS M2T Configurator software program (as explained in section 6) makes use of the RS232 control lines. The RS-232 channel utilizes a 3-wire configuration. The pin out for the I/O connector is shown in Table 1. NOTE: A USB connector and an additional RS232 channel (labeled "DATA") are currently provided with the external breakout cable. The USB interface is an alternate method of interfacing to the PC if DB-9 connectors are not available. The "Data" RS232 channel is dedicated for low-rate data to be transmitted along with the audio and video.

Table 1 – Control DB-15 Connector Pin Out

Pin	Signal	Notes
1	RS232 Data Tx	
2	RS232 Data Rx	
3	RS232 GND	
4	Not connected	
5	SDA	I^2 C bus
6	SCL	I^2 C bus
7	CVBS/Y	Dual use input. 1. **Composite video in**; 2. **Luminance in** (when used with S or Component Video). Must be selected with GMS Control Software or through the front panel of the in-line camera mount box
8	GND	GND for composite video
9	C/Pr	Dual use input. 1.**Chroma video** (when used with S-video); 2**. Pr** (red component when used with Component Video). Must be selected with GMS Control Software or through the front panel of the in-line camera mount box.
10	GND	GND for chroma video/Pr component
11	Pb	Blue component when used with Component Video.
12	GND	GND for Pb component
13	GND	GND
14	11-15Vdc	Input power to unit
15	Not connected	
16	USB power, Reset	
17	USB Data -	
18	USB Data +	
19	USB Gnd	
20-29	Not connected	
30	PA_Shut_DN	Provides TTL level [+3V] signal for control of external PA
31	RS232 Control Tx	
32	RS232 Control-Rx	
33	RS232 GND	
34-36	Not connected	
37	Audio right +	
38	Audio right -	
39	Audio right line opt.	Pin 39 is connected to pin 38 for audio right channel input impedance of 600 ohms , balance in (mic or line level)
40	Audio right GND	
41	Audio left +	
42	Audio left -	
43	Audio left line opt	Pin 43 is connected to pin 42 for audio left channel input impedance of 600 ohms; balance in (mic or line level).
44	Audio left GND	

7.0 Software Overview

A PC based application (MS Windows) called the GMS M2T Configurator has been developed to provide in depth control, configuration and monitoring of the transmitter.

This Graphical User Interface (GUI) program provides the end user with a straightforward way to interface with the M2T. During normal operation the M2T Configurator GUI does not need to be active and can be disconnected from the transmitter unit.

7.1 System Requirements

The GMS M2T Configurator program has been developed and tested on Windows 2000, Windows XP and Windows NT. Although the GMS M2T Configurator program may work properly on other operating systems, no support or assistance can be provided with regards to other operating systems.

7.2 Installation

The following instructions outline the installation process for the GMS M2T Configurator program:

1. Insert provided CD-ROM into the computer.
2. View the folders (and files) on the CD-ROM and double click on the 'setup.exe' file. This launches the GMS_M2T Setup program and several initial setup files are copied to the computer.
3. After the initial setup files are copied over, the GMS_M2T Setup program prompts the user to close any applications that are running. Once all other programs are exited, click on the 'OK' button.
4. The GMS_M2T Setup program prompts the user to click on the 'computer icon' button to begin installation. If desired, the user can change the destination directory from the default. Click on the 'computer icon' button.
5. The GMS_M2T Setup program then prompts the user to 'Choose Program Group'. If desired, the user can change the program group from the default. Click on the 'Continue' button.
6. After installing the program, the GMS_M2T_Setup program shows a status window stating that the setup was completed successfully. Click 'OK'.
7. The USB drivers can be installed now. View the folders on the CD and open the USB folder "USB_9052151". Open the file named " AN232-05_how to install.pdf" and follow the step-by-step instructions on how to load the USB drivers.

7.3 M2T Configurator Functions

The M2T Configurator program provides the user access to many different configuration, control and monitoring options. When the M2T Configurator program is launched, the screen shown in Figure 4 is displayed. The user should first select the serial port their computer is connected to via the Serial Port Selector and Status region. Use the pull down menu to select a port. If the selected serial port is valid, the gray-colored status box will show 'Ready'.

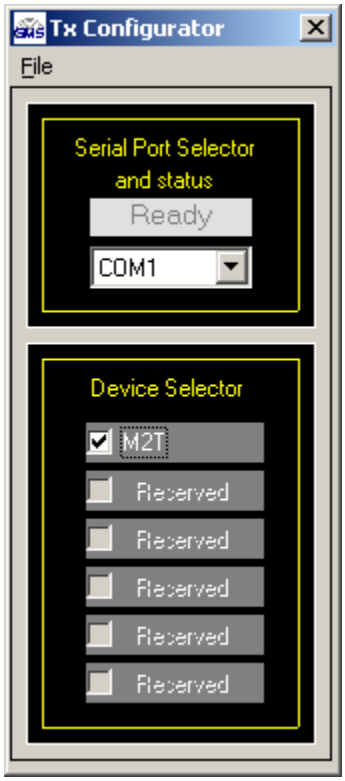


Figure 4 – M2T Configurator Main Screen

The M2T also works with a USB connection (correct drivers need to be loaded which are provided on the CD). The computer maps the USB port to an active RS-232 COM port. You need to check which port the computer has mapped the RS-232 COM port (this may also change each time the transmitter is booted). Check the port by right clicking on “My Computer” icon and select “properties”. Under the “Hardware” tab select “Device Manager” button (you can also get to the same menu from the “Control Panel” under the “Start” button and click on the “System” icon). Then select the “Ports (COM & LPT)”. Under this section the computer shows which port has been mapped to which COM port. Note this COM port and use it when selecting the COM port under the “Serial Port Selector and status” of the M2T Configurator software.

The Device Selector region allows the end user to select from various devices. Presently the existing selections are reserved for future devices. To start the application, select the ‘M2T’ check box in the Device Selector region. Once the box is selected, the opening screen as shown in Figure 5 appears. The M2T Configurator program contains function buttons and configurable settings. The following sections explain, in detail, the various options available.

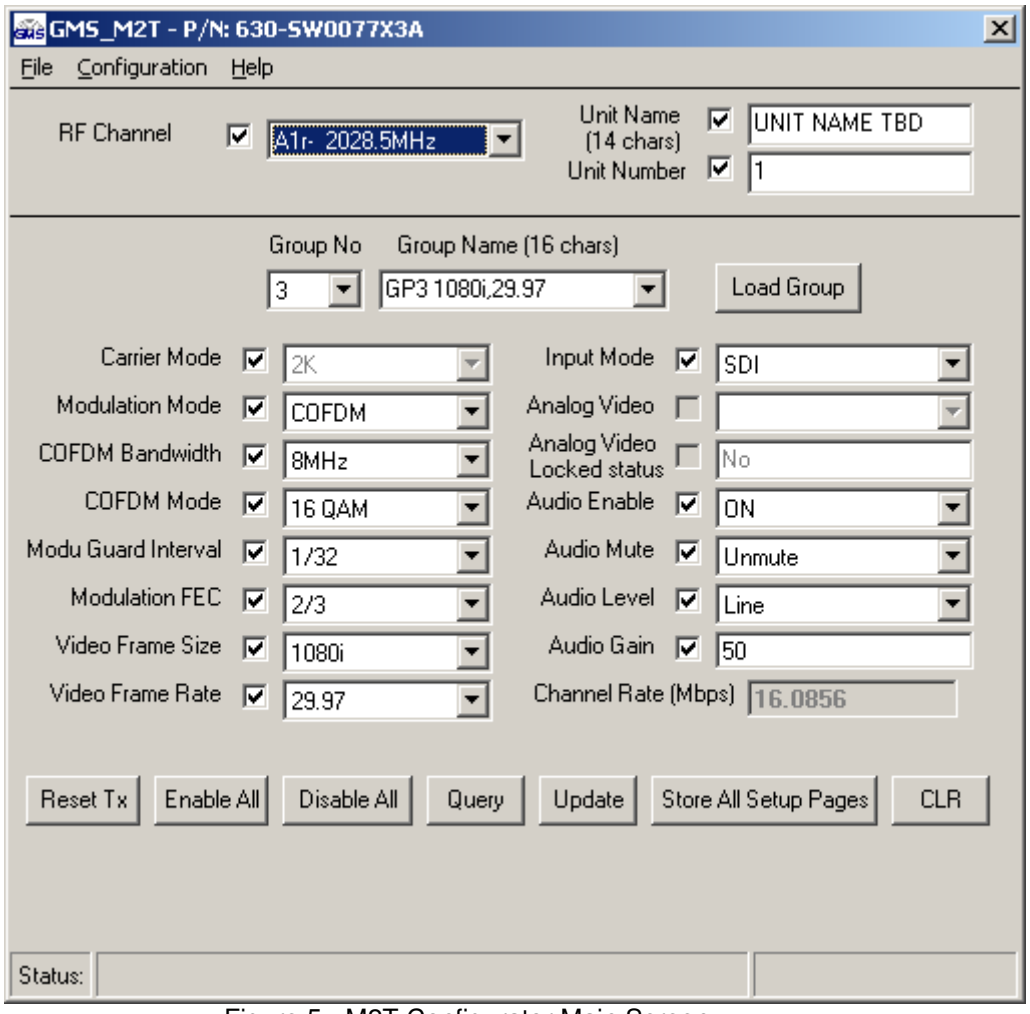


Figure 5 - M2T Configurator Main Screen

7.3.1 Function Buttons

- "**Reset Tx**": Clicking on this button re-boots the transmitter re-initializing the M2T to a known state. Be aware that it may take approximately 30 seconds for the transmitter to fully initialize.

- "**Enable All" Button**: Clicking on this button enables all the check boxes on the screen. This operation is done to prepare all the fields to be written to (or read from). Alternatively, the end user can individually select a given field by using the mouse and clicking its corresponding check box (individual selection of a given field speeds up the read write operations significantly).

- **"Disable All" Button**: Clicking on this button disables all the check boxes on the screen. This operation is done to inhibit all the fields to be written to (or read from). Alternatively, the end user can individually deselect a given field by using the mouse and clicking its corresponding check box.

- **"Query" Button**: Clicking on this button performs a read operation on all the fields that have their check box enabled. Once clicked, all the selected fields will be read back reflecting their current configuration.

- **"Update" Button**: Clicking on this button performs a write operation on all the fields that have their check box enabled. Once clicked, all the selected fields will be written to with the value denoted in their respective field (text box).

- **"Store All Setup Pages" Button:** Clicking on this button stores all setup pages, even if they are not shown.

- **"CLR" Button:** Clicking on this button clears out all fields on the screen, regardless of whether the fields' check boxes are selected or not. This button proves useful when the end user wants to verify that a write operation has been correctly performed. An example scenario would be to 1) enable all fields, 2) change desired field(s), 3) perform an 'Update' (write) operation, 4) perform a 'CLR' operation and 5) perform a 'Query' operation. As a result of the 'Query' operation, the fields on the screen should all update to those values that were written during the 'Update' operation.

- **"Load Group" Button:** The data structure of the M2T is organized into "Groups" of selected fields. A Group contains the following fields (refer to Figure 7 above): ***Carrier Mode, Modulation Mode, COFDM Bandwidth, COFDM mode, Guard Interval, Modulation FEC, Video Frame Size, Video Frame Rate and Input Mode.***

  Clicking on the 'Load Group' button loads the selected Group to be operated on by the M2T. A Group can be selected by selecting Group Name under the pull down text box "Group Name (16Chars)" or by its Group Number under the "Group No" pull down text box.

  ☞ *Note: After selecting a group by either its' group number or group name you must click on the "Load Group" button for the group to take effect.*

  The M2T allows up to 20 group types to be stored in the non-volatile memory each with its' own unique Group name and associated Group Number. The unit is provided with 20 established groups (see appendix C) in which the parameters have been carefully chosen for optimal performance.

  The end user has the ability to change the name of a group (limited to 16 characters), and to change the parameters of the fields associated with a

group. Once the group is saved (pressing the “stored all setup pages”) the default parameters of the existing group are overwritten.

The sequence to change the default parameters of any group or group name is as follows: First load a group by clicking on the “Load Group” button. After the group loads change the parameters as desired (group name can also be changed) and then click on the “Update” button. To save the changes click on the “Stored All Setup Pages” button.

☞*Note: Clicking on the ‘Update’ button only implements any changes made temporary (until the transmitter is re-powered). The ‘Stored All Setup Pages’* must *be clicked on for the changes to be saved and stored permanently.*

7.3.2 Field Definitions

The fields as shown in Figure 5 of the main screen (above) are defined below in Table 2. The Table also indicates if the field is a read or a write field or both.

Table 2 - M2T Field Definitions

Field	R/W	Description
RF Freq (MHz)	R/W	RF output frequency. Desired frequency is entered in MHz (i.e., 1.296GHz would be entered as 1296).
Unit Name	R/W	Allows the user to assign a unique unit name to the M2T.
Unit Number	R/W	Allows the user to assign a unique unit number to the M2T
Group No.	R/W	The number assigned to a specific video group
Group Name	R/W	The name assigned to a specific video group
Carrier Mode	R/W	The number of Carriers within a C-OFDM carrier: Selects 2K carriers per C-OFDM or 4K carriers (optional) per COFDM.
Modulation Mode	R/W	Modulation mode. Desired modulation mode is selected from the following values*:* C-OFDM (default), Off (shuts off modulation) or I/Q CAL ON (puts unit in calibration mode).
C-OFDM Bandwidth	R/W	**C-OFDM** transmit bandwidth. Desired bandwidth is selected from the following values: 6, 7 or 8 MHz in 2K carrier mode or 12, 14 or 16 MHz in 4K carrier mode.
C-OFDM Mode	R/W	**C-OFDM** modulation type. Desired **C-OFDM** modulation type is selected from the following values: QPSK, 16QAM or 64QAM
Mod Guard Interval	R/W	Modulation guard interval size. Desired modulation guard interval size is selected from the following values: $^{1}/_{32}$, $^{1}/_{16}$, $^{1}/_{8}$, or $^{1}/_{4}$
Modulation FEC	R/W	Modulation FEC (Forward Error Correction) rate. Desired modulation FEC rate is selected from the following values: $^{1}/_{2}$, $^{2}/_{3}$, $^{3}/_{4}$, $^{5}/_{6}$, $^{7}/_{8}$.
Video Frame Size	R/W	Video frame size (resolution). “i” stands for interlaced; ‘p” stands for progressive.
Video Frame Rate	R/W	Video Frame Rate in number of frames per second. Only legitimate video frame rates are shown for the

Field	R/W	Description
		selected video frame size.
Input Mode	R/W	Choice between Analog SD video or SDI (serial digital interface). Supports both HD SDI and SD SDI.
Analog Video	R/W	Video input format. Desired video input format is selected from the following values: PAL, NTSC, S-video PAL, S-video NTSC, and Component Video.
Analog Video Locked Status	R	Analog video lock status. This read-only field indicates that the M2T has line-locked onto the SD analog video input signal [*not applicable when the "Input Mode" is set for SD-SDI or HD-SDI*].
Audio Enable	R/W	Analog audio encoder enable. Desired mode of operation of the audio encoder is selected from the following values: Off or On.
Audio Mute	R/W	Choice between mute or un-mute audio stream
Audio Level	R/W	Choice between mic or line level audio
Audio Gain	R/W	Adjustable gain values are adjustable between 0- 100.
Channel Rate (Mbps)	R	Channel rate is displayed in Mbps and is based on parameters selected such as C-OFDM mode, FEC and Guard Interval. *See Channel Rate Guide under the HELP menu.*

7.3.3 Pull-Down Menu Definitions

There are several different pull-down menus that are included in the M2T Configurator program. Each of these pull-down menus contains further user-configurable options or commands. The following sections describe these menus in detail.

7.3.3.1 File

You can exit the program by clicking on the 'X' box in the upper right hand corner or by clicking on the 'File' menu and choosing 'Exit'. You can save the settings before exiting by clicking on the 'Store All Setup Pages' button on the front page or by choosing the 'Save Parameters' under the 'File' menu.

7.3.3.2 Configuration

This pull-down menu (reference Figure 6) contains several different configuration options. These are outlined below:

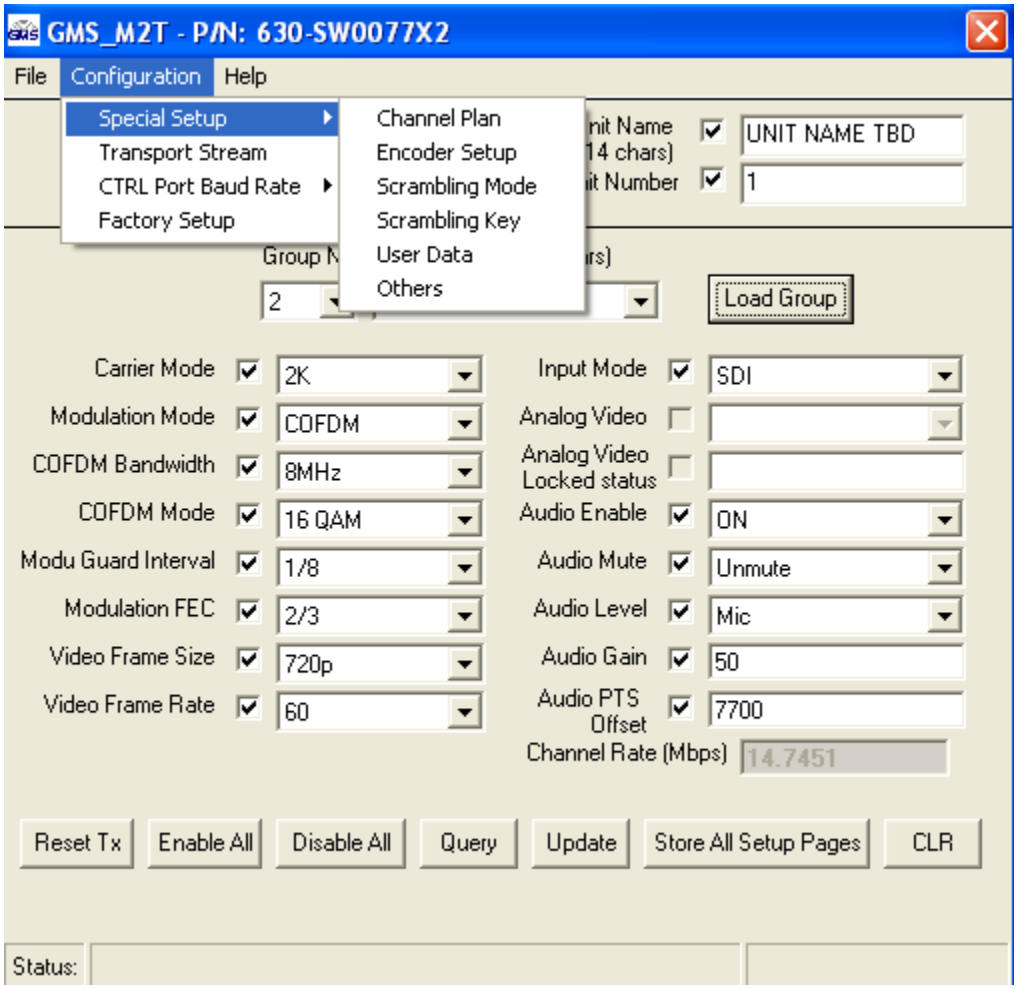


Figure 6 – Configuration Pull Down Menus

7.3.3.2.1 Special Setup

7.3.3.2.1.1 Channel Plan

The Channel Plan default channel mode is NEW BAS frequencies as shown in the opening screen in Figure 7. The RF channel mode selected here is also reflected in the 'RF Freq (MHz)' text box on the front page of the GMS configurator and also displayed on the LCD display under the main menu under the 'TX RF FREQ' display.

- New BAS – (only S2 Band units) this channel plan is pre-determined frequency plan with 30 channels. .

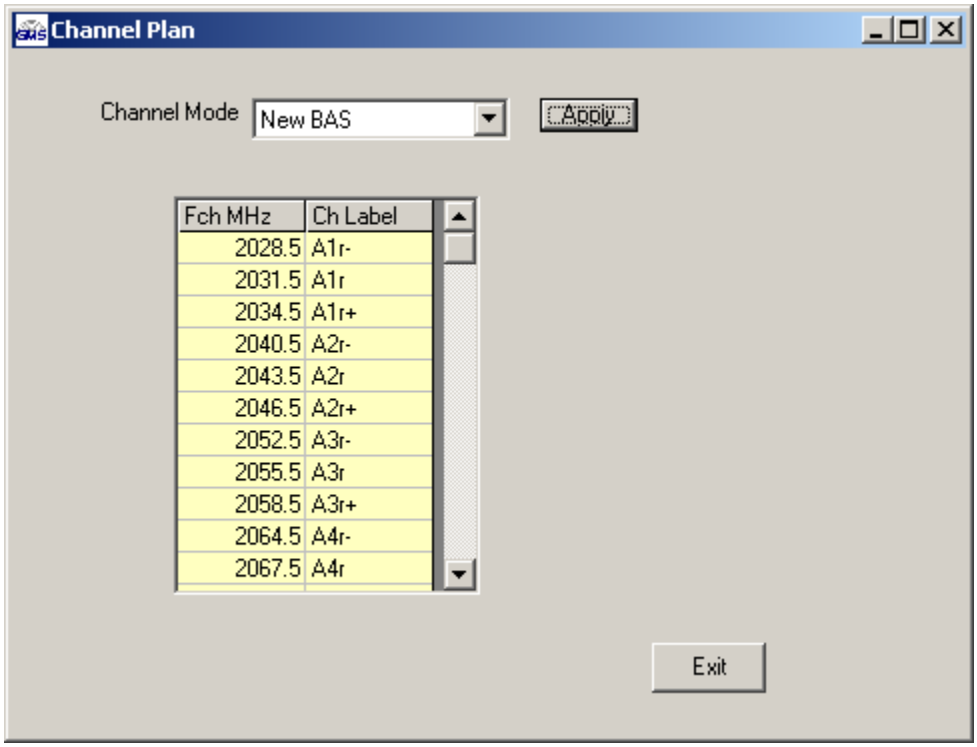


Figure 7 – Channel Plan Opening Screen

7.3.3.2.1.2 Encoder Setup

This pull-down menu (see Figure 9) displays the following choices:

- ***'Encoder Mode' –*** There are two selections from this pull-down menu, 'Tx Encoder' or 'Encoder Only'. ' Tx Encoder' is the default mode in which the transmitter module provides an external clock source for the encoder and the transmitter C-OFDM modulator limits the high end of bit rate to 32 Mbps (64 Mbps using the 4 K high-throughput option).

  When the "Encoder Only" mode is selected an internal clock source (from the encoder module itself) is used as the source. The bit rate is limited to the high end bit rate of the encoder (up to 50 Mbps). The encoder module can be used as a stand alone module encoding rates up to 50 Mbps using the ASI out (J2) port of the M2T. This Transport Stream does not include the SI tables, User-

Data, or AES encryption which is added later in the processing chain.

☞ *Note*: *If the transmitter is suspected of having RF interference the user can test the encoder section of the M2T by attaching a cable from the ASI port (J2) to a decoder ASI input port directly.*

- ***GOP Length -*** *User* can select GOP (Group of pictures) length. Choices include 10, 20, 30, 40 or 50 GOP.
- ***Video Delay Mode –*** User can select from three different delay modes involving different trade offs:
  Normal – this mode is the default, gives the best picture but the delay is longer than the other two modes.
  Low – this mode is faster (less delay) however the picture quality is not as good as Normal mode.
  Ultra-Low – this mode which can only be used with GMS HD decoder offers the fastest, < 44mS system latency (future upgrade).
- ***Additional Video Delay (frames)***
  Additional video delay (in units of frames) from 0 to 500 can be added.
- ***Additional Audio Delay (frames)***
  Additional audio delay (in units of frames, fractional quantities allowed) can be added.

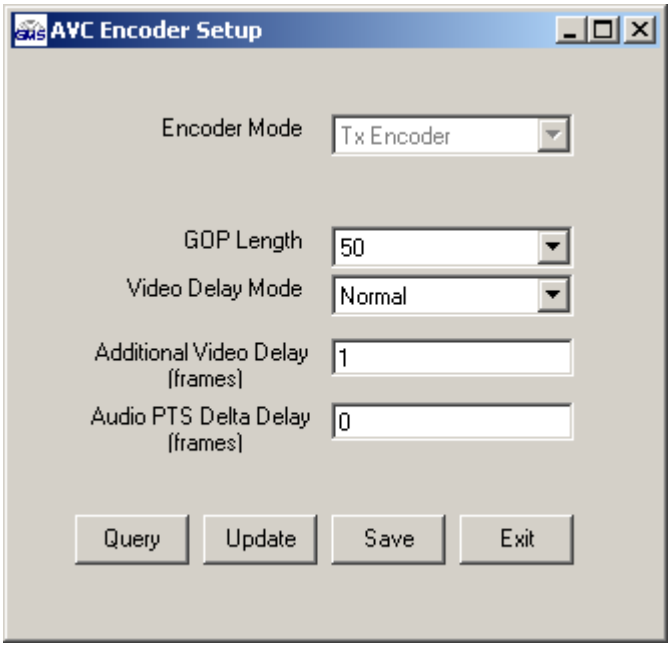


Figure 9 - HD Setup

7.3.3.2.1.3 Scrambling Mode (Optional)

Scrambling Mode (this menu may not be available if the option has not been purchased) This option requires GMS DDPC card with AES option on RX side– The "Scrambling Mode" pull down text box offers three choices (see Figure 10):

- ***OFF-*** Scrambling (Encryption) turned off (disabled).
- ***AES, Never Store the key in the TX –*** Scrambling is turned on (Enabled). When scrambling is turned on, a key code (a series of 32 Hex characters) must be entered. Entering the key code is discussed in the following section under 'Scrambling Key'. In this mode the key code is not stored in the transmitter's memory. When power is removed the key code will be lost and must be re-entered when power is re-applied. The same key code must be entered in the DDPC of the MSR. See DDPC manual 100-M0070**.
- ***AES, Store the key in the Tx*** – Scrambling is turned on (Enabled). In this mode the key is stored in the transmitter's memory. When power is removed the key code will not be lost.
- ***Query*** – Clicking this button performs a read operation which will read back the current scrambling mode configuration.
- ***Apply –*** Clicking this button will perform a write operation of the selected mode.
- ***Exit -*** Exit the scrambling mode

.

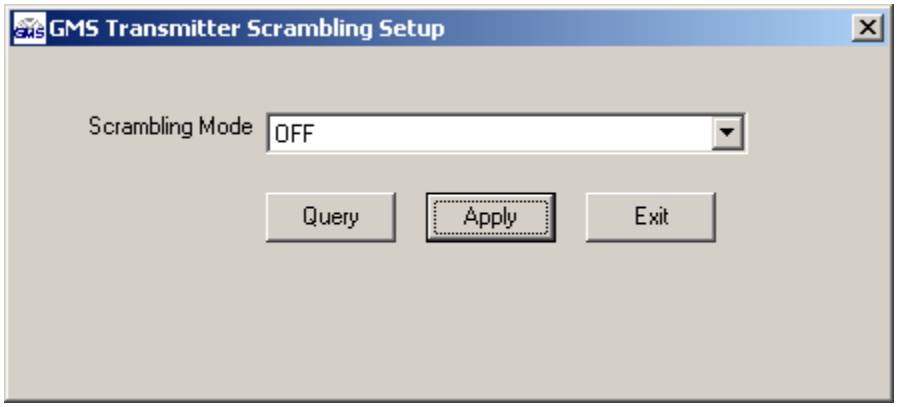


Figure 10 – Scrambling Set-Up

7.3.3.2.1.4 Scrambling Key (Optional)

Scrambling Key (this menu may not be available if the option has not been purchased) – This menu displays the following (see Figure 11):

- ***Enter Scrambling Key from Keyboard –*** The 32 character key code can be manually entered from the keyboard. The characters must be Hex numbers. When the numbers have been typed use the Apply button to initialize the code.
- ***Load Scrambling from a file –*** The key code can be selected from a file. The browser button can be used to search thru the Directory for a file containing the key code. Once a path has been established it can be saved using the Save Path button. The Load Key from File is used to retrieve a key code from a file as specified by the path. Use the Exit key to close this window

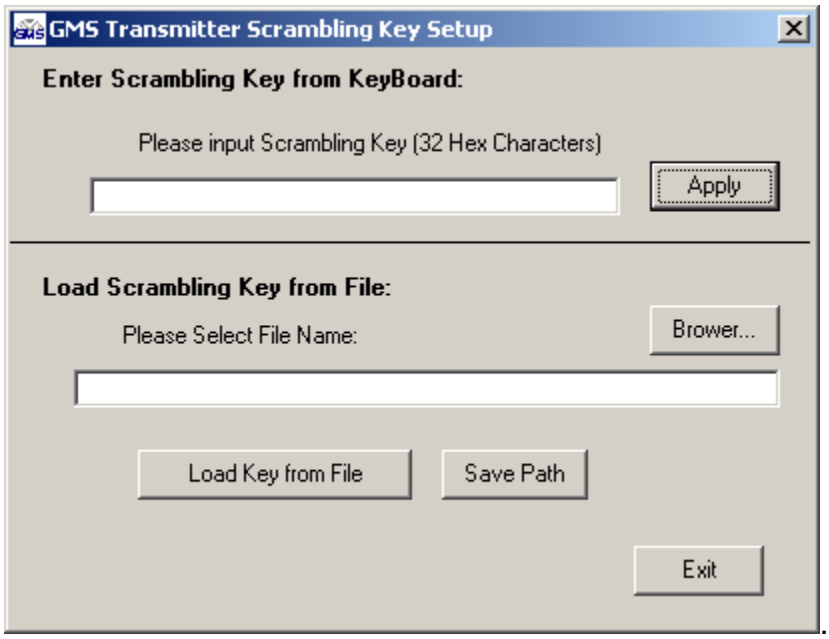


Figure 11 – Scrambling Key Set-Up

7.3.3.2.1.5 User Data (Optional)

User Data (this menu may not be available if the option has not been purchased). This option requires GMS DDPC card with AES option on RX side.

M2T transmitters with 'User Data' option can simultaneously transmit video/audio and ASCII user data. Baud rates up to 38400 (encoder dependant) are supported. Input ASCII data is injected into the 'Data' port of the transmitter using the format: 8 data bits, no parity, 2 stop bits (when transmitting continuous data) and no flow control. Received user data is taken from the GMS MSR receiver on the DDPC RS232 User data port.

This pull down menu displays the following (see Figure 12):

- **User Data Baud Rate:** Baud rate is selected with this pull down box. High end baud rate is limited to 38400.
- **User Data PID:** If 'OFF' is selected 'User Data' is disabled. When 'Insert User Data' is selected 'User Data' is enabled. Default PID is shown in text box in which user can change, however note that PIDs are limited to the range 0x0001 – 0x1FFF, and the receive side user data PID must match this PID.
- **Reset Tx:** Clicking on this button resets the transmitter to a known state. Transmitter needs to be reset after changing user data PID.
- **Update**: When any change is made, baud rate selection, new PID, etc, click on the 'Update' button so that the changes take effect.
- **Exit:** Clicking on this button exits the window.

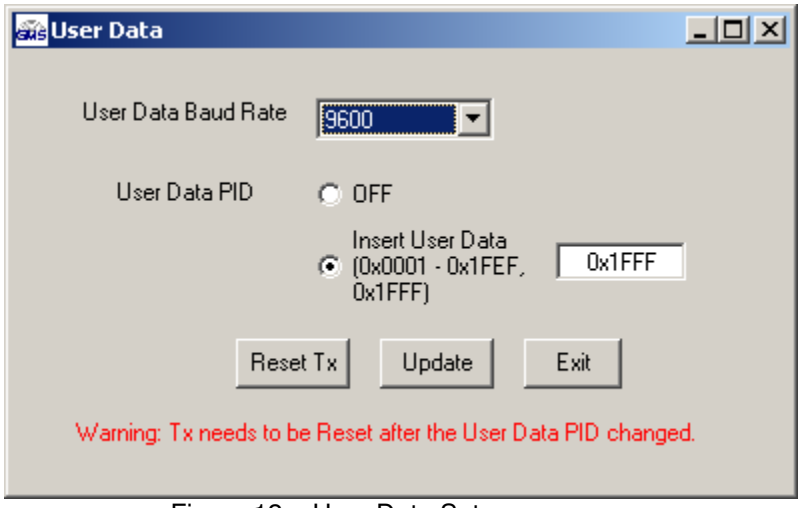


Figure 12 – User Data Setup

7.3.3.2.1.6 Others

This menu displays the following (see Figure 13)

- ***RF Output Att (0dB – 7dB)*** **–** The RF output can be attenuated in 1 dB increments up to a frequency band defined maximum.
- ***C-OFDM Spectrum Inversion*** **–** Choices include normal or inverted. The transmitter is configured with the receiver it ships with and the inversion mode does not require changing. However if a different receiver is used the inversion mode may be required to be changed. Some receivers will accept either inversion modes.
- ***Sleep Mode*** **–** Can be used to put the transmitter in a sleep mode, where the encoder functions and many of the power regulators are shut down enabling a saving in current (approx. 40%) when the transmitter is not active.

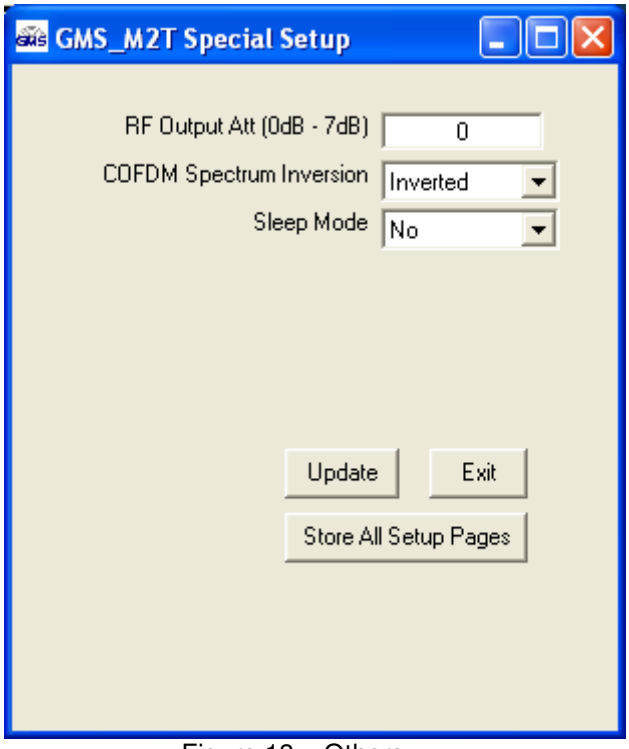


Figure 13 – Others

7.3.3.2.2 Transport Stream

The transport stream menu (reference Figure 14) displays the parameters of the current transport stream (of the transmitter). The fields are read/write-able. Normally the fields require no manipulation and should work quite well as defaulted from the factory. However, high end users may have a need to change the transport stream parameters.

7.3.3.2.3 Ctrl Port Baud Rate

The control port baud rate menu allows different baud rates to be selected. Some computers may need the baud rate adjusted for optimal communications.

7.3.3.2.4 Factory Setup

Factory Setup – The menu is for factory use only.

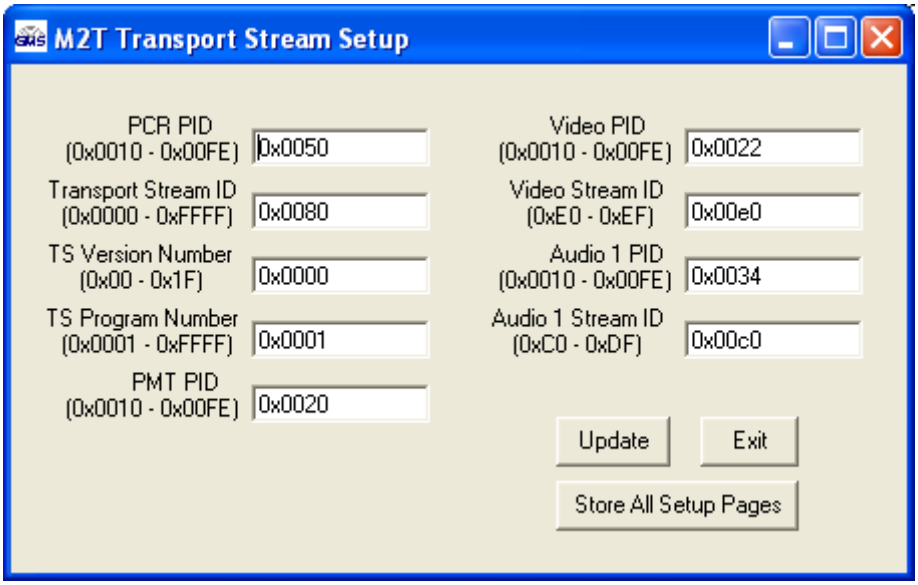


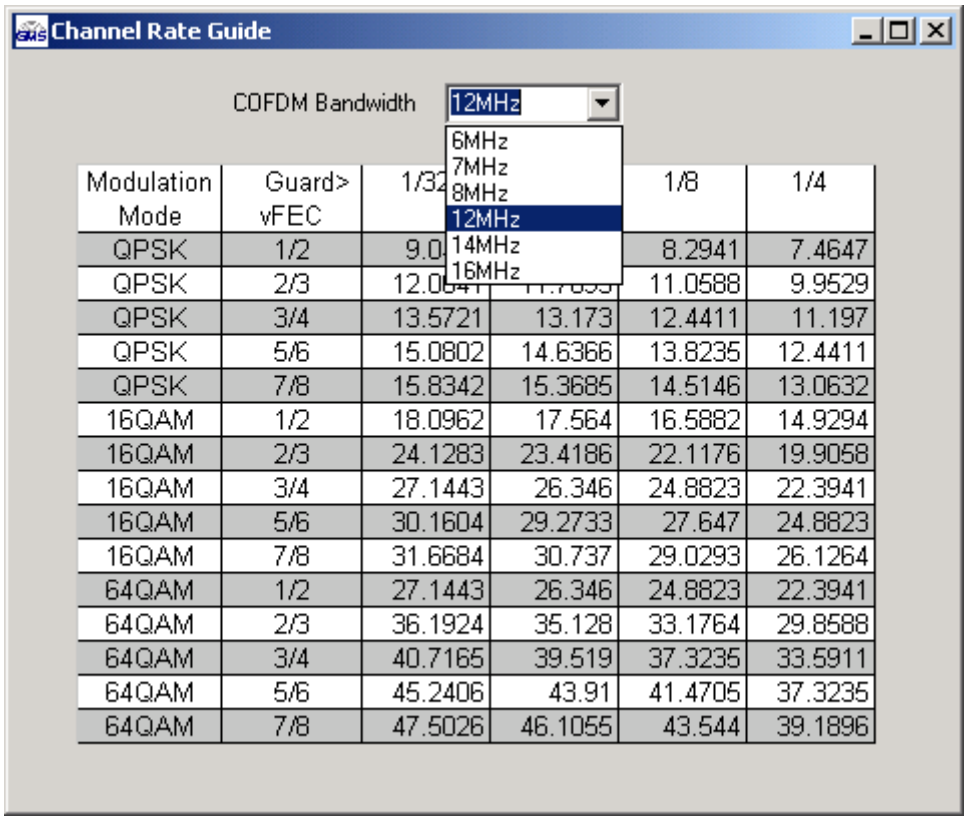
Figure 14 - Transport Stream Setup

7.3.3.3 Help

This pull-down menu contains information about the M2T firmware and the M2T Configurator software. This information is outlined below:

- ***Channel Rate Guide***: This selection pulls up a table that displays the relationship between the Modulation mode, Modulation Guard Interval and FEC mode resulting in the bit rate displayed in 'Mbps'. For example with a modulation mode of 16 QAM, a guard interval of 1/8 and a FEC of 2/3 the bit rate displayed is 14.745 Mbps. Table values will change depending on COFDM Bandwidth selected. See Figure 15.

- ***FW version***: This selection pulls up a window that displays the M2T unit serial number and current versions of firmware. See Figure 16.
- ***About***: This selection pulls up a window that displays the Version Number of the M2T Configurator program. See Figure 17.



Modulation Mode	Guard> vFEC	1/32		1/8	1/4
QPSK	1/2	9.0		8.2941	7.4647
QPSK	2/3	12.0		11.0588	9.9529
QPSK	3/4	13.5721	13.173	12.4411	11.197
QPSK	5/6	15.0802	14.6366	13.8235	12.4411
QPSK	7/8	15.8342	15.3685	14.5146	13.0632
16QAM	1/2	18.0962	17.564	16.5882	14.9294
16QAM	2/3	24.1283	23.4186	22.1176	19.9058
16QAM	3/4	27.1443	26.346	24.8823	22.3941
16QAM	5/6	30.1604	29.2733	27.647	24.8823
16QAM	7/8	31.6684	30.737	29.0293	26.1264
64QAM	1/2	27.1443	26.346	24.8823	22.3941
64QAM	2/3	36.1924	35.128	33.1764	29.8588
64QAM	3/4	40.7165	39.519	37.3235	33.5911
64QAM	5/6	45.2406	43.91	41.4705	37.3235
64QAM	7/8	47.5026	46.1055	43.544	39.1896

Figure 15 - Channel Rate Guide

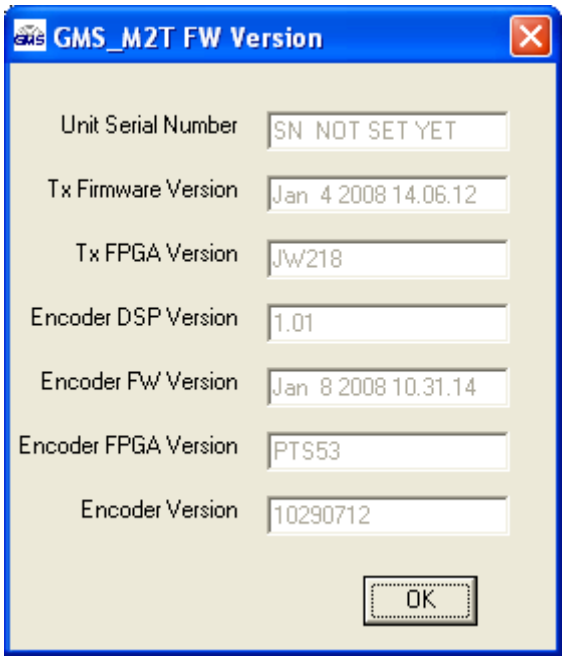


Figure 16 – FW Version

Figure 17 – About Box

8.0 Specifications

The following sections outline the overall specifications for the M2T unit.

8.1 Video Encoding (HD)

Interfaces: HD-SDI (1.4875Gbps)
Standards: SMPTE-274M, -293M, -294M, -296M
Compression Standard: AVC / h.264 (per ISO/IEC 14496-10)
Motion Est. Range: +/-192 Horiz., +/-128 Vert.

Video formats/resolutions supported:

Format	Resolution @ Frame Rate
1080i	1920x1080i @ 23.96/24/25/29.97/30 fps
1080p	1920x1080 @ 23.96/24/25/29.97/30 fps
720p **	1280x720 @ 50/59.94/60 fps
480p	720x480 @ 59.94/60 fps

Variable GOP Structure: I-only and IP
Profiles: **supported** BP@HL
****Video bit rates:** HDTV to 50Mbps
*****System Latency:** <44mS(Ultra-Low Mode using GMS decoder)
Connector: BNC-F

8.2 Video Encoding (SD)

Interfaces: SDI, Component, Composite or S-Video
Standards: SMPTE-292M
Compression Standard: AVC / h.264
(Per ISO/IEC 14496-10)
Motion Est. Range: +/- 192 Horiz., +/- 128 Vert.
Video format standards: NTSC or PAL

Format	Resolution @Frame Rate
576i	720x576 @ 25/29.97 fps (PAL)
480i	720x480i @ 25/29.97 fps (NTSC)

Variable GOP Structure: I-only and IP
Profiles: BP@ML
****Video bit rates:** to 50 Mbps
***** System Latency:** <44mS (Ultra-Low Mode using GMS decoder)
Connectors: p/o DB-44

8.3 Audio Encoding

Analog Audio: Dual, Line-Level or Mic-Level, Differential or Single-Ended, Clip Level 12dBm
Input Impedance: 600 Ohms (Line)
2K Ohms (Mic)
Standards: SMPTE-272M, -299M

Digital Audio: Embedded 2 CH (future update)
Compression Standard: MPEG layer II
Audio Enable: On or Off
Bit Rates: 256 kbit/s/ch
Sampling Frequency: 32kHz, 44.1kHz or 48kHz
THD: < 0.1% maximum
Response: 20Hz to 20kHz, +/- 0.25dB
Crosstalk: >55dB minimum
S/N: >60 dB RMS
Connector: XLR-F (Qty 2)

8.4 Transport Stream

Standard: per ISO/IEC 13818-1
Packet Size: 188 byte
Bit Rate: Automatically set from active service settings.
ASI output
ASI Input (future upgrade)
Connector: BNC-F

8.5 Control

Local frequency control is provided on housing. The M2T can be fully controlled through either the RS-232 or USB-1 control ports via a MS Windows based control application (sold separately). A Remote Control Unit (RCU) is also available for either local or remote control.

8.6 COFDM RF Output

Output Frequency: 2025-2110 MHZ, 2450-2483.5 MHZ [D3 BAND]
Bandwidth: Selectable 6, 7 or 8 MHz Standard
6, 7, 8, 12, 14, 16 MHz Optional*
RF Output Power: Standard **-** Up to 200mW
2W available for L/S Band
Connector: SMA-F

Note: Transmitters should not be powered on without a load. Doing so could cause the output PA to stop working. A proper heat sink is also required.

8.7 Modulation

Modulation Type: C-OFDM w/ QPSK, 16QAM or 64 QAM

8.8 Standard DVB-T Compliant

FEC: $^{1}/_{2}$, $^{2}/_{3}$, $^{3}/_{4}$, $^{5}/_{6}$, $^{7}/_{8}$
Guard Intervals: $^{1}/_{32}$, $^{1}/_{16}$, $^{1}/_{8}$, $^{1}/_{4}$
Spurious: 50dBc
Number of C-OFDM Carriers: 2k

8.9 High Throughput Option

FEC: $^{1}/_{2}$, $^{2}/_{3}$, $^{3}/_{4}$, $^{5}/_{6}$, $^{7}/_{8}$
Guard Intervals: $^{1}/_{32}$, $^{1}/_{16}$, $^{1}/_{8}$, $^{1}/_{4}$
Spurious: 50dBc
Number of C-OFDM Carriers: 4k Carriers

8.10 Power

DC Input Voltage Range: 9 to 15 VDC
Power Consumption: 18 Watts SD Mode
22 Watts HD Mode
Power supplied through DB-44 connector.
(DB-44 pins 14, +Vcc, Pin 13 GND)

8.11 Environmental

Operational Temperature: -10 to +65 °C
(***EXTERNAL COOLING REQUIRED***)
Humidity: Up to 100% (non-condensing)

8.12 Physical

Dimensions (less connectors): 3.25” (W) x 4.5” (D) x 1.95” (H)
8.26 cm x 11.43 cm x 4.95 cm
Weight: 13.4 oz (380.5 grams)

8.13 Physical Interfaces

RF Antenna Port: SMA-F
ASI Out: BNC-F
SDI/HDSDI Input: BNC-F
Control/Audio/Power/Component&CompositeVideo : DB-44F

8.14 Scrambling Option

Type: 128 Bit Advanced Encryption Standard (AES)
Key Storage: User Controlled, Local or Remote
Implementation: Everything except TS Header
Requires: DDPC with AES Option on RX side

8.15 User Data Option

Protocol: RS232C, Asynchronous, 8 Bits, No Parity, 2 Stop Bits (when sending continuous data).
Data Rate: Selectable, Up to 38.4 kBaud
User Data PID: Selectable
Connector: p/o DB-44 F
Requires DDPC with AES Option on Rx Side

* With 4K High-Throughput Option
** C-OFDM modulator limits high end of bit rate to 32 Mbps or 64 Mbps*.
*** End to End System Latency Delay is Decoder Dependent

9.0 D/C (Down Converter) IF frequencies explained

9.1 IF Frequencies

- MSR receivers (and many other digital receivers) are capable of receiving direct frequencies in the range of approximately 49MHz to 861MHz. If the transmitter is not in this range then a down-converter (also refer to a BDC, block down converter) is used to convert the frequency to this range. The frequency out of the down-converter is called the IF (intermediate frequency) which is fed to the receiver.

  Down-converters have a LO (local oscillator) which is mixed with the transmitter frequency (M2T) and converts it to the IF frequency. MSR receivers need to know the LO (local oscillator) of the down-converter and the RF frequency of the transmitter. It then automatically calculates the IF frequency. The IF frequency changes as the RF frequency changes however the LO remains constant.

On non-GMS receivers it may be necessary to program the receiver with the IF frequency directly. The user may have to do the simple math to arrive at the IF frequency so that it can be entered into the receiver. ***The down-converter LO must be known***. The math involve is as follows: "LO – transmitter frequency (or transmitter frequency – LO) = IF frequency". For example, it the transmitter is set for 2000MHz and the LO of the down-converter is 2800MHz then the IF frequency is 800MHz (2800-2000 = 800). The receiver will need to be set to 800MHz to receive the transmitter frequency of 2000MHz. Each time the transmitter frequency is changed the IF must be re-calculated and entered into the receiver. It must also be mentioned, as you may have noticed with the equation "LO-transmitter frequency or transmitter frequency – LO" that two answers are possible. For example 2800-2000 = 800 or 2000-2800 = -800. The negative answer may indicate the receiver wants the signal to be inverted. See section 6.3.3.2 for inverting the signal.

9.2 Local and Remote Power for Down Converters

Customers have the option of using remote or local power:

- Remote power is provided from the MSR through the BNC connector from each of the tuners located on the rear panel. Power is turned on through the software control application (refer to the MSR online manual). The +12Vdc provided from the receiver will travel through the coax cable to the D/C.

  If the D/C is located relatively close to the receiver then using remote power makes sense. However, if the D/C is located at great distances away from the receiver there may be excessive DC voltage drop in the coax cable (due to cable resistances). If this is the case then local DC power should be considered as discussed below. If unsure of the DC voltage drop measure the DC voltage present

(using a DMM) at the end of the coax cable run. The D/C normal operating voltage is approximately +12Vdc but can operate down to +10Vdc.

- Local power is provided by applying +12Vdc to pin 1, GND to pin 3 of the DB-9 connector located on the bottom of the D/C. The +12 Volt power supply must be able to source at least 500mA. The power switch (located on the side of the D/C) enables the user to control the 'ON'/'OFF' positions for local power. If using local power then the remote power should be set to "OFF".

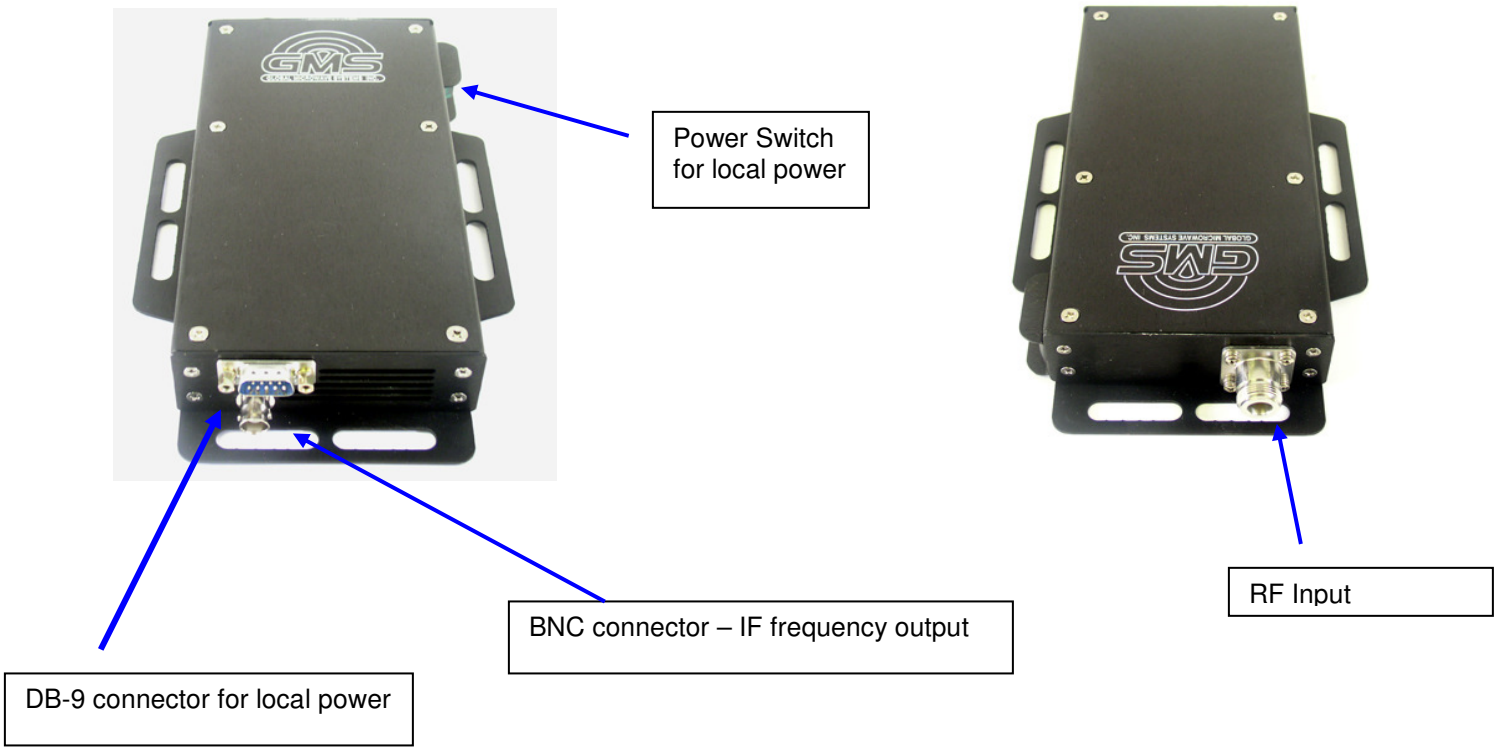


Figure 18 - BDC Connectors

Table 3 - DB-9 Connector Pin Out for the D/C

Pin	Signal	Notes
1	+12Vdc	Power supply must be able to source at least 500mA. Voltage should not drop below +10Vdc.
3	GND	Power ground
2, 4-9	NC	Not Connected

10.0 Cable Losses

10.1 Coax Cable

Cable losses must be taken into consideration if the D/C is located a great distance from the receiver. As mentioned above long cable runs can contribute to more resistance in the lines and also can contribute to signal attenuation because of the additional capacitance. Even when using a good coax cable such as RG59/U the attenuation of the signal can be significant. For example, RG59/U coax will drop approximately 2dB per 100 feet at 50MHz and 8dB per 100feet at 900MHz. The intermediate frequency (IF) in this system can fall between 49MHz to 850MHz. An inline amplifier matching the cable losses should be considered if losses exceed 6dB.

Appendix A - Product outline and mounting documentation

Appendix B – Cable, M2T External Breakout Cable

Appendix C – Default Groups

GP0 1080i, 23.98
GP1 1080i, 24
GP2 1080i, 25
GP3 1080i, 29.97
GP4 1080i, 30
GP5 1080p, 23.98
GP6 1080p, 24
GP7 1080p, 25
GP8 1080p, 29.97
GP9 1080p, 30
GP10 720p, 59.94
GP11 720p, 60
GP12 576i, 25
GP13 576i, 29.97
GP14 480i, 25
GP15 480i, 29.97
GP16 480p, 59.94
GP17 480p, 60
GP18 NTSC Comp