Operational Description of GMS's M2T D3 band Microwave Transmitter

INTRO:
GMS's M2T is a very compact 200mW (average power) transmitter which provides a robust video, audio and RS232 data wireless link by using Coded Orthogonal Frequency division Multiplexed (COFDM) digital modulation that makes use of frequency diversity and powerful Forward Error Correction (FEC) algorithms. Typical applications include Electronic News Gathering (ENG), sports, helicopter links, UAV/UGV applications and studio wireless links. Key system features include a built in MPEG-4 encoder, AES scrambling option, low system latency (40mS), ASI, SDI, component and s-video interfaces.

The M2T consists of two main sections, the Audio/Video Encoder module along with its power supply/SDI interface (a two card set) and the MDT-3 card. The MDT-3 card handles overall control & monitoring (via a microcontroller), analog audio & video decoding (conversion to digital), FEC & C-OFDM modulation and all the RF generation. Refer to 100-B0086X1 Block Diagram. All output and control signals are generated on the MDT-3 Card.

Power Supply:
The M2T transmitter accepts the nominal input voltage of +12 VDC (input range is from +10.5 VDC to +15 VDC) through the DB44 pin connector pins 13 (GND) and 14 (+12 VDC) and is routed to connector J100 (of the MDT-3 card set) and to connector J102 of the audio/video encoder power supply card set.

With respect to the MDT-3 card set, +12VDC entering at J100:

Reverse polarity protection is provided by diode D100. The +12 VDC is stepped down, using a dc/dc controller U100, to + 3.3D and +1.5D to provide power for most of the digital ICs. In addition the +12 VDC is routed to IC U203 where it is subdivided down to +5VD and using IC regulators U204 and U205 to +5VA and -5VA. The +5 VA and -5VA are used for biasing the audio amplifiers U1000 and U1001. The +5VD is used to power IC U605 the USB to RS232 converter. In addition the +5VA is used for biasing some of the RF ICs such as U401, U400 and U501. It is also used to power the COFDM modulator U301 and the I/Q DAC U300 and is further subdivided down to +3.3VA_SYN providing power to the U302 synthesizer.

With respect to the audio/video encoder power supply card, +12VDC entering at J102:

Reverse polarity is provided by Q400A, Q400B, D402 and Q401. The +12 VDC is stepped down to +5VDC using regulator U402 and then further sub divided into the following voltages using a dc/dc controller IC U500 LTC3773EUHF, 1.2 VDC, 1.8 VDC, and 3.3 VDC. The 3.3 VDC is routed to regulator U600 to produce a 2.5 VDC and to U601 to produce a 0.9VDC

Total current consumption at +12VDC is approximately 1.7A

Video Processing:
The MDT-B accepts either analog component, s-video, or composite video through a Video Decoder (Digitizer) on the MDT-3 card or Digital Video through the SDI (serial digital interface) via the AVC Encoder Module. It can also accept DVB-ASI streams (asynchronous serial interface) for re-transmitting through the same SDI interface. The analog video baseband (component, s-video, composite) which enters the MDT-3 card (transmitter) through the DB44 pin connector is converted into digital component video (U700, TVP5145) and sent to the MPEG-4 encoder (700-A0864) for encoding. The SD/HD video in SDI format enters the audio/video power supply board (700-A0865) SDI interface and is de-serialized and then sent to the MPEG-4 encoder for encoding. The encoder compresses the video according to MPEG-4 specifications and then it multiplexes the video (along with audio, see Audio Modulation) and forms a transport stream. The transport stream is sent back down to the MDT-3 (transmitter) board (700-A0750) where the logic circuits (U900) convert the information to I/Q data.

Audio Processing:
The M2T is supplied with one audio channel (two inputs) which is capable of balance dual channel, or stereo (mic or line level). Analog audio is applied to the transmitter DB44 pin connector pins 37 through 44. It is then amplified using ICs U1000, U1001, U1003 and U1002. The audio is then digitized to an I2S format using IC U1004 and the logic circuits of the FPGA, U900. From there it is sent in I2S format to the AVC encoder board (700-A0864). The encoder compresses the audio using MPEG Layer II compression. It is then multiplexed with the video and forms a transport stream. The transport stream is sent back down to the MDT-3 board and is routed through the logic circuits where it converts it to I/Q data. The I/Q data modulates the COFDM modulator (U301) and the modulating LO is then amplified and transmitted.

Frequency LO Creation (on MDT-3 Card 700-A0750):
The entire RF generation and processing chain is designed in an isolated section of the MDT-3 card to reduce noise coupling from the digital circuits. The synthesizer is the first step in generating the RF signal. It produces a clean sine wave at the center frequency of the C-OFDM signal which can be tuned at 250 KHz steps in this band. PLL frequency synthesizer U302 forms the basis for the main frequency carrier. The differential LO (from the PLL synthesizer) is fed to the COFDM modulator (U301). A 48 MHz clock oscillator (Y300) provides the reference in for the PLL. The modulated digital output from the COFDM modulator is amplified through the RF chain (see RF amplification section) and transmitted.

Frequency selection is determined either by the position of the selector switches (4 ea located on the side panel, S1- S4) which the microprocessor (U702) reads or by using the GMS RS232 configurator software program. This information is fed back to the PLL IC U302.

I/Q Modulation (on MDT-3 Card):
GMS uses direct IQ modulation in all of our transmitters. This eliminates any harmonics or spurs related to the Hetrodyne Process. The LO is fed into an analog I/Q Modulator (U301) via a transformer. The C-OFDM modulation is digitally created in an FPGA and the I/Q baseband 14 bit digital signals are passed to a Dual DAC (U300) which creates the analog I & Q signals. These signals are filtered and level shifted prior to being applied to the I/Q Modulator. The modulated signal from the Modulator, which can be 8 MHz, 7 MHz or 6 MHz bandwidth, is sent to a programmable attenuator.

Level Control (on MDT-3 Card):
Refer to 100-SO370 sheet 5. The output power is controlled via U500 a 5-Bit Digital RF Attenuator providing 31 db of attenuation. Fine adjustments of the output power can be accomplished through the peak to peak level of the I/Q baseband signals from the FPGA. See previous Section. U500 is used both for calibration of the output signal level over the tuning bandwidth of the transmitter, automatic 3 dB back-off in 64 QAM operating mode and for User attenuation of the output signal (up to 10 dB). GMS's calibration approach takes the tuning range of the transmitter and divides it into 20 segments. Calibration is performed via ATE at the center of each of these frequency segments and the calibration setting is stored in non-volatile memory in the transmitter. When the transmitter is tuned to any frequency within a specific segment, the calibration settings for that segment are applied to both the RF attenuator and the I/Q modulation. A 10 dB range is reserved for User Controlled Attenuation and an automatic -3dB back-off to improve shoulders in 64-QAM operation. Note that the digital control lines leading to the RF Attenuator are filtered to eliminate Digital noise. The output of the RF Attenuator is sent to the Amplifier Chain.

RF Amplification (on MDT-3 Card):
Refer to 100-SO370 sheet 4 & 5. The signal is amplified three times, through U501 and U400, which are 19 dB gain broadband amplifiers and then through U401, a power amplifier with 28 dB of gain.

RS232 User Data:
The MDT-B transmitter has the capability of transmitting low speed RS232 data, rates up to 38.4 kBaud. User data enters on the DB44 pin connector pins 1 through 3. The User Data is then placed into the transport stream after it returns from the MPEG-4 encoder board through the TS (transport stream bus) interface board down to the transmitter board. This is done in the logic circuits of the FPGA U900 on the transmitter board (700-A0750). From here, as stated under Video and Audio modulation, the logic circuits convert this information to I/Q data which modulates the COFDM modulator. It is then amplified and transmitted (see RF amplification section). This option requires the receiver system to use a GMS Digital Data Processing Card.

AES Encryption:
MDT-B transmitters have the ability to scramble the transport stream with the optional AES scrambling system which provides secure protection in sensitive applications. This option also requires the receiver system to use a GMS Digital Data Processing Card.