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TIMTER™ Multi-mode Digital Telemetry Transmitter

Installation and Operation Manual



Quasonix, Inc.
6025 Schumacher Park Dr.
West Chester, OH 45069
10 December 2018

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1 Introduction

1.1 Description

This document describes the Installation and Operation of Quasonix' TIMTER™ T3 Multi- mode Digital Telemetry Transmitters. The transmitters are designed to transmit airborne telemetry data from a test article to ground stations. The transmitters are developed, manufactured, and supported by:

Quasonix, Inc.
6025 Schumacher Park Drive
West Chester, OH 45069
CAGE code: 3CJA9

1.2 Nomenclature

The earliest models of these transmitters were referred to as Tier I Missile Test Transmitters (TIMTER™) because they were intended for missiles and offered only ARTM Tier I (SOQPSK) modulation. Although the model line now includes much more than ARTM Tier I, and they are in widespread use on many platforms besides missiles, the "TIMTER" name remains. Now in its third generation and commonly referred to as TIMTER™ 3, the transmitter is available in a number of variations, depending on the options specified at the time of order. The type of features and modes installed in each unit are identified in the model number, as depicted in Figure 1. Package field codes are listed in Table 10. For questions about specific packages, please contact Quasonix.

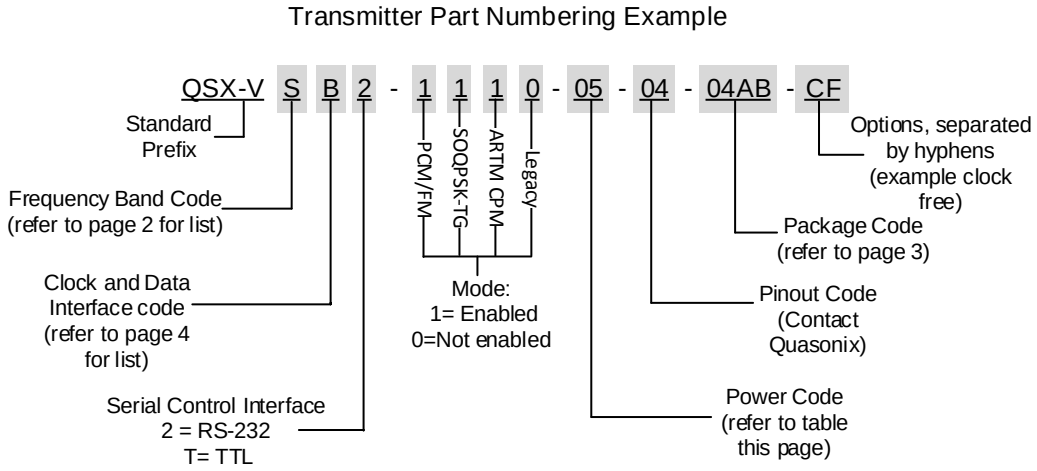


Figure 1: Quasonix Part Number Construction Description

In this manual, the words Terminal Control and Serial Control have the same meaning and are used synonymously throughout this manual. Serial control originates from configuring the transmitter from a computer's legacy RS-232/422 serial communications (COM) port. Terminal Control reflects the more generic case where the transmitter could be controlled by other standard computer interfaces such as Ethernet.

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The nanoTX transmitter models are covered in a separate user manual, available for download from the company website: www.quasonix.com.

The available TIMTER™ software and hardware options are listed below. Refer to section 1.3 for detailed descriptions of each option.

- AC Automatic carrier wave output
- AI Auxiliary Input for digital data that is already premod filtered
- AP Adapter plate for 2.5"x 3.5" footprint – Include this hardware accessory with order
- BRx Request non standard baud rate for serial control
- C7 Quasonix interpretation of IRIG 106-17 Appendix 2-C serial control protocol
- CE Convolutional encoder (includes NRZ-M encoding) (k=7 rate 1/2)
- CF Clock-free baseband interface
- CG Clock generator output to baseband connector
- DP Dual power (Ability to set a low and a high setting, hardware controlled*)
- DSWBX Includes switch box and 18" MDM-9 to MDM-9 cable harness (For use with P9 option)
- EN Ethernet Payload Capability
- FM Allows the TIMTER™ to function as an analog FM transmitter
- FO Frequency Offset
- GN GPS notch filters to meet 115 dBm in 3 kHz band at L1 and L2 (S band only) – Include this hardware option with order
- HR Increases max bit rate up to 46 Mbps (23 Mbps for PCM/FM)
- ID Internal Clock and Data can be saved as a power-up default
- LC Low current in the RF Off state, 10 mA (hardware option)
- LD LDPC forward error correction encoding
- LD6 Extended LDPC
- LR Decreases min bit rate to 50 kbps (25 kbps for PCM/FM)
- MA Below Lower S band (for Space Operations and Space Research applications)
- MK Randomizer hardware control – Include this hardware option with order
- MS Modulation scaling
- P9 MDM-9 Accessory board (use with switch box part QSX-AC-SWBX-P9-3B-3M)
- PF Parallel port frequency programming
- PM Parallel port mode selection
- PS Enable hardware presets (specify 2, 4, 8, or 16 – PS2, PS4, PS8, PS16)
- PW020 RF Output 20 mW (+13 dBm)
- RH Recall Holdoff
- RN Randomizer output to baseband connector

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- STDN Supports Spacecraft Tracking and Data Network (PM/BPSK) mode
- VF Variable FIFO Depth, controls transmitter latency
- VP Variable power (31 settings, spanning 24 dB), software controlled*
- WV Wide input voltage range

Refer to Table 13 in section 4.2.1 for detailed descriptions of each option. Due to input connector pin count limitations, certain combinations of options are not available. Please contact Quasonix for support in ordering TIMTER™ options or for information regarding upgrades to TIMTER™ units that you may already own.

The model number identifies the configuration of the unit. For example, model number QSX-VSTT-1100-10-04-04AB-CF defines a unit configured as shown in Table 1.

Table 1: Model Configuration Example

Identifiers	Description
QSX	Quasonix product
V	Variable bit rate
S	S band code
T	TTL clock and data interface code
2	RS-232 serial control interface: baud rate 57,600
1100	Tier 0 present, Tier I present, Tier II absent, Legacy absent
10	10 Watt RF output
04	Pinout code 04
04AB	Package code
CF	Clock-free baseband interface option

1.3 Part Number Field Codes

1.3.1 Frequency Bands

Frequency band codes are listed in Table 2. All frequency bands may be tuned 0.5 MHz above or below the stated frequency.

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Table 2: Frequency Band Codes

Band ID Code	Band	Minimum Freq	Maximum Freq	Default Freq	Tuning Steps	Max Power
A	Lower S	2200.5 MHz	2300.5 MHz	2250.5 MHz	0.5 MHz	25 W
B	Mid C and Euro Mid C	5091.0 MHz 5150.0 MHz	5150.0 MHz 5250.0 MHz	5120.0 MHz	0.5 MHz	20 W
C	C “Low”	4400.0 MHz	4950.0 MHz	4620.0 MHz	0.5 MHz	20 W
D	C (with Mid C)	4400.0 MHz and 5091.0 MHz	4950.0 MHz and 5150.0 MHz	4620.0 MHz	0.5 MHz	20 W
E	(all) L, S, C	1435.5 MHz 1750.0 MHz 2200.5 MHz 2300.5 MHz 4400.0 MHz 5091.0 MHz 5150.0 MHz	1534.5 MHz 1855.0 MHz 2300.5 MHz 2394.5 MHz 4950.0 MHz 5150.0 MHz 5250.0 MHz	2370.5 MHz	0.5 MHz	10 W
F	S and C	2200.5 MHz and 4400.0 MHz	2394.5 MHz and 4950.0 MHz	2370.5 MHz	0.5 MHz	20 W
G	Euro Mid C	5150.0 MHz	5250.0 MHz	5150.0 MHz	0.5 MHz	20 W
H	L and C	1435.5 MHz and 4400.0 MHz	1534.5 MHz and 4950.0 MHz	1450.5 MHz	0.5 MHz	10 W
J	C, Mid C, and Euro Mid C	4400.0 MHz and 5091.0 MHz 5150.0 MHz	4950.0 MHz and 5150.0 MHz 5250.0 MHz	4620.0 MHz	0.5 MHz	18 W
K	S and C, Mid C, and (with Euro Mid C)	2200.5 MHz 4400.0 MHz and 5091.0 MHz 5150.0 MHz	2394.5 MHz 4950.0 MHz and 5150.0 MHz 5250.0 MHz	2370.5 MHz	0.5 MHz	18 W
L	Lower L	1435.5 MHz	1534.5 MHz	1450.5 MHz	0.5 MHz	20 W
M	Lower L, Upper L, and S	1435.5 MHz 1750.0 MHz and 2200.5 MHz	1534.5 MHz 1855.0 MHz and 2394.5 MHz	1450.5 MHz	0.5 MHz	20 W

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Band ID Code	Band	Minimum Freq	Maximum Freq	Default Freq	Tuning Steps	Max Power
N	Upper S	2300.5 MHz	2394.5 MHz	2370.5 MHz	0.5 MHz	25 W
Q	L, S, and C	1435.5 MHz 1750.0 MHz 2200.5 MHz 4400.0 MHz 5091.0 MHz	1534.5 MHz 1855.0 MHz 2394.5 MHz 4950.0 MHz 5150.0 MHz	1450.5 MHz	0.5 MHz	10 W
S	S	2200.5 MHz	2394.5 MHz	2370.5 MHz	0.5 MHz	25 W
T	Lower L and C	1435.5 MHz 4400.0 MHz 5091.0 MHz	1534.5 MHz 4950.0 MHz 5150.0 MHz	1450.5 MHz	0.5 MHz	20 W
V	S and C (with Mid C)	2200.5 MHz 4400.0 MHz and 5091.0 MHz	2394.5 MHz 4950.0 MHz and 5150.0 MHz	2370.5 MHz	0.5 MHz	20 W
W	S and C, Mid C, and (with Euro Mid C)	2200.5 MHz 4400.0 MHz and 5091.0 MHz 5150.0 MHz	2394.5 MHz 4950.0 MHz and 5150.0 MHz 5250.0 MHz	2370.5 MHz	0.5 MHz	18 W
X	Mid C band	5091.0 MHz	5150.0 MHz	5120.0 MHz	0.5 MHz	20 W
Y	L and C	1435.5 MHz 1750.0 MHz and 4400.0 MHz 5091.0 MHz	1534.5 MHz 1855.0 MHz and 4950.0 MHz 5150.0 MHz	1450.5 MHz	0.5 MHz	20 W
Z	L and Euro Mid C	1435.5 MHz and 5150.0 MHz	1534.5 MHz and 5250.0 MHz	1450.5 MHz	0.5 MHz	20 W

*Note: Currently the MA option enables below Lower S band frequencies for use in space operations and space research. Refer to the MA option in section 1.3.30 for additional information or contact Quasonix.

1.3.2 Clock and Data Interface

Clock and data interface codes are listed in Table 3.

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Table 3: Clock and Data Interface Codes

Clock and Data Interface Code	Baseband Clock and Data Interface
H	TTL – 10k ohms to ground
T	TTL – 75 ohms to ground
A	TTL – Selectable between 75 ohms to ground and 10k ohms to ground
R	TIA/EIA-422 (RS-422) – 120 ohms differential
B	TIA/EIA-422 (RS-422) – 120 ohms differential, even when unit is powered off)
M	Dual-mode – Selectable between TTL (terminated 10 ohms to ground) and RS-422 (terminated 120 ohms differential)
D	Dual-mode – Selectable between TTL (terminated 75 ohms to ground) and RS-422 (terminated 120 ohms differential)
S	Tri-mode – Selectable between TTL (terminated 75 ohms to ground), TTL (terminated 10k ohms to ground), and RS-422 (terminated 120 ohms differential)
L	LVDS (Low Voltage Differential Signal)

1.3.3 Serial Control Interface

Serial control interface codes are listed in Table 3.

Table 4: Serial Control Interface Codes

Serial Control Interface Code	Serial Control Interface
1	LVTTL; 57,600 baud rate
2	RS-232; 57,600 baud rate
T	TTL; 57,600 baud rate
4	RS-422; 57,600 baud rate

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1.3.4 ARTM Tier 0 (PCM/FM)

ARTM Tier 0 codes are listed in Table 5.

Table 5: ARTM Tier 0 Codes

Part Number Code	PCM/FM (ARTM Tier 0)
0	Absent
1	Present

1.3.5 ARTM Tier I (SOQPSK-TG)

ARTM Tier I codes are listed in Table 6.

Table 6: ARTM Tier I Codes

Part Number Code	SOQPSK-TG (ARTM Tier I)
0	Absent
1	Present

1.3.6 ARTM Tier II (Multi-h CPM)

ARTM Tier II codes are listed in Table 7.

Table 7: ARTM Tier II Codes

Part Number Code	Multi-h CPM (ARTM Tier II)
0	Absent
1	Present

1.3.7 Legacy

Legacy modes include BPSK, QPSK, and OQPSK. Legacy codes are listed in Table 7.

Table 8: Legacy Codes

Part Number Code	Legacy Modes
0	Absent
1	Present

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1.3.8 RF Output Power

RF output power codes are listed in Table 9.

Table 9: RF Output Power Codes

Part Number Code	RF Output Power
00	10 mW (+10 dBm), ±1 dB 20 mW (+13 dBm), ±1 dB Requires DC input of 6.5 V, unless "WV" option is specified
01	1 watt (+30 dBm), minimum
02	2 watt (+33 dBm), minimum
05	5 watts (+37 dBm), minimum
10	10 watts (+40 dBm), minimum
20	20 watts (+43 dBm), minimum
25	25 watts (+44 dBm), minimum

1.3.9 Packages

Package field codes are listed in Table 10. Detailed information for packages other than 04AB is located in the TIMTER™ Transmitter Packages document, available at the Quasonix web site. For questions about specific packages, please contact Quasonix.

Table 10: Package Codes

TIMTER™ Package	Volume	Width	Length	Height
02XX	1.992 in^3	2.000"	3.000"	0.332"
04XX	4.200 in^3	2.000"	3.000"	0.700"
05XX	4.800 in^3	2.000"	3.000"	0.800"
06XX	6.072 in^3	2.000"	3.000"	1.012"
07XX	6.546 in^3	2.000"	3.000"	1.091"
	6.672 in^3	2.000"	3.000"	1.112"
08XX	7.590 in^3	2.200"	3.450"	1.000"
	8.418 in^3	2.000"	3.450"	1.403"
09XX	9.180 in^3	2.000"	3.000"	1.530"

*Package dimensions do not include connectors

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Transmitter weight may vary depending on packages and applications. For information about the weight of a particular transmitter, please contact Quasonix.

1.3.10 Automatic Carrier Wave Output Option – AC

This option allows the TIMTER to transmit a carrier wave when the clock input is absent, which would normally cause the RF output to be turned off.

1.3.11 Auxiliary Input Option – AI

The AI option provides an auxiliary input that allows the TIMTER™ to transmit Filtered PCM (FPCM) data. FPCM is a binary data waveform that has been filtered such that the data transitions are slowed down. The FPCM signal at the TIMTER, viewed on an oscilloscope, might look something like the following figure.

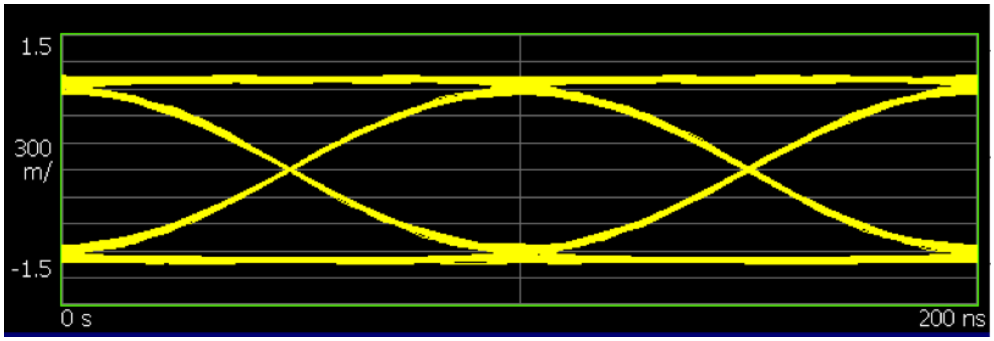


Figure 2: FPCM Signal on Oscilloscope

The AI option allows the TIMTER™ to replace a legacy analog transmitter, but only for use in transmitting a digital data stream. **Refer to the FM option in section 1.3.22 for configuring the TIMTER™ to transmit a true analog signal, such as NTSC video.** The AI option is frequently used to interface the TIMTER™ to legacy encryption devices, which often include filtering on their outputs, including a DC blocking capacitor. By default, the Auxiliary Input is configured to accept an AC-coupled input. The AIR command may be used to select between a zero and a non-zero DC bias.

The auxiliary input converts the FPCM input back to an unfiltered bit stream, locks an internal bit sync to that bit stream (refer to the CF option), and then modulates the transmitter based on that digital bit stream, in which case the deviation and the internal premod filter bandwidth are set by the bit rate, and are independent of the analog voltage levels presented to the transmitter.

Use of the auxiliary input requires the –AI option. The command for controlling auxiliary input is AI, which enables/disables the auxiliary input (when disabled, the normal digital input is used). Since there is no clock input, the Clock Free option (CF) is required. (Refer to section 1.3.15 for more information about Clock Free.)

To configure the TIMTER™ for use with the Auxiliary Input, issue the following commands:

AI = 1 (get data stream from Auxiliary Input)

CF = 0 (operate clock free)

BR xxx, where xxx = data rate in Mbps, or BR A for automatic data rate

AIR x, where x = 0 for zero DC bias and x = 1 for 1.65V DC bias

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1.3.12 Adapter Plate – AP

Use this option to include the 2.5" x 3.5" adapter plate (hardware accessory) with the order.

1.3.13 Baud Rate Option – BRx

The BR option changes the serial communications default baud rate on the transmitter to the one selected. A number from 0-7 follows the BR option request. Corresponding values are as follows: 0 = 57600; 1 = 4800; 2 = 9600; 3 = 19200; 4 = 38400; 5 = 56000; 6 = 57600; 7 = 115200.

1.3.14 CP07 Control Protocol Option – C7

The Quasonix interpretation of IRIG 106-17, Appendix 2-C serial control protocol (CP07), "provides standards for commands, queries, and status information when communicating with telemetry transmitters configured with communication ports." The Basic command set contains the minimum (required) commands for transmitter control, query, and status. The Extended command set contains optional commands that may or may not be implemented at the manufacturer's discretion. CP07 is enabled when the C7 option is requested.

The default baud rate for CP07 transmitters is 9600.

1.3.15 Convolutional Encoder Option – CE

The CE option enables convolutional encoding and NRZ-M conversion. This encoding adds redundant information to the transmitted data stream to help detect and correct bit errors that may occur, particularly due to predominantly Gaussian noise. Use of convolutional encoding requires a matching Viterbi decoder in the receiver to extract the source data. The encoded data rate will be twice the source data rate, and the occupied bandwidth will also be doubled.

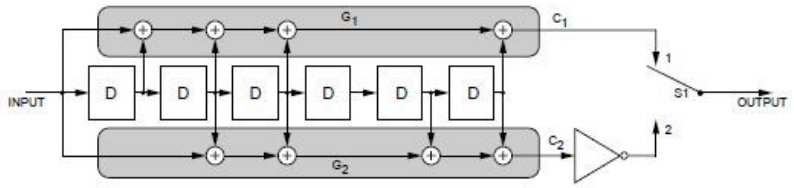
For example, the transmitter has two encoders, one for in-phase ("I") data and one for quadrature ("Q") data. Call the input symbol stream I0/Q0, I1/Q1, … . Each encoder outputs 2 bits for every input bit, so call the output bit stream from the first convolutional encoder I0(1), I0(2), I1(1), I1(2), … , and call the output bit stream from the second convolutional encoder Q0(1), Q0(2), Q1(1), Q1(2), … . Combining the outputs of the two encoders, then, the output symbol stream is I0(1)/Q0(1), I0(2)/Q0(2), I1(1)/Q1(1), I1(2)/Q1(2), … .

For modes that do not employ Quadrature modulation, such as PCM/FM, Multi-h CPM, and BPSK, only a single encoder is used.

A single encoder is implemented exactly as described in the "Consultative Committee for Space Data Systems, Recommendation for Space Data System Standards, TM Synchronization and Channel Coding, CCSDS 131.0-B-1, Blue Book, September 2003, Section 3."

A basic convolutional encoder block diagram, as illustrated in CCSDS 131.0-B1, is shown in Figure 3.

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NOTES:

1. D = SINGLE BIT DELAY.
2. FOR EVERY INPUT BIT, TWO SYMBOLS ARE GENERATED BY COMPLETION OF A CYCLE FOR S1: POSITION 1, POSITION 2.
3. S1 IS IN THE POSITION SHOWN (1) FOR THE FIRST SYMBOL ASSOCIATED WITH AN INCOMING BIT.
4. ⊕ = MODULO-2 ADDER.
5. = INVERTER.

Figure 3-1: Basic Convolutional Encoder Block Diagram

"Consultative Committee for Space Data Systems, Recommendation for Space Data System Standards, TM Synchronization and Channel Coding, CCSDS 131.0-B-1, Blue Book, September, 2003," page 3-2.

Figure 3: CCSDS 131.0-B-1 Rendering of Basic Convolutional Encoder Diagram

1.3.16 Clock-free Baseband Interface Option – CF

Clock-free is an optional mode that transmits user data, but uses an internal bit sync to take the place of the normal external clock. The standard TIMTER requires external clock and data inputs. With the CF option, no external clock is required. The clock is generated directly from the data and a user-specified bit rate.

Because the internal bit sync's clock takes the place of the normal external clock in clock-free mode, the selected clock source must be external for clock-free just like it is for normal clock/data. This mode is most often used to retrofit older analog transmitters in TM systems where the crypto device does not deliver a clock to the transmitter.

The commanded clock-free rate can be saved with the SV command, and if so, it will be restored at power-on. When the CF option is used, the bit rate range is as defined in Table 12 for all waveform modes. It is limited by the bit rate achievable for the current mode. (Refer also to the HR and LR options for extended bit rates, the ID option for Internal Clock and Data, and Table 11 for a snapshot of bit rate information.)

Do not confuse the **CF option** with CS/DS **commands**.

Internal clock (CS 1 Command) is used when the transmitter is to be a test source only. The unit transmits the selected internal data pattern (DS 1 command) at the bit rate set by the user via the IC command. The internal clock is not used to transmit actual payload data.

External clock (CS 0 Command) is the normal mode: the user supplies clock and data, or in clock-free mode, the user only supplies valid data. Refer to Table 13 for user commands.

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Table 11: Standard Data Bit Rates and Rate Adaptation Compared to Clock Free Data Bit Rates

Data (bit) rate, automatic rate adaptation	TIMTER: TIMTER *option* HR: TIMTER *option* LR:	0.1-28 Mbps (0.05-14 Mbps for PCM/FM) Extends upper limit to max of 46 Mbps for SOQPSK and ARTM CPM (23 Mbps for PCM/FM) Extends lower limit to min of 50 kbps for SOQPSK and ARTM CPM (25 kbps for PCM/FM)
Clock Free Data (bit) rate	With BR x command: With BR A command:	Allows user to enter a fixed bit rate in the range defined in the Data (bit) rate specifications above Automatically detects bit rate in the range defined in The Data (bit) rate specifications above; Quasonix guarantees automatic bit rate operation up to 35 Mbps; beyond that operation is dependent on input data signal quality (jitter, truly random data, etc.)

1.3.17 Clock Generator Output Option – CG

The standard TIMTER includes internal clock and data generators, generally used for system test. The CG option enables this internal clock out of the unit on the primary MDM-15 connector. The assignment of output pins depends on the other features selected.

1.3.18 Dual Power Option – DP

The standard TIMTER operates at its full rated RF output power. The DP option provides two software-programmed, hardware-actuated settings, designated by the user as “high power” and “low power”. There are 32 choices for “high power” and 32 choices for “low power”. The low power setting can provide as much as 24 dB of attenuation from the high power setting.

1.3.19 Digital Switch Box Option – DSWBX

The TIMTER™ provides a standard configuration interface that is easily accessible via a computer terminal. Some users prefer configuration via an external switch box. The 2nd Generation Quasonix switch box provides six LED digits used to display the mode and frequency. This includes a total of five digits of frequency step up or down, in MHz, and one digit of mode selection, in terms of the ARTM “Tier” number. There is also a channel selector for channel 1 or channel 2. Two channel operation is only valid when connected to a Dual Telemetry Transmitter. Standard transmitters default to Channel 1. An 18” MDM-9 to MDM-9 cable harness is included with the switch box. (For use with the P9 option)

1.3.20 Ethernet Payload Capability – EN

The –EN option gives the transmitter the ability to send Ethernet data via direct connection to a standard Ethernet network. Operating in Ethernet mode, the user sets the desired transmission rate through the transmitter control interface. As Ethernet data are presented to the TIMTER, they are loaded into a large transmit buffer. If the presented Ethernet traffic does not keep the buffer filled, bit stuffing is used to attain the programmed transmit rate. If the presented traffic overflows the buffer, Ethernet data are discarded.

The Ethernet interface is supported via an MDM-9 connector, and is compatible with 10Base-T and 100Base-TX Ethernet physical layers. The maximum transmission rate is 46 Mbps. Use of a transmitter with the –EN option requires a Quasonix RDMS™ receiver to reconstruct the Ethernet data at the receive end.

Pre-assembled MDM-9 Male to RJ-45 cables are available from Molex:

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- 83421-9224 Micro-D 9 to RJ-45, 1.2m
- 83421-9225 Micro-D 9 to RJ-45, 10.0m
- 83421-9226 Micro-D 9 to RJ-45, 3.0m

1.3.21 Analog Frequency Modulation – FM

This option allows the TIMTER™ to function as an analog FM transmitter. In this mode, the analog input voltage is converted to frequency offset, relative to the carrier, based on a settable deviation scale factor. No filtering or other signal processing is performed, and commands and functions related to digital clock/data do not affect the modulated output. This mode of operation is designed for use with a true analog signal, such as NTSC video. By default, the analog FM input is AC coupled, with a low frequency cutoff of less than 15 Hz. Contact Quasonix if you need a DC coupled analog input.

FM mode is not optimal for sending digital data; refer to the AI option in section 1.3.11 for that configuration. However, if your TIMTER™ has only the FM option, and not the AI option, you can still use it to transmit digital data, but you will not have the greatest benefit of the AI option: the internal bit sync is not available to set the internal premod filter and deviation automatically. When using the FM mode to send digital data, the premod filtering must be performed externally, and the deviation is set using the AFMS command (refer to section 1.3.21.1).

1.3.21.1 Using True Analog FM

Analog FM provides the capability of frequency modulating the RF carrier based on an analog input signal voltage, making the Quasonix digital transmitter behave virtually identically to an analog PCM/FM transmitter (but with improved phase noise, more precise deviation control, etc.). Analog FM requires the –FM option. The two commands for controlling analog FM are MO and AFMS. MO 12 enables the analog FM input, and AFMS sets the sets the deviation in MHz per Volt. (Refer to the Command Set section 4.2.1, for specific information about each command.)

In order to use TRUE analog FM:

- The –FM option must be in the part number
- Mode must be set to MO 12
- Use AFMS xx command to set the deviation sensitivity to xx MHz / volt; for example AFMS 1.0

Refer also to the Auxiliary Input option, section 1.3.11.

1.3.22 Frequency Offset – FO

This option is used to set frequencies that are NOT aligned to the synthesizer step size for their units, typically 500 kHz, and it enables the FO user command.

1.3.23 GPS Notch Option – GN

Use this option to specify GPS notch filters to meet 115 dBm in 3 kHz band at L1 and L2 (hardware note). Available for S band only. Consult Quasonix for pricing and availability.

1.3.24 High Bit Rate Option – HR

The standard TIMTER supports bit rates from 0.1 to 28 Mbps in SOQPSK-TG and ARTM CPM modes, 0.05 to 14 Mbps in PCM/FM (Tier 0) mode and in all legacy modes. The HR option increases the bit rate to a maximum of 46 Mbps (23 Mbps for PCM/FM). Refer to the CF option for information about the Clock Free option.

Refer to Table 12 for bit rate comparisons by mode.

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Table 12: Standard Bit Rates Compared to Low/High Rate Options

	Standard Bit Rate	With Low Rate Option –LR	With High Rate Option –HR
ARTM Tier 0 Modulation (PCM/FM)	0.05 -14 Mbps	Down to 0.025 Mbps	Up to 23 Mbps
ARTM Tier I Modulation (SOQPSK-TG)	0.1 – 28 Mbps	Down to 0.050 Mbps	Up to 46 Mbps
ARTM Tier II Modulation (Multi-h CPM)	0.1 – 28 Mbps	Down to 0.050 Mbps	Up to 46 Mbps
Legacy Modulation (BPSK)	0.05 – 10 Mbps	N/A	N/A
Legacy (QPSK, OQPSK)	0.05 – 20 Mbps	N/A	N/A

1.3.25 Internal Clock and Data Option – ID

The ID option allows the CS and DS user settings to be reloaded on power up or on a manual recall of a setup. Without the ID option, CS and DS are both forced to 0. Refer to the CF option for information about the Clock Free option.

1.3.26 Limited Current Option – LC

This option is used to specify low current in the RF Off state. Current draw is less than 10 mA when the transmitter is Off. This is a hardware option.

1.3.27 Forward Error Correction / Low Density Parity Check (LDPC) Option – LD

This option provides the Low Density Parity Check (LDPC) encoding, which is being considered for use on the iNET program. LDPC has been adopted by the Range Commander's Council, IRIG 106-17, Appendix 2-D.

1.3.28 Forward Error Correction / Low Density Parity Check (LDPC) Option – LD6

This option adds the extended LDPC option to the unit. It lets the user select from the six implemented LDPC codes, and allows the randomizer command to select the CCSDS randomizer, if LDPC is enabled. Adding this option automatically enables the existing LD option.

The IRIG standard calls out six variants of LDPC codes—all combinations of two different information block sizes (k=4096 bits and k=1024 bits) and three different code rates (r=1/2, r=2/3, and r=4/5).

K=4096, r=1/2

k=1024, r=1/2

k=4096, r=2/3

k=1024, r=2/3

k=4096, r=4/5

k=1024, r=4/5

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1.3.29 Low Bit Rate Option – LR

The standard TIMTER™ supports bit rates from 0.1 to 28 Mbps in SOQPSK-TG and ARTM CPM modes, 0.05 to 14 Mbps in PCM/FM (Tier 0) mode and in all legacy modes. The LR option decreases the bit rate to a minimum of 50 kbps (25 kbps for PCM/FM). Refer to the CF option for information about the Clock Free option.

Refer to Table 12 for bit rate comparisons by mode.

1.3.30 Space Operations and Research S band Option – MA

This option enables frequencies below Lower S band (generally used for Space operations and Space research applications). The frequency range is 2025.0 MHz to 2110.0 MHz with a default frequency of 2050.5 MHz in 0.5 MHz tuning steps. Maximum power currently allowed is 10 W.

1.3.31 The standard Randomizer Control Option – MK

The standard TIMTER™ provides a user command (RA) that reports or sets the randomizer state. This option enables ON/OFF control of the randomizer with a hardware pin. Use this option to specify the Randomizer Control (hardware configuration) with the order.

1.3.32 Modulation Scaling Option – MS

This option enables the MS and MJ commands which allow a user to set the modulation scaling factor and scale the modulation index of the transmitted signal. For additional information, refer to Table 13, or contact Quasonix.

1.3.33 MDM-9 Accessory Board – P9

Use this option to include the MDM-9 Accessory Board (sometimes referred to as a “tophat board”) (hardware accessory), for use with switch box part number QSX-AC-SWBX-P9-3B-3M, with the order.

1.3.34 Parallel Port Frequency Programming Option – PF

This option adds a parallel port in the form of an MDM-15 connector for manual frequency tuning. The PF option requires the addition of a Quasonix MDM-9 Accessory Board. Consult Quasonix to order the PF option.

1.3.35 Parallel Port Mode Selection Option – PM

This option adds a parallel port in the form of an MDM-15 connector for manual mode selection. The PM option requires the addition of a Quasonix MDM-9 Accessory Board. Consult Quasonix to order the PM option.

1.3.36 Hardware Preset Option – PS (PS2, PS4, PS8, or PS16)

The TIMTER™ supports one or more hardware presets. A single preset defines the complete state of the transmitter, including carrier frequency, modulation mode, data polarity, randomizer state, etc. Without the PS option, the TIMTER™ supports only one hardware preset, which it reverts to at power-up. The PS in the option string specifies that the unit supports multiple hardware presets (2, 4, 8, or 16). Presets are engaged by grounding various combinations of pins on the terminal/parallel control selection. The number of presets available and which pins engage the presets depend on the other features specified. Due to the limited number of pins available, the PS option may require the elimination of the RF On/Off pin. Due to firmware part number parsing requirements, the hardware preset option code must be at the very end of the part number to be valid. On units which use the standard MDM-15 connector, the ZY command displays the connector pinout showing preset pin locations. For additional information, refer to Appendix A – Preset Option.

1.3.37 Power Output Option – PW020

When ordered with Power Code 00, this option enables RF output at 20 mW (+13 dBm).

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1.3.38 Recall Holdoff Option – RH

If the RF On/Off pin is grounded on power up, then the RF command is set to RF 0 (OFF) regardless of how the command was saved. The user must send the RF On/Off command via serial port to enable RF output. Otherwise, if RF 1 (ON), and the RF On/Off pin is active (based on the RZ command setting), and the unit has a clock (non clock free, non AC unit), then the RF output is set to ON.

1.3.39 Randomizer Output Option – RN

The standard TIMER includes the IRIG-106 randomizer for the RF output. The IRIG-106 randomizer is controlled through the serial interface. The RN option brings the randomized data out on the primary MDM-15 connector. The assignment of output pins depends on the other features selected. Consult Quasonix for details.

1.3.40 Spacecraft Tracking and Data Network Option – STDN

This option supports the PM/BPSK mode (Spacecraft Tracking and Data Network mode).

1.3.41 Variable FIFO Depth Option – VF

This option enables the VF command which allows the user to set the FIFO depth on the transmitter for controlling latency time between bits in and bits out. The range is 0 to 255 with 128 being the default. If no value is entered, the current value displays.

1.3.42 Variable Power Option – VP

The standard TIMTER™ operates at its full rated RF output power. The software-based VP option provides 64 discrete power level settings, approximately 0.5 dB apart. For TIMTER packages of 2 cubic inches or less, the VP option provides 32 discrete power level settings, approximately 1.0 dB apart.

1.3.43 Wide Input Voltage Range Option – WV

The standard TIMTER™ operates from +28 $\pm$ 4 VDC. The WV option extends operating input voltage range as shown in following table.

Voltage Ranges with WV Option
+6.5 to +34 VDC for 10 mWatt version
+6.5 to +34 VDC for 20 mWatt version
+6.5 to +34 VDC for 1 Watt version
+6.5 to +34 VDC for 2 Watt version
+12 to +34 VDC for 5 Watt version
+21 to +34 VDC for 10 Watt version
+21 to +34 VDC for 20 Watt version
+21 to +34 VDC for 25 Watt version

Note: The WV option is not supported on 25 W S-band and 20 W L/C or S/C-band transmitters.

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2 Accessories

Quasonix offers a number of optional accessories for TIMTER™, including a fan-cooled heat sink, a 2.5” x 3.5” adapter plate, pre-wired mating MDM-15 connectors, complete MDM-15 cable assemblies, a ruggedized handheld programmer, and a USB to serial converter cable. Contact Quasonix for pricing and availability of TIMTER™ accessories.

2.1 Fan-cooled Heat Sink

Part Number: QSX-AC-32-HS-12V

The heat sink assembly includes an integral +12 VDC fan and a power supply transformer, shown in Figure 4. The heat sink is shown with a mounted 6 cubic inch TIMTER™ in Figure 5.



Figure 4: Fan-cooled Heat Sink and Power Supply



Figure 5: Fan-cooled Heat Sink with 6 cubic inch TIMTER™

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2.2 Transmitter-powered Heat Sink (for airborne applications)

Part Number: (QSX-AC-32-HS-28V-SP)

The heat sink assembly includes an integral +12 VDC fan, power supply, and temperature-controlled power on at +37°C. Fan speed is regulated to compensate for changes in air pressure/density under high altitude conditions. Two MDM-15 connectors and a provided pigtail cable, shown in Figure 6, allow the heat sink to draw power directly from a TIMTER™ transmitter eliminating the need for a separate external power supply. An adapter plate is also included with the heat sink.

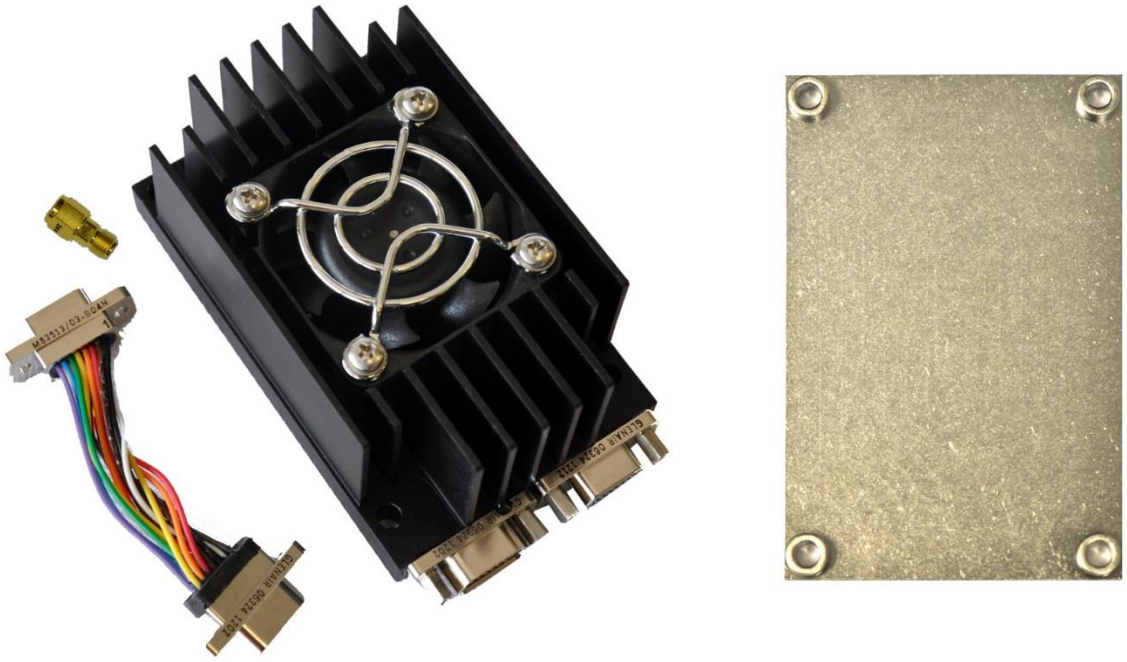


Figure 6: Transmitter-powered Heat Sink, Pigtail Cable, SMA Extender, and Adapter Plate

The heat sink is shown mounted on a standard 04AB TIMTER™ in Figure 7 and mounted on a larger 07AE TIMTER™ in Figure 8. The pigtail cable connects to any TIMTER™, regardless of MDM-15 gender, by plugging the pigtail into either the male or female connector, as shown in Figure 9 and Figure 10.

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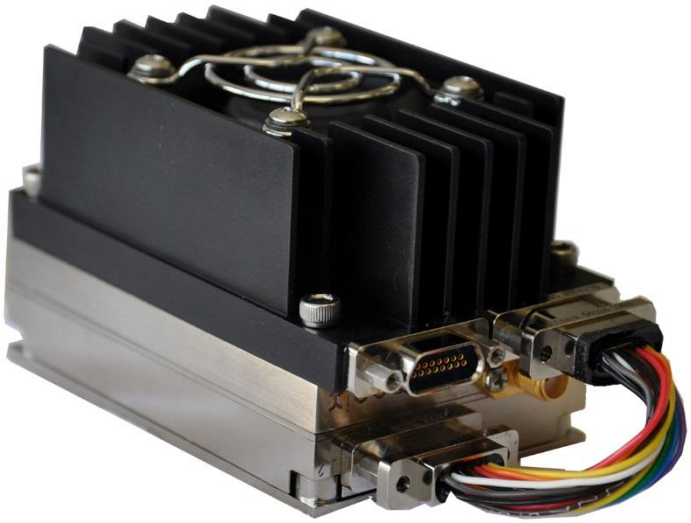


Figure 7: Transmitter-powered Heat Sink Mounted on an 04AB Package

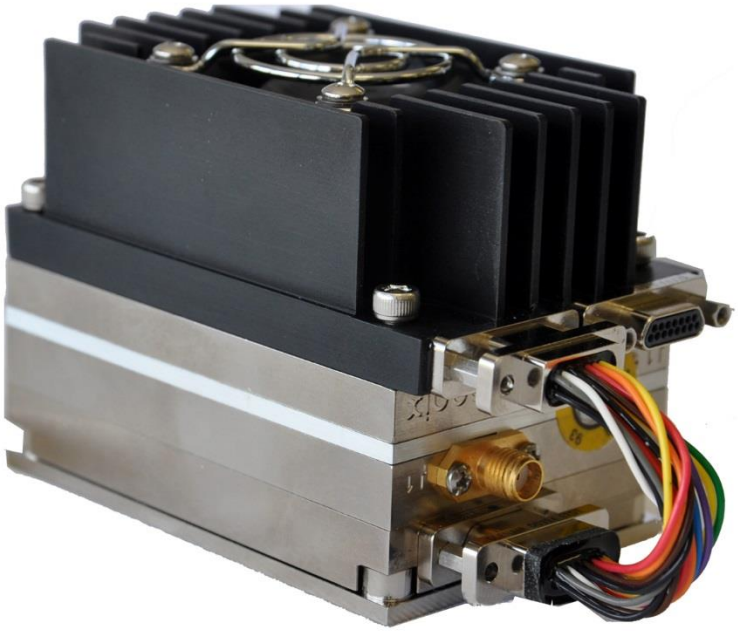


Figure 8: Transmitter-powered Heat Sink Mounted on a 07AE Package

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Figure 9: Close-up Using Female MDM-15 Connector



Figure 10: Close-up Using Male MDM-15 Connector

2.3 Adapter Plate

Part Number: QSX-AC-AP-96

The adapter plate, shown in Figure 11, allows for the standard 2” x 3” footprint TIMTER™ to be mounted to the larger 2.5” x 3.5” mounting surface occupied by other industry transmitters. Note, this adapter plate is not used with the Transmitter-powered Heat Sink. The appropriate adapter plate is included in the kit.



Figure 11: Adapter Plate

2.4 Pre-wired MDM-15 for RS-422 Units

Part Number: QSX-AC-MDM15-36-PIN

An MDM-15 connector with 36” color-coded pigtail cables for connecting to transmitters with the RS-422 clock and data baseband interface is shown in Figure 12.

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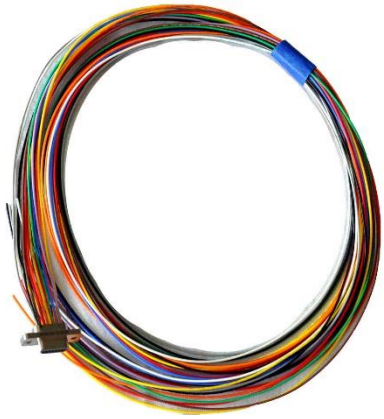


Figure 12: Pre-wired MDM-15 with 36” Pigtails for RS-422

2.5 Pre-wired MDM-15 for TTL Units

Part Number: QSX-AC-MDM15-36-SOCK

Quasonix offers an MDM-15 connector with 36” color-coded pigtail cables for connecting to transmitters with the TTL clock and data baseband interface.



Figure 13: Pre-wired MDM-15 with 36” Pigtails for TTL

2.6 MDM-15 Wiring Harness for RS-422 Units

Part Number: QSX-AC-MDM15-HARNESS-PIN

An MDM-15 wiring harness for connecting to transmitters with RS-422 clock and data baseband interface is shown in Figure 14. It includes banana plugs for power and ground, BNC connectors for clock and data, and a DB-9 connector for serial control and is 35 to 36 inches long depending on the connectors.

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Figure 14: MDM-15 Cable Harness for RS-422

2.7 MDM-15 Wiring Harness for TTL Units

Part Number: QSX-AC-MDM15-HARNESS-SOCK

Quasonix offers an MDM-15 wiring harness for connecting to transmitters with TTL clock and data baseband interface. It includes banana plugs for power and ground, BNC connectors for clock and data, and a DB-9 connector for serial control and is 35 to 36 inches long depending on the connectors.



Figure 15: MDM-15 Cable Harness for TTL

2.8 Ruggedized Handheld Programmer

Part Number: QS-PROG0021050

The handheld programmer is an ultra-rugged Pocket PC with custom Quasonix software that allows the user to configure transmitters through its serial interface directly in the field. The programmer is shown in Figure 16.

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Figure 16: Ruggedized Handheld Programmer

2.9 USB to Serial Converter Cable

Part Number: QSX-AC-USBSER-CONV

The 36 inch long USB to serial converter cable allows for configuration of the transmitter with a computer that does not have a serial port. The cable is pictured in Figure 17. An 18 inch long cable is also available.



Figure 17: USB to Serial Converter Cable

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2.10 2nd Generation Digital Switch Box

Part Number: QSX-AC-DSWBX

This accessory enables configuration of a TIMTER™ via an external digital switch box. Six LED digits are used to display the mode and frequency. A channel selector for channel 1 or channel 2 enables operation with a Quasonix Dual Telemetry Transmitter. Standard transmitters default to channel 1. Included with the switch box is an 18" MDM-9 to MDM-9 cable harness. The switch box and cable harness is pictured in Figure 18.

The transmitter which will use the switch box requires the P9 option when ordering to ensure an MDM-9 port is installed.

If you already own a Quasonix transmitter with an old switch box, the digital switch box can be swapped for the old one seamlessly.

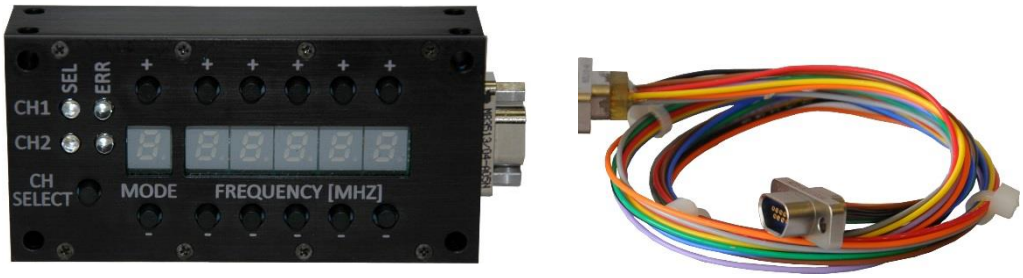


Figure 18: Digital Switch Box with 18" MDM-9 to MDM-9 Cable Harness

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3 Installation Instructions

3.1 Mechanical

The standard 4.2 cubic inch TIMTER™ (04AB package) is designed to be mounted by four (4) 6-32 screws through the holes in the four corners, as depicted in Figure 20. Photos and drawings of additional TIMTER™ packages are located in the document "TIMTER™ Transmitter Packages" on the Quasonix web site.



Figure 19: 4.2 in3 TIMTER™

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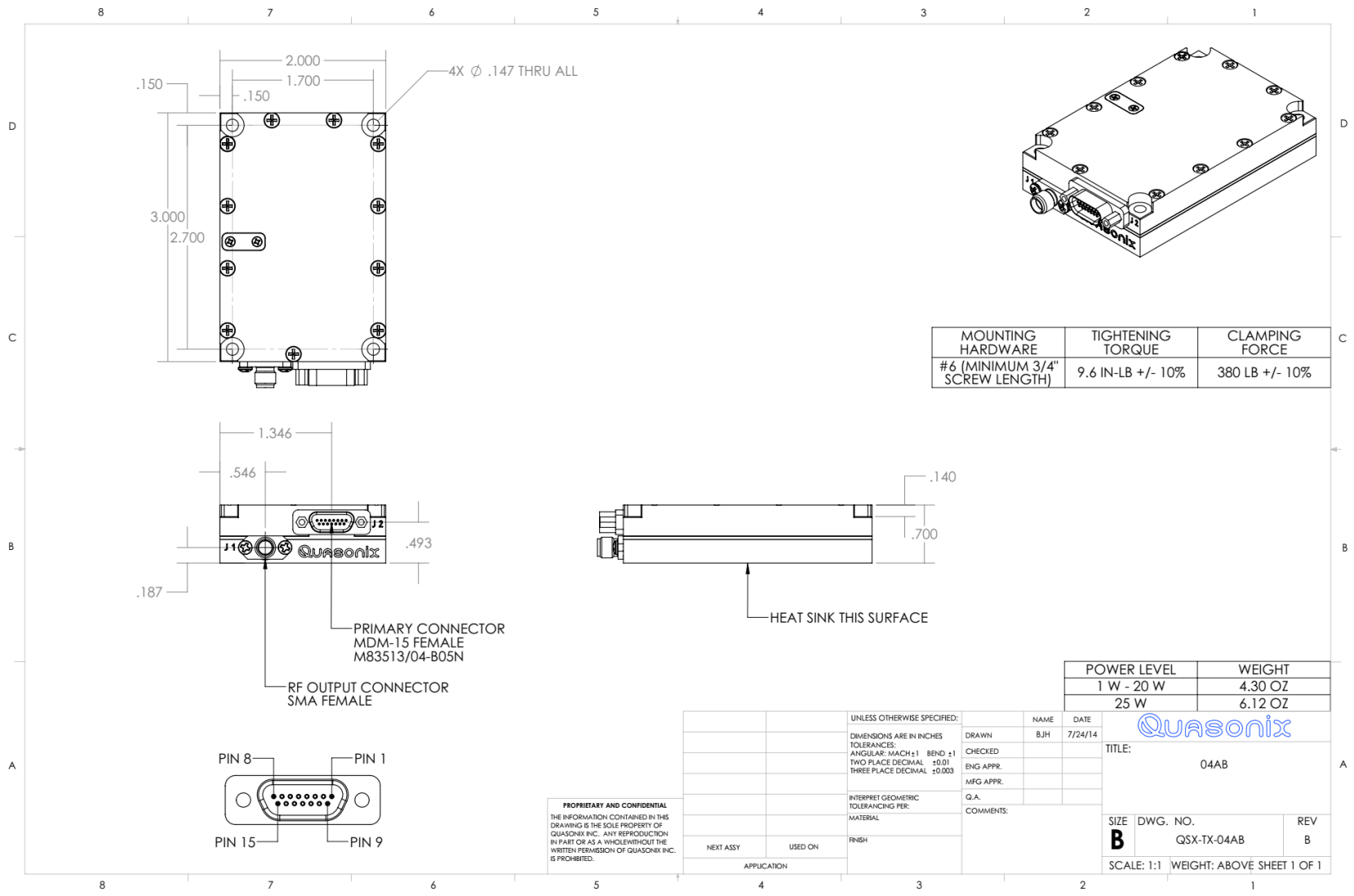


Figure 20: Outline Drawing, TIMTER™ 04AB Telemetry Transmitter

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3.2 Thermal

It is important that the bottom surface (on the face opposite the product label) be securely attached to a baseplate capable of dissipating the power produced by the transmitter model in use. This mounting baseplate must be flat, smooth, and clean. Contact Quasonix for the heat sink power dissipation required for your transmitter model.

> **ATTENTION: Do not operate the transmitter without a proper heat sink. Failure to do so may lead to permanent damage to the unit and will void the warranty.** Overheating can occur in a matter of seconds when a transmitter is not properly heat-sinked. In absolutely no case should any type of stickers or labels be applied to the bottom surface of the transmitter.

The heat sink required for a particular transmitter depends heavily on the installation. Factors such as altitude, air temperature, air flow, and mass of the mounting surface all have a substantial impact on the flow of heat away from the transmitter. Quasonix offers several types of integrated and add-on heat sinks (refer to Section 0). Please contact Quasonix for heat sink recommendations for your particular TIMTER™ transmitter.

Regardless of the heat sink, Quasonix strongly suggests using a thermal pad, such as Q-Pad® II from Bergquist.

3.3 Electrical

The standard TIMTER™ has two external connectors, an MDM-15 type connector known as the primary, and an SMA female for the RF output connection. A second MDM-15 connector of opposite gender, labeled “parallel control,” is included when either PF or PM options are ordered.

The pin numbering and wiring for the MDM-15 female connector used on the 04AB package (RS-422 interface) are shown in Figure 11. To illustrate the difference in the TTL interface, the pin numbering and wiring for the MDM-15 male connector on the 04AD package are shown in Figure 22.

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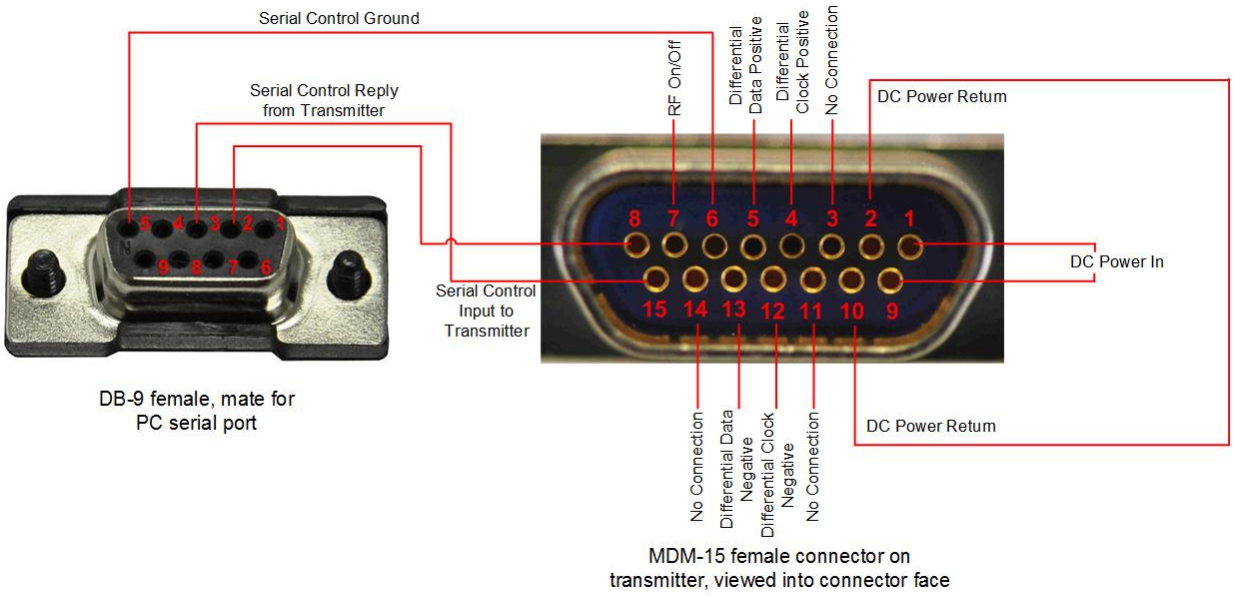


Figure 21: MDM-15 Female Pin Numbering, RS-422 Interface – 04AB Package

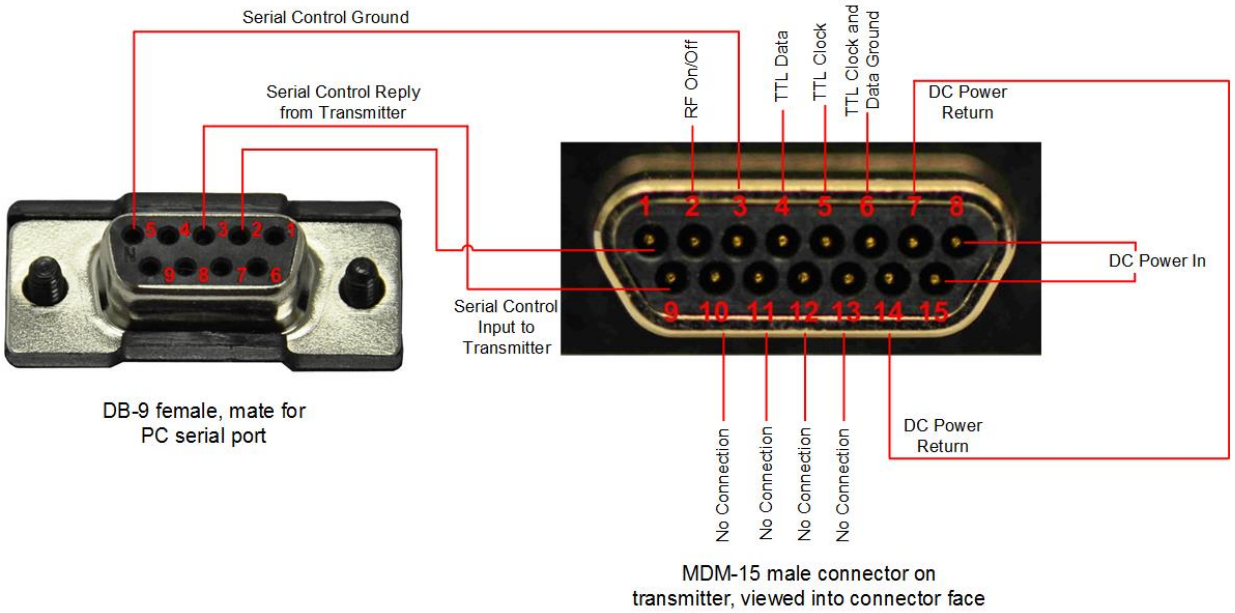


Figure 22: MDM-15 Male Pin Numbering, TTL Interface – 04AD Package

The pin assignments can change, depending on the options selected. A variety of pinouts are available with the 04AD package. Consult Quasonix for details.

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The data is sampled on the falling edge of the clock, as shown in Figure 23.

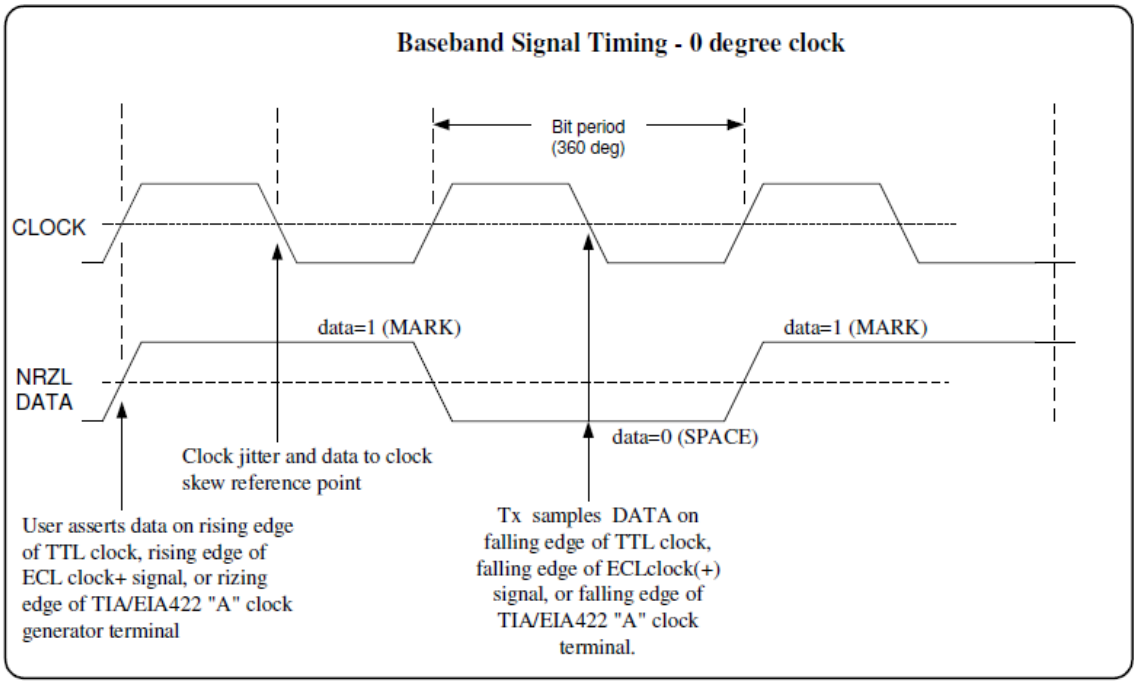


Figure 23: Baseband Signal Timing

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4 Operating Instructions

4.1 Power-on Operation

Upon power up, the transmitter loads any stored parameters present in its nonvolatile memory. If parameters have not been stored previously, the transmitter initializes default parameters and then stores them in the first preset slot, 0. There are a total of 16 available software-based presets (0 through 15) for saving multiple parameters at once for future use.

PF / PM OPTION NOTE: Stored parameters are loaded based on the state of the startup configuration (SC) setting. The SC setting allows the user to choose the priority between the parameters stored in nonvolatile memory and the frequency and/or mode settings designated by pins on the external parallel control connector. For other variations, contact Quasonix.

4.1.1 Dual Power via Hardware Control

When the dual power option (DP) is specified, the transmitter uses the hardware pin to switch between the low power setting and the high power setting.

When the pin is left floating or pulled high (logical 1), the transmitter enters the high power mode. When the pin is grounded (logical 0), the transmitter enters the low power mode.

4.2 TIMTER™ Serial Control Protocol

When in Serial Control (Terminal) mode, the TIMTER™ is controlled via a simple three-wire serial interface (transmit, receive, and ground). The serial port configuration is as follows:

- 57600 baud rate (changeable depending on the configuration option)
- 8 bits
- No parity
- 1 stop bit
- No flow control

For setup and configuration via a standard Windows-based PC, you may use HyperTerminal. For a more flexible, full-featured control interface, we recommend Terminal, available for download from the Quasonix website (Documents tab > Accessories link) or directly at:
http://www.quasonix.com/sites/default/files/terminal_ver20080315.zip.

If the terminal program is active when power is applied to the transmitter, the following welcome message displays, as shown in Figure 24. At this point, you can verify that your serial connection is active in both directions by issuing any standard command, such as “FR” to learn the frequency.

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```
Quasonix Multi-Mode Digital Transmitter

Customer Part # = QSX-xxx-xx-xx…
Customer Name = Quasonix Customer
Contract # = 999999-9
TX Serial # = 1001
Hardware Rev: A
PA Rev: F
PA Serial #: 1001
PA Model #: XMTR-PAM-10-F-SCPA
IRIG 106-09
6025 Schumacher Park Drive
West Chester, OH 45069
(513) 942-1287
www.Quasonix.com
CAGE CODE: 3CJA9
FPGA HW Type: T4D
FPGA version: 001h 02ah
FPGA Buld: 0x5B6C5E7C =  Aug 9 2018 15:32:12
Firmware version: T4 V1.131 8/9/2018

Preset 0 read
SOQPSK>HVA table not valid for any band.
DL table not valid for any band.
Ready for Commands
SOQPSK>RF on/off pin changed from 0 to 1
SOQPSK>BB clock rate out of limits (clk = 0 kHz)
SOQPSK>
```

Figure 24: TIMTER™ Welcome Message

4.2.1 Command Set: Standard and Optional Commands

All standard and optional user commands in Table 13 consist of one or two alphabetic characters, followed by 0, 1, or 2 arguments. If the command is issued with arguments, there must be a space after the alphabetic characters. The commands are not case sensitive. A carriage return is required to initiate each command except for the single key commands described at the beginning of the table.

Most parameters set by these commands are stored in the unit's nonvolatile flash memory (CS and DS are the exception). On power-up, ALL settings are restored from preset 0, which is the default power on configuration. If the parallel interface is active, then any applicable configuration settings are read from the parallel port and updated accordingly after the initial power on sequence is completed. Refer to the Startup Configuration command (SC) for exceptions.

All settings can be changed via the serial control port; however, parallel port settings will in general override the serial port settings. However, configurations can only be saved from the serial control port. Changes made by the user via either method are NOT saved unless the Save command (SV) is issued from the serial control port before powering down.

***SV Note:** Users may save internal clock and data in presets for bench debug use BUT on a power up or when a *hardware* preset is restored, **CS** and **DS** will be forced to **0** (external clock and data). This action prevents a transmitter from powering up or

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changing hardware presets and being set to internal clock and/or data. The ONLY way to restore CS and/or **DS** as **1** from a saved configuration is by executing the **RC** command.

Note: All user commands do not apply to all transmitters. Command availability varies depending on the options ordered and any project specific customization applied. Questions? Please call Quasonix for assistance.

Table 13: Standard and Optional User Commands

Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
[	Frequency Step Down	Left square bracket key retunes the transmitter to the next lower frequency, as determined by the frequency step (FS) parameter Reply to the control window is the new frequency, in MHz No Enter key required	Standard	N/A	N/A
]	Frequency Step Up	Right square bracket key retunes the transmitter to the next higher frequency, as determined by the frequency step (FS) parameter Reply to the control window is the new frequency, in MHz No Enter key required	Standard	N/A	N/A
?	Help	Displays abbreviated list of available commands No Enter key required	Standard	N/A	N/A
<	Step Down Power	Incrementally steps down the output power level, from 31 down to 0 One step per key press No Enter key required	VP	N/A	N/A
>	Step Up Power	Incrementally steps up the output power level, from 0 up to 31 One step per key press No Enter key required	VP	N/A	N/A

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Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
AC	Automatic Carrier Output	Report or set automatic carrier output state With automatic carrier ON (AC 1), the unit will output an unmodulated, on-frequency carrier if there is no clock present. When automatic carrier is OFF (AC 0), the RF output will be muted in the absence of clock. Note that the AI, CF, and CS commands can create a clock, even when one is not externally applied. Examples: AC Report the automatic carrier state AC 0 Set automatic carrier OFF AC 1 Set automatic carrier ON	AC	N	AC 1
AFMS	Analog FM	Set analog FM mode Examples: AFMS 1.0 Set analog FM deviation in units of MHz per volt	FM	Y	AFMS 0
AI	Aux Input Select	Enable, disable, or show the current state of the auxiliary input With the auxiliary input active, the unit automatically switches to clock-free operation (CF 0). Examples: AI Report the current value of AI AI 1 Enable the aux input AI 0 Disable the aux input	AI	Y	AI 0

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Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
AIR	Analog Input Reference Select	Select the reference level for the analog input Examples: AIR Report the current value of AIR AIR 1 Select 1.65V AIR 0 Select 0V Refer to section 4.2.1.1.2 for related IS command detail	AI (also Rev J or newer T3D board)	Y	AIR 0
BR	Bit Rate	Used when the Clock Free (CF) option is specified and internal transmitter clock is in use Report or set the bit rate of the bit sync that is locking to the externally applied data Not to be confused with “IC”, which sets the rate of the internally generated clock Bit rate must be below 35 Mbps to use automatic bit rate detection Examples: BR Report the bit rate BR 5 Set the bit rate to 5 Mbps BR A Set the bit rate automatically	CF	Y	BR 5
BT	Baseband Interface Type	Report or set the clock and data input reference levels Clock and data interfaces are set to either TTL or RS-422. Clock interface and data interface are always the same type. Examples: BT Report the ref level BT 1 Set the baseband type to TTL BT 3 Set the baseband type to RS-422	Clock and Data Interface selection D or M required	Y	BT 3

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Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
CC	Convolutional Encoder	Enables or disables the convolutional encoder Examples CC Report convolutional encoder state CC 0 Set the convolutional encoder to Disabled CC 1 Set the convolutional encoder to Enabled	CE	Y	CC 0
CF	Clock Free	Report or set the clock free state Examples: CF Report the clock free state CF 0 Unit uses its internal bit sync (internally synthesized) CF 1 Unit uses its externally applied clock	CF	Y	CF 1
CG	Clock Generator Source Select	Report or set the clock generator output source Examples: CG Report the clock free state CG 0 Clock Gen output Off CG 1 Use Internal clock Refer to section 4.2.1.1.1 for additional CG command detail	CG	Y	CG 0

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Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
CP	Clock Polarity	Report or set clock polarity Examples: CP Display the current clock polarity CP 0 Set clock polarity to NOT inverted CP 1 Set clock polarity to inverted CP A Set clock polarity to auto; Automatically selects the most reliable clock edge	Standard	Y	CP A
CR	Current Preset Read	Reports the currently selected software preset being used by the transmitter	Standard	N/A	N/A
CS	Clock Source	Report or set the clock source Unit always reverts to CS 0 (external) at power-up Examples: CS Display the current clock source CS 0 Set clock source to external CS 1 Set clock source to internal When set to internal clock source, the data source must also be set to internal via the DS command in order to have synchronous, usable data.	Standard	N	CS 0

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Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
DD	Debounce Delay	Report or set the time, in milliseconds (ms), that the unit will idle after a change is detected on the parallel interface before executing the change This command provides the user with the ability to either slow down changes to prevent accidental, and potentially illegal, frequency or mode alterations, or to reduce the time the transmitter takes to update after a hardware switch is altered. Valid entries are 500 – 9000 rounded to nearest 500 ms. Examples: DD Report the debounce delay DD 500 Set the debounce delay to 500 ms	PM or PF	Y	DD 500
DE	Differential Encoding	Report or set differential encoding for the SOQPSK-TG or other PSK mode (Differential encoding typically disabled for other modes) If LDPC enabled, DE resets to 0 Examples: DE Report the differential encoding setting DE 0 Set differential encoding OFF DE 1 Set differential encoding ON	Standard	Y	DE 1

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Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
DP	Data Polarity	Report or set data polarity Examples: DP Display the current data polarity DP 0 Set data polarity to NOT inverted (OFF) DP 1 Set data polarity to inverted (ON)	Standard	Y	DP 0
DS	Data Source	Report or set data source state Unit always reverts to DS 0 (external) at power-up Examples: DS Display current data source DS 0 Set data source to external DS 1 Set data source to internal (value of internal source is set by ID command)	Standard	N	DS 0
FO	Frequency Offset	Offsets the synthesizer +X MHz and the FPGA –X MHz Example: FO 0.0055 offsets 5.5 kHz	FO	Y	FO 0
FP	Read Frequency Plugs	Report the transmit frequency designated by the parallel port	PF or PM	N/A	N/A

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Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
FR	Frequency	If no argument is passed, it reports the frequency. If an argument is passed, it sets the frequency. The argument specifies the frequency in MHz. If the command is entered with a '?', then the allowed frequency ranges for this unit display. This command rounds the frequency to the nearest 0.5 MHz. If the rounded frequency is within one of the transmitter's allowed bands, the transmitter will tune that frequency and confirm the change for the user. If the frequency is outside of the allowed range for the unit, the transmitter will NOT retune but will report an error to the user. Examples: FR Display the current frequency FR ? Display allowed frequency ranges FR 1436.5 Set frequency to 1436.5 MHz	Standard	Y	FR 1436.5
FS	Frequency Step	If no argument is passed, it reports the current frequency step. If an argument is passed, it sets the frequency step size, which is activated by the left and right square bracket keys. The argument specifies the frequency step in MHz, with 0.5 MHz being the smallest available step. Examples: FS Display the current frequency step FS 1 Frequency step = 1 MHz	Standard	Y	FS 1

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Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
H or HE	Help	Displays a list of available commands Commands require a carriage return at the end of the line and may also accept parameters Some commands may not be enabled depending on required options	Standard	N/A	N/A
HP	High Power	Report or set high power level Valid range is 0 to 31 Examples: HP Report the present high power level HP 31 Set high power to 31 HP Max Set high power to the highest allowable value for the unit HP Min Set high power to the minimum allowable value for the unit	DP	Y	HP 31
HX	eXtended Help	Displays a full list of available commands	Standard	N/A	N/A

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Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
IC	Internal Clock Rate	Report or set the internal clock rate This rate is used if the clock source is set to internal (CS 1) and the data source is set to internal (DS 1). It should not be confused with "BR", which sets the rate of the internal bit sync, which phase locks to the externally applied data. If no argument is passed, the unit reports the clock frequency. If a valid frequency is given, the internal clock frequency is set. The frequency is in Mbps. Examples: IC Display current internal clock rate IC 4.95 Set internal clock rate to 4.95 MHz Valid range is 0.002 MHz – 28.0 MHz Observes same bit rate limits as HR/LR cmds (PCM/FM half)	Standard	Y	IC 5

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Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
ID	Internal Data Gen	Report or set the internal data pattern This setting is used if the Data Source is set to internal (DS 1) and the Clock Source is set to internal (CS 1). When setting the data, the argument must be “PN6” (or “PN06”), “PN11”, “PN15”, or “PN23”, or a valid 4 digit hexadecimal value. Examples: ID Report the internal data pattern ID PN15 Set internal data pattern to PN15 ID AA55 Set internal data pattern to 0xAA55 In SOQPSK mode, ID 5555 or ID AAAA will result in an unmodulated carrier, at the nominal carrier frequency. Note: If the CP07 option is present, the input argument does not include the “PN” and a hexadecimal value requires the addition of a leading “x”, as shown in the following example. CP07 Examples: ID Report the internal data pattern ID 15 Set internal data pattern to PN15 ID xAA55 Set internal data pattern to 0xAA55	Standard	Y	ID PN15

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Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
IS	Input Source Selection	Selects the clock and data source (and user pattern and clock rate, where applicable) using a single command IS PN15 4.5 Sets unit to internal clock/data with a PN15 pattern at 4.5 Mbps IS AT AUTO Sets unit to use the auxiliary TTL input in clock free mode with auto bit rate enabled IS EN 10 Sets unit to use the Ethernet interface for both clock and data and to set the desired bit rate to 10 Mbps Refer to section 4.2.1.1.2 for additional IS command detail	Standard on all T3 units version 2.409 or greater	N/A	N/A
LC	List Configurations	Lists the stored configurations on the unit If a configuration number is supplied, then the saved parameters for that configuration are displayed. Examples: LC List all internal saved configurations LC 7 Show configuration 7 details	Standard	N/A	N/A

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Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
LD	LDPC Encoding Enable	Enable, disable, or show the current state of the Forward Error Correction (FEC) / Low Density Parity Check (LDPC) encoder Examples: LD Show the current encoder state LD 1 Enable the LDPC encoder LD 0 Disable the LDPC encoder Automatically disables differential encoding; *PSK modes default to DE enabled Automatically re-enables DE for SOQPSK mode Refer to section 4.2.1.1.3 for additional LD command detail	LD, LD6	Y	LD 0
LP	Low Power	Report or set low power level Valid range is 0 to 31 Examples: LP Report the present low power level LP 3 Set low power to 3 LP Max Set low power to the highest allowable value for the unit LP Min Set low power to the minimum allowable value for the unit	DP	Y	LP 0
MA	Modes Allowed	Reports the modes enabled on the transmitter, as determined by the part number	Standard	N/A	N/A

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Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
MC	NRZ-M Conversion	Enables or disables the NRZ-L to NRZ-M conversion Examples: MC Show the current NRZ state MC 1 Enable the NRZ-L to NRZ-M conversion MC 0 Disable the NRZ-L to NRZ-M conversion	CE	Y	MC 0
MJ	Modulation Scaling Step Size	Sets the current modulation scaling factor used when the single key Power Step Up and Power Step Down functions are used Valid range is .0009 to 10.01	MS	Y	MJ 1.5
MO	Modulation	Report or set modulation setting Mode 6, Carrier only, is present on every transmitter Examples: (depending on modes ordered) MO Report the modulation setting MO 0 Set modulation to PCM/FM MO 1 Set modulation to SOQPSK-TG MO 2 Set modulation to MULTI-h CPM MO 3 Set modulation to BPSK MO 4 Set modulation to QPSK MO 6 Carrier only, no modulation MO 7 Set modulation to OQPSK MO 8 Set modulation to UQPSK MO 10 Set modulation to STDN MO 11 Set modulation to SQPN MO 12 Set modulation to Analog_FM	MO 12 requires FM option All other mode availability dependent on modes ordered	Y	MO 0 or the first one the customer has installed on the unit Example: MO 1 if no PCM/FM installed; MO 2 if only CPM installed

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Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
MS	Modulation Scaling	Scales the deviation (modulation index) of the transmitted signal relative to the standard default deviation Example: For PCM/FM – if the standard modulation index is 0.7, setting MS to 2.0 scales a modulation index of 1.4 Value range is .09 to 10.01	MS	Y	MS 1
OC	Overtemperature Control Enable	Enables or disables overtemperature control OC 0 Disable Overtemperature Control OC 1 Enable Overtemperature Control If the transmitter temperature goes above the set limit stored on the device and the current power level is over 25, the transmitter automatically starts to back off power in 2 dB steps to a maximum of 6 dB.	Standard	Y	OC 1
PF	PSK Filter Select	Sets or shows the current PSK filter selection This is valid if the PSK mode option is enabled and for any *PSK (legacy) modes AND for DPM (no option required) if that mode exists on the transmitter. Valid filter range is 0 to 255 Examples: PF Show current PSK filter PF 42 Set PSK filter to 42	All *PSK	Y	PF 255 (PF 10 if DPM)

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Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
PL	Power Level	PL reports or sets the current power level setting for the dual power feature. If the user enters 1, the power level is set to current "high" power level (refer to HP command). If the user enters 0, then power is set to the current "low" power level (refer to LP command). Examples: PL Report the current power level state PL 0 Set the current power level to "low" PL 1 Set the current power level to "high" Disabled in Parallel Mode	DP	Y	PL 0
PR or RE	Restore Defaults	Restores factory default parameters for the unit Default is currently the lowest number modulation supported by the transmitter with the selected band and frequency limits Default power level is Full power	Standard	N/A	N/A
QA	Query All	Displays common device settings in one compact display Display is a subset of SS or ST	Standard	N/A	N/A
QT or TE	Query Temperature	Report the temperature in degrees Celsius	Standard	N/A	N/A
RA or RN	Randomizer	Report or set randomizer state Examples: RA Report the randomizer state RA 0 Set randomizer OFF RA 1 Set IRIG-106 randomizer ON RA 2 Set CCSDS randomizer ON	Standard RA 2 requires LD6 option and LDPC enabled	Y	RA 0

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Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
RC (or PP or RL)	Recall Configuration	Load a saved configuration into the active configuration if the configuration number entered is valid If the selected configuration has no valid data or the command is issued without a configuration number, the transmitter is initialized with the default data and saved. Example: RC Load configuration 0 (default setup) RC 3 Load configuration 3	Standard	N/A	N/A
RF	RF Output	Report or set RF output control state Note that there may be no RF output, even if the software control is set to ON. This can happen if there is no valid clock in use, or if the RF On/Off hardware pin is in the OFF state. Examples: RF Report the RF output state RF 0 Set RF output OFF RF 1 Set RF output ON	Standard	Y	RF 1 (if option CP07, default is RF 0)

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Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
RZ	RF On/Off Pin Polarity	Set or show the polarity of the RF On/Off pin, which is pulled high internally to 3.3 VDC RZ 0 means the RF is ON when the RF On/Off pin is low RZ 1 means the RF is ON when the RF On/Off pin is high (floating) Examples: RZ Show the current RF On/Off polarity RZ 0 Set RF On/Off polarity to “pin low = on” RZ 1 Set RF On/Off polarity to “pin high = on”	Standard	Y	RZ 1
SB	Cycles per Bit	Report or set cycles per bit (The subcarrier frequency is cycles per bit times bit rate.) SB Report cycles per bit SB x Set cycles per bit	STDN	Y	SB 0
SC	Startup Configuration	Report or set startup configuration priority between nonvolatile settings and parallel port settings Examples: SC Report startup configuration priority SC 0 Prioritize stored parameters SC 1 Prioritize parallel port settings SC 2 Always ignore parallel port settings SC 3 Always ignore serial frequency or mode command	PM or PF	Y	SC 1

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Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
SM	Modulation Sweep	Sweeps the transmitter modulation between the provided limits with the provided step size at a fixed rate Examples: SM Toggle sweep ON/OFF with current values SM ? Displays current sweep state SM start stop step msec start = low index stop = high index step = index step size msec = milliseconds between steps	MS	N	SM Disabled
SN	Serial/Part Number	Report the serial number and part number for the unit	Standard	N/A	N/A
SS	Show Settings	Displays most of the common device settings in one compact display	Standard	N/A	N/A
SV or SA (or PS or PW)	Save Configuration	Saves the current transmitter configuration to a user-selected preset number, from 0 to 15 where 0 is the power-on default unless hardware presets are enabled The SV command also allows the user to assign an alias to the desired preset. Examples: SV 1 Save current configuration to preset 1 SV 7 xyz Save current configuration to preset 7 and assign alias name “xyz” *Refer to SV Note below for exception	Standard	N/A	N/A

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Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
SY	System Status	Displays the system status of the transmitter The first argument specifies the period, in milliseconds, between status updates. Zero (0) disables continuous monitoring. The second argument specifies the number of status lines between header outputs. Examples: SY Displays current status report settings SY 5 Sets status output period to 5 milliseconds SY 5 100 Sets status header output once every 100 status updates Refer to section 4.2.1.1.3 for additional SY command detail	Standard	N/A	N/A
TXBR	Transmitter Baud Rate	Temporarily changes system baud rate; for odd baud rates (non-standard) accuracy may vary Valid range is about 300 to 230,400 baud – Not saved Examples: TXBR Displays current system baud rate TXBR 200 Sets system baud rate to 200	Standard	N	N/A
VE (or RV)	Version (Revision Information)	Report the current Firmware (software) version information for the transmitter	Standard	N/A	N/A
VF	Variable FIFO Depth	Sets the FIFO depth for controlling latency time between bits in and bits out Valid range is 0 to 255 Example: VF 120 (120 = Variable Power)	VF	Y	VF 128

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Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
VP	Variable Power	Report or set variable power level Valid range is 0-31 Examples: VP Report the variable power level VP 31 Set variable power to 31 VP 5 Set variable power to 5 VP Max Set variable power to the highest allowable value for the unit VP Min Set variable power to the minimum allowable value for the unit	VP	Y	VP 0
ZX	Show Preset Inputs	Displays the current preset inputs on the parallel connector Available presets depend on the number specified for the unit Values are PS2, PS4, PS8, or PS16	Standard	N/A	N/A
ZY	Show Connector	Displays the transmitter's baseband connector pinout with proper gender, numbering, and signal labeling Valid only with standard 15-pin transmitters	Standard	N/A	N/A
ZZ	Show Options	Displays the current hardware configuration and options on the transmitter	Standard	N/A	N/A

All commands generate a response of one or more lines, which indicate successful completion of the command or an error.

After a command's response, the transmitter displays the mode name followed by the character ">" as a prompt, which may be interpreted as meaning the radio is ready to accept new characters. If the CP07 option is enabled, only the character ">" displays as a prompt.

***SV Note:** Users may save internal clock and data in presets for bench debug use BUT on a power up or when a *hardware* preset is restored, **CS** and **DS** will be forced to **0** (external clock and data). This action prevents a transmitter from powering up or changing hardware presets and being set to internal clock and/or data. The ONLY way to restore CS and/or **DS** as **1** from a saved configuration is by executing the **RC** command.

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4.2.1.1 Additional Command Set Details

4.2.1.1.1 Clock Generator Source Select Command – CG

CG is only active if the unit has the -CG option. CG 0 is the default to match legacy units.

The CG command allows the user to pick one of the following for the clock generator output source:

0 Clock Gen output Off

1 Internal clock always

2 External clock always

3 Clock Free clock always

4 Active clock:

Internal clock if CS = 1

External clock if (CS = 0, CF = 1)

Clock Free clock if (CS = 0, CF = 0)

Syntax: CG 1 // Set CG output to external clock always

CG ? // Display the choices

4.2.1.1.2 Input Source Selection Command – IS

The IS command is used to select the clock and data source (and the user pattern and clock rate where applicable) for the transmitter with one command. This command can conceivably replace CS, DS, ID, IC, BR, BT, AIR, CF, and EN. *This command is standard on all T3 units version 2.409 or greater.*

Syntax: IS [ds/?/pnxx/XXXX [cs/AUTO/rate]]

where **ds** is data source which can be:

ET – external TTL data (if QSX-VxT or -VR enabled)

ER – external RS422 data (if QSX-VxR or -VR enabled)

EL – external LVDS data (if QSX-VxL or -VR enabled)

I – internal with currently selected data pattern

PNxx - internal with specified PN sequence

XXXX - internal with specified fixed 4 digit hex pattern

AB – auxiliary input bipolar data (if -CF and -AI enabled)

AT – auxiliary input TTL data (if -CF and -AI enabled)

EN – Ethernet (if -EN enabled)

If ds = ET, then cs MAY be:

- Nothing (defaults to ET for an external TTL clock)
- ET for an external TTL clock

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Actions: ds 0, cs 0, bt 1 (if needed), cf 1 (if needed)

- X for clock free with current BR (if -CF enabled)

  Actions: ds 0, cs 0, (bt 1 if needed), cf 0
- AUTO for clock free with BR = auto

  Actions: ds 0, cs 0, cf 0, br a (bt 1, ai 0, and en 0 if needed)
- XX.xxx for clock free with BR = XX.xxx

  Actions: ds 0, cs 0, cf 0, br XX.xxx (bt 1, ai 0, and en 0 if needed)

If ds = ER or EL, then cs MAY be:

- Nothing (defaults to ER for an external RS422 clock)
- ER for an external RS422 clock
- EL for an external LVDS clock

  Actions: ds 0, cs 0, bt 3 (if needed), cf 1 (if needed)
- X for clock free with current BR (if -CF enabled)

  Actions: ds 0, cs 0, (bt 3 if needed), cf 0
- AUTO for clock free with BR = auto

  Actions: ds 0, cs 0, cf 0, br a (bt 3, ai 0, and en 0 if needed)
- XX.xxx for clock free with BR = XX.xxx

  Actions: ds 0, cs 0, cf 0, br XX.xxx (bt 3, ai 0, and en 0 if needed)

If ds = I, then cs MAY be:

- Nothing (defaults to internal clock at current IC rate) (displayed)
- I for an internal clock at current IC rate (displayed)

  Actions: ds 1, cs 1, ic
- XX.xxx for internal clock with ic = XX.xxx

  Actions: ds 1, cs 1, ic XX.xxx

If ds = PNxx, then cs MAY be:

- Nothing (defaults to internal clock at current IC rate) (displayed)
- I for an internal clock at current IC rate (displayed)

  Actions: ds 1, cs 1, id pnxx, ic
- XX.xxx for internal clock with ic = XX.xxx

  Actions: ds 1, cs 1, id pnxx, ic XX.xxx

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If ds = XXXX, then cs MAY be:

- Nothing (defaults to internal clock at current IC rate) (displayed)
- I for an internal clock at current IC rate (displayed)

  Actions: ds 1, cs 1, id XXXX, ic
- XX.xxx for internal clock with ic = XX.xxx

  Actions: ds 1, cs 1, id XXXX, ic XX.xxx

If ds = AB, then cs MAY be:

- Nothing (defaults to clock free at current BR) (displayed)

  Actions: ds 0, cs 0, ai 1, cf 0 AIR 0 br (en 0 if needed)
- X for clock free with current BR

  Actions: ds 0, cs 0, ai 1, cf 0 AIR 0 br (en 0 if needed)
- AUTO for clock free with BR = auto

  Actions: ds 0, cs 0, ai 1, cf 0 AIR 0 br a (en 0 if needed)
- XX.xxx for clock free with BR = XX.xxx

  Actions: ds 0, cs 0, ai 1, cf 0 AIR 0 br XX.xxx (en 0 if needed)

If ds = AT, then cs MAY be:

- Nothing (defaults to clock free at current BR) (displayed)

  Actions: ds 0, cs 0, ai 1, cf 0 AIR 1 br (en 0 if needed)
- X for clock free with current BR

  Actions: ds 0, cs 0, ai 1, cf 0 AIR 1 br (en 0 if needed)
- AUTO for clock free with BR = auto

  Actions: ds 0, cs 0, ai 1, cf 0 AIR 1 br a (en 0 if needed)
- XX.xxx for clock free with BR = XX.xxx

  Actions: ds 0, cs 0, ai 1, cf 0 AIR 1 br XX.xxx (en 0 if needed)

If ds = EN, then cs MAY be:

- Nothing (defaults to Ethernet clock at current IC rate) (displayed)

  Actions: ds 0, cs 0, en 1 (cf 1 if needed) (ai 0 if needed)
- EN for Ethernet clock at current IC rate) (displayed)

  Actions:: ds 0, cs 0, en 1 (cf 1 if needed) (ai 0 if needed)
- XX.xxx for Ethernet clock with ic = XX.xxx

  : ds 0, cs 0, en 1 ic XX.xxx (cf 1 if needed) (ai 0 if needed)

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Notes:

1. Numbers need only as many significant digits as necessary. For example, to specify 10 Mbps (for either BR or IC) you can enter 10, 10.0, 10.000, etc.
2. Some command versions require the unit to have specific options and will not work without those options. For instance, you cannot specify EN for Ethernet unless the unit has the -EN option in the part number.
3. While this command incorporates the functionality of nine (9) or more commands, those commands are still usable. For example, if the unit has the -VR option then the BT command can still be used by itself to switch between TTL and RS-422 inputs for clock and data.

Examples:

IS ET unit	Sets unit to 'normal' mode expecting external TTL clock and data to be applied to the inputs
IS PN15 4.5	Sets unit to internal clock/data with a PN15 pattern at 4.5 Mbps
IS AT AUTO	Sets unit to use the auxiliary TTL input in clock free mode with auto bit rate enabled
IS EN 10	Sets unit to use the Ethernet interface for both clock and data and to set the desired bit rate to 10 Mbps

4.2.1.1.3 Low Density Parity Check (LDPC) Command – LD

The LD command enables, disables, and shows the current state of the Forward Error Correction (FEC) / Low Density Parity Check (LDPC) encoder. There is an optional selection for the block and rate selection. This requires purchase of the LD6 option which enables LD and enables user code selection. LD6 also allows the randomizer command (RA or RN) to select CCSDS, if LDPC is enabled.

This is only valid in *PSK modes, and it automatically turns OFF differential encoding. When LDPC is disabled, the state of DE is determined by the mode (eg. All *PSK modes default to DE On.)

If the transmitter includes the LD option (but not LD6), then LD 0 or LD 1 are used to disable or enable LDPC, as shown in the example immediately following. With the LD option, the block size and code rate are always 4096 2/3.

Examples:

LD Show the current encoder state

LD 1 Enable the LDPC encoder

LD 0 Disable the LDPC encoder

If the transmitter includes the LD6 option, the user may select from the six implemented LDPC codes. This also allows user selection of the CCSDS randomizer using the RA or RN command. Adding LD6 automatically enables the existing LD option.

The IRIG standard calls out six variants of LDPC codes—all combinations of two different information block sizes (k=4096 bits and k=1024 bits) and three different code rates (r=1/2, r=2/3, and r=4/5).

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LD6 Code	Block Size and Code Rate
0	k=4096, r=1/2
1	k=1024, r=1/2
2	k=4096, r=2/3
3	k=1024, r=2/3
4	k=4096, r=4/5
5	k=1024, r=4/5

With the LD6 option, use LD 0 or 1 to disable or enable LDPC, then use 0-5 to indicate the desired LDPC code. A space is required between the disable/enable code and the desired LDPC selection, as shown in the examples.

Examples:

LD 0 Disable the LDPC encoder

LD 1 2 Enable the LDPC encoder and set the block size and code rate to k=4096, r=2/3

LD 1 5 Enable the LDPC encoder and set the block size and code rate to k=1024, r=4/5

4.2.1.1.4 System Status Command – SY

The SY command is defined as follows.

```
Mode       CF Rate          Freq         Tmp         Crate
                (b/s)          (Hz)          ©         (b/s)
---------- ---------- ---------- ---------- ----------
     0     10001252   2255000000    27.0     19999948
```

Mode – Current mode number (such as 0 = PCM/FM)

CF Rate – Clock free estimated data rate. This rate is based on the external data input (TTL or RS-422) even if internal data is presently in use (CS = 1).

Freq – Tuned frequency

Tmp – Current temperature

Crate – Clock filter clock rate. This is the actual over the air bit rate, regardless of the selected data source, and including any increases due to encoding (LDPC or convolutional). IN clock free automatic mode, it may differ from CF Rate because it will track the bit sync rate (exact, if locked) rather than the clock free estimated rate (approximate).

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5 RF Output Notes

There are three methods of muting the RF output. If you do not have RF output, check these conditions:

1. RF On / Off command – From the control terminal, type **RF** to query the current state of the RF On/Off variable. If it is 0, type **RF 1** to turn the output back ON.
2. External clock removal – If the unit is configured to use the external clock (CS = 0), that clock's presence is detected. If it is not present, the RF output automatically shuts OFF. When the data clock comes back, the RF output automatically turns ON. The lag from data clock state change to RF output change is about 0.1 seconds.
3. RF On / Off pin – Pin 2 on the TTL interface or pin 7 on the RS-422 interface is a hardware RF On/Off control. If this pin is grounded, the RF is turned OFF. This hardware control overrides the RF On/Off serial command.

5.1 Troubleshooting the RF on a Quasonix Transmitter

The following is a quick, three-part test to verify that the RF output on the transmitter is working correctly. This procedure should work for most transmitters with no modifications, however the sheer number of extra options and variations means that some units will need some special instructions or may work slightly differently. Examples are auto-carrier (-AC option), clock free (-CF option) and recall-holdoff (-RH option). If the procedure below does not demonstrate the working RF output on the transmitter, please contact Quasonix technical support for further help in resolving the issue.

The three sections below demonstrate RF output functionality one step at a time: first a carrier, then a waveform based on internal clock and data, and finally the waveform using the user supplied external clock and data. Part one demonstrates a simple carrier output at the desired frequency. Part two demonstrates proper waveform modulation using internal clock and data generated by the transmitter itself. Part three switches to the user supplied external clock and data for normal operation. If the first two parts work correctly, then the only missing piece is the external clock and data, so resolving any final issues becomes easier.

Part 1: Checking for carrier power output on frequency

1. Turn on power to the transmitter.
2. Set the mode to 6 (carrier only) using command **MO 6**.
3. Set transmitter to the desired frequency using the **FR** command. For example, **FR 2200.5**.
   - To see the allowed frequencies on your unit, type **FR ?**.
4. Turn the soft RF control on with **RF 1**.
5. Use a Spectrum Analyzer to determine whether there is a stick at the desired frequency. If there is, go on to Part 2.
6. If there is no output, check the state of the RF On/Off pin.
   - If the pin appears to be in the correct state to enable the output, check the RF On/Off pin polarity using the **RZ** command.
   - If the polarity is incorrect, change it.
     - **RZ 1** sets the transmitter output to turn ON when the RF On/Off pin is high (3.3 VDC).
     - **RZ 0** sets the transmitter output to turn ON when the RF On/Off pin is low.
7. Is the output present now? If so, go on to Part 2 below. If not, call Quasonix for technical support.

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Part 2: Verifying modulation output on frequency with internal data

1. Turn on the transmitter.
2. Set the mode to one of the available modes on your unit. For example, **MO 0** for PCM/FM, **MO 1** for SOQPSK, etc.
3. Set transmitter to the desired frequency using the **FR** command. For example, **FR 2200.5**.
   - To see the allowed frequencies on your unit, type **FR ?**.
4. Turn the soft RF control ON with **RF 1**.
5. Enable the internal clock source with **CS 1**.
6. Enable the internal data source with **DS 1**.
7. Set the internal clock rate to 5 Mbps with **IC 5**.
8. Set the internal data pattern to PN15 with **ID PN15**.
9. Use a spectrum analyzer to verify the desired waveform on the RF output at the desired frequency.
10. If the waveform is NOT present, check the state of the RF On/Off pin. Use the **RZ** command to check the current polarity of the RF On/Off pin.
    - **RZ 1** sets the transmitter output to turn ON when the RF On/Off pin is high (3.3 VDC).
    - **RZ 0** sets the transmitter output to turn ON when the RF On/Off pin is low.
11. Change either the RF On/Off pin or the polarity to turn the RF output ON.
12. Check for the RF output on the spectrum analyzer.
    - Is the output present now? If so, go on to Part 3.
    - If not, call Quasonix for technical support.

Part 3: Verifying modulation output on frequency with user data

1. Turn on the transmitter.
2. Set the mode to one of the available modes on your unit. For example, **MO 0** for PCM/FM, **MO 1** for SOQPSK, etc.
3. Set transmitter to the desired frequency using the **FR** command. For example, **FR 2200.5**.
   - To see the allowed frequencies on your unit, type **FR ?**.
4. Turn the soft RF control on using **RF 1**.
5. Disable the internal clock source with **CS 0**. This is the normal state on power up for most units.
6. Disable the internal data source with **DS 0**. This is the normal state on power up for most units.
7. Be sure that a clock source is connected to the correct pins of the transmitter input connector with the correct type (TTL or RS-422) of signal and in the case of RS-422, the correct polarity.
8. Be sure that the clock source is ON and that the clock rate is within the allowed range for the mode selected. Typically this is 100 kbps to 28 Mbps for Tier 1 and 2 waveforms and 50 kbps to 14 Mbps for Tier 0.

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9. Be sure that a data source is connected to the correct pins, with the correct type (TTL or RS-422) and polarity as above.
10. Use a spectrum analyzer to verify the desired waveform on the RF output at the desired frequency.
11. If the waveform is NOT present, check the state of the RF On/Off pin. Use the **RZ** command to check the current polarity of the RF On/Off pin.
    - **RZ 1** sets the transmitter output to turn ON when the RF On/Off pin is high (3.3 VDC).
    - **RZ 0** sets the transmitter output to turn ON when the RF On/Off pin is low.
12. Change either the RF On/Off pin or the polarity to turn the RF output ON.

You may issue the RF command and observe the status which is returned. This status indicates whether the transmitter believes the RF output is actually ON or not.

The **SY** command may be issued to check the actual clock rate that the transmitter sees if no RF output is detected. One of the most common problems is a clock rate that is too high or too low (or missing) for the desired modulation.

Finally, if you have a full RF loop running with a BERT and are having trouble achieving a zero bit error rate or lock, try the loop using internal data with the standard PN15 bit pattern. Be sure the BERT pattern is set to match the selected data pattern (**ID** command) on the transmitter. Assuming the internal data syncs and produces a zero bit error rate, you can switch back to the external clock and data. In this case, you can also check (and change) the clock polarity (**CP**) the data polarity (**DP**), the randomizer (**RA**), and the differential encoder (**DE** – normally on for SOQPSK and off for other waveforms) to resolve the sync and bit error rate issues.

If you are still having difficulties at this point, then contact Quasonix technical support.

Quasonix Technical Support
(1-513-942-1287) or email (support@quasonix.com)

When calling technical support, it will speed things up if you have the following information handy:

- Model number (obtained with the **ZZ** command) ***Note that this is different from the customer part number.***
- Serial number (obtained with the **SN** command)
- Software Version (obtained with the **VE** command)

It is also helpful if you can call from a phone in your lab so our tech support people can actually walk you through setting, checking, and controlling your transmitter).

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6 Performance Specifications

6.1 RF Output

The minimum RF output power is one of the following: 10 mW, 20 mW, 5 W, 10 W, 20 W, or 25 W with the RF load VSWR < 2:1 at all phase angles from 0 to 360 degrees.

6.2 Electrical Current

The electrical current drain for TIMTER™ transmitters is provided in Table 14.

Table 14: DC Input Current at Standard Input Voltage

Band Type	Wattage	Maximum Current	Typical Current @ 28 VDC
L or S band	10 mWatt	0.3 amps	0.25 amps
L or S band	20 mWatt	0.35 amps	0.30 amps
L or S band	5 Watt	0.8 amps	0.7 amps
L or S band	10 Watt (2in³ packages)	1.4 amps	1.1 amps
L or S band	10 Watt (>2in³ packages)	1.8 amps	1.5 amps
L or S band	18 or 20 Watt	2.8 amps	2.5 amps
L/S band	5 Watt	1.2 amps	1.0 amps
L/S band	10 Watt	2.2 amps	1.8 amps
L band	18 or 20 Watt	3.2 amps	2.8 amps
S band	18 or 20 Watt	2.8 amps	2.5 amps
S band	25 Watt	3.2 amps	2.9 amps
C band	10 mWatt	0.3 amps	0.25 amps
C band	5 Watt	1.5 amps	1.3 amps
C band	10 Watt	2.4 amps	1.9 amps
C-band	18 or 20 Watt	3.4 amps	3.0 amps
L/C band and S/C band	10 mWatt	0.3 amps	0.25 amps
L/C band and S/C band	20 mWatt	0.35 amps	0.30 amps
L/C band and S/C band	10 Watt	2.0 amps	1.8 amps
L/C band and S/C band	18 Watt	3.5 amps	3.2 amps
L/S/C band	10 mWatt	0.45 amps	0.40 amps

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Band Type	Wattage	Maximum Current	Typical Current @ 28 VDC
L/S/C band	20 mWatt	0.50 amps	0.45 amps
L/S/C band	5 Watt	2.2 amps	1.5 amps
L/S/C band	10 Watt	2.5 amps	1.8 amps

6.3 Environmental Specifications

TIMTER™ transmitters meet the environmental requirements shown in Table 15.

Table 15: TIMTER™ Environmental Specifications

Environmental Specifications	Description
Operating temperature (10 mW, 20 mW, 1 W, 5 W, 10 W models)	-40°C to +85°C
Operating temperature (20 W and 25 W models)	-40°C to +70°C
Non-operating temperature (all models)	-55°C to +100°C
Operating humidity	0 to 95% (non-condensing)
Altitude	Up to 100,000 ft.

6.4 Carrier Frequency Tuning

The carrier frequency is selectable in 0.5 MHz steps. Frequencies supported by TIMTER™ transmitters are listed in Table 16.

Table 16: Carrier Frequencies (MHz)

Band ID Code	Band	Minimum Freq	Maximum Freq	Default Freq	Tuning Steps	Max Power
A	Lower S	2200.5 MHz	2300.5 MHz	2250.5 MHz	0.5 MHz	25 W
B	Mid C and Euro Mid C	5091.0 MHz	5250.0 MHz	5120.0 MHz	0.5 MHz	20 W
C	C “Low”	4400.0 MHz	4950.0 MHz	4620.0 MHz	0.5 MHz	20 W
D	C (with Mid C)	4400.0 MHz and 5091.0 MHz	4950.0 MHz and 5150.0 MHz	4620.0 MHz	0.5 MHz	20 W

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Band ID Code	Band	Minimum Freq	Maximum Freq	Default Freq	Tuning Steps	Max Power
E	(all) L, S, C	1435.5 MHz 1750.0 MHz 2200.5 MHz 2300.5 MHz 4400.0 MHz 5091.0 MHz 5150.0 MHz	1534.5 MHz 1855.0 MHz 2300.5 MHz 2394.5 MHz 4950.0 MHz 5150.0 MHz 5250.0 MHz	2370.5 MHz	0.5 MHz	10 W
F	S and C	2200.5 MHz and 4400.0 MHz	2394.5 MHz and 4950.0 MHz	2370.5 MHz	0.5 MHz	20 W
G	Euro Mid C	5150.0 MHz	5250.0 MHz	5150.0 MHz	0.5 MHz	20 W
H	L and C	1435.5 MHz and 4400.0 MHz	1534.5 MHz and 4950.0 MHz	1450.5 MHz	0.5 MHz	10 W
J	C, Mid C, and Euro Mid C	4400.0 MHz and 5091.0 MHz 5150.0 MHz	4950.0 MHz and 5150.0 MHz 5250.0 MHz	4620.0 MHz	0.5 MHz	18 W
K	S and C, Mid C, and (with Euro Mid C)	2200.5 MHz 4400.0 MHz and 5091.0 MHz 5150.0 MHz	2394.5 MHz 4950.0 MHz and 5150.0 MHz 5250.0 MHz	2370.5 MHz	0.5 MHz	18 W
L	Lower L	1435.5 MHz	1534.5 MHz	1450.5 MHz	0.5 MHz	20 W
M	Lower L, Upper L, and S	1435.5 MHz 1750.0 MHz and 2200.5 MHz	1534.5 MHz 1855.0 MHz and 2394.5 MHz	1450.5 MHz	0.5 MHz	20 W
N	Upper S	2300.5 MHz	2394.5 MHz	2370.5 MHz	0.5 MHz	25 W
Q	L, S, and C	1435.5 MHz 1750.0 MHz 2200.5 MHz 4400.0 MHz 5091.0 MHz	1534.5 MHz 1855.0 MHz 2394.5 MHz 4950.0 MHz 5150.0 MHz	1450.5 MHz	0.5 MHz	10 W
S	S	2200.5 MHz	2394.5 MHz	2370.5 MHz	0.5 MHz	25 W

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Band ID Code	Band	Minimum Freq	Maximum Freq	Default Freq	Tuning Steps	Max Power
T	Lower L and C	1435.5 MHz 4400.0 MHz 5091.0 MHz 5091.0 MHz	1534.5 MHz 4950.0 MHz 5150.0 MHz 5250.0 MHz	1450.5 MHz	0.5 MHz	20 W
V	S and C (with Mid C)	2200.5 MHz 4400.0 MHz and 5091.0 MHz	2394.5 MHz 4950.0 MHz and 5150.0 MHz	2370.5 MHz	0.5 MHz	20 W
W	S and C, Mid C, and (with Euro Mid C)	2200.5 MHz 4400.0 MHz and 5091.0 MHz 5150.0 MHz	2394.5 MHz 4950.0 MHz and 5150.0 MHz 5250.0 MHz	2370.5 MHz	0.5 MHz	18 W
X	Mid C band	5091.0 MHz	5150.0 MHz	5120.0 MHz	0.5 MHz	20 W
Y	L and C	1435.5 MHz 1750.0 MHz and 4400.0 MHz 5091.0 MHz	1534.5 MHz 1855.0 MHz and 4950.0 MHz 5150.0 MHz	1450.5 MHz	0.5 MHz	20 W
Z	L and Euro Mid C	1435.5 MHz and 5150.0 MHz	1534.5 MHz and 5250.0 MHz	1450.5 MHz	0.5 MHz	20 W

6.5 Carrier Frequency Error

The frequency error is less than ±20 ppm over all combinations of temperature, voltage, and aging (up to five years).

6.6 Bit Error Rate

The transmitter meets the following BER limits when tested with the Quasonix' multi-mode, multi-symbol trellis demodulator.

Table 17: Transmitter BER Specifications with Quasonix Demodulator

BER	Maximum Eb/N0 (dB)		
	PCM/FM, Tier 0	SOQPSK-TG, Tier I	MULTI-h CPM, Tier II
10-3	7.0	9.0	11.8
10-4	8.5	11.0	13.3
10-5	9.5	12.5	14.3

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BER	Maximum Eb/N0 (dB)		
	PCM/FM, Tier 0	SOQPSK-TG, Tier I	MULTI-h CPM, Tier II
10-6	10.5	14.0	15.3

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6.7 Modulated RF Power Spectrum

The transmitter's modulated spectrum complies with the IRIG-106 PSD mask:

$$\mathbf{M\ (dBc) = Max\ (\ \{K - 100\ log\ |f - f_c| + 90\ log\ (R)\},\ \{-(55 + 10\ log\ (P))\}\ ),\ |f - f_c| \geq R/m\ where}$$

M	=	power relative to unmodulated carrier (i.e., units of dBc) at frequency f (MHz)
f	=	frequency in MHz
f_c	=	the carrier frequency in MHz
R	=	the bit rate in Mb/s
P	=	the rated power output of the UUT, in Watts

and the values of K and m are as tabulated in Table 18.

Table 18: K and m Values per Waveform

	K	m
PCM/FM, Tier 0	-28	2
SOQPSK TG, Tier I	-61	4
MULTI-h CPM, Tier II	-73	4

As noted in the equation above, the mask has a floor at –(55 + 10 log(P)) dBc, and the mask imposes no limit on the spectrum for frequency offsets less than R/m. Representative examples of the transmitted spectrum, with the appropriate mask, are shown in Figure 25, Figure 26, and Figure 27.

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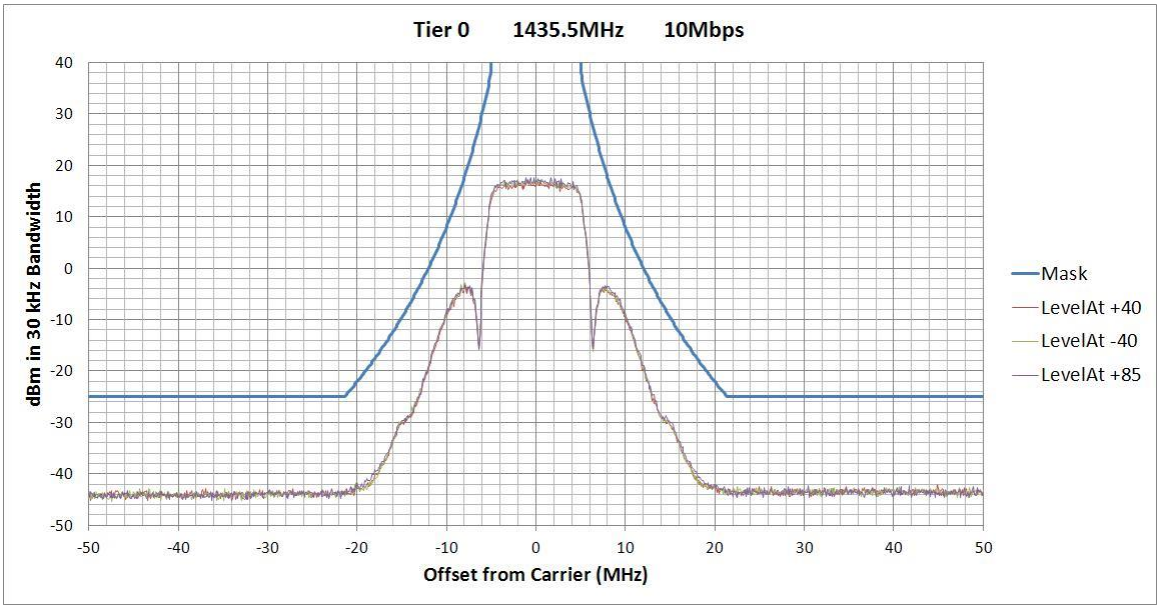


Figure 25: PCM/FM (Tier 0) Power Spectral Density with Mask

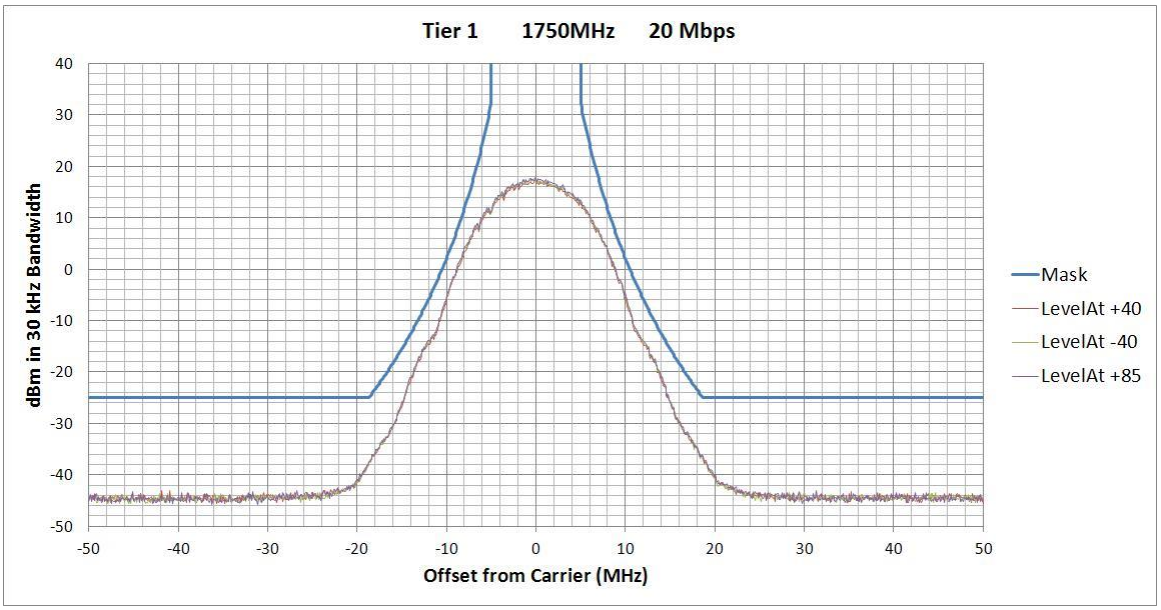


Figure 26: SOQPSK-TG (Tier I) Power Spectral Density with Mask

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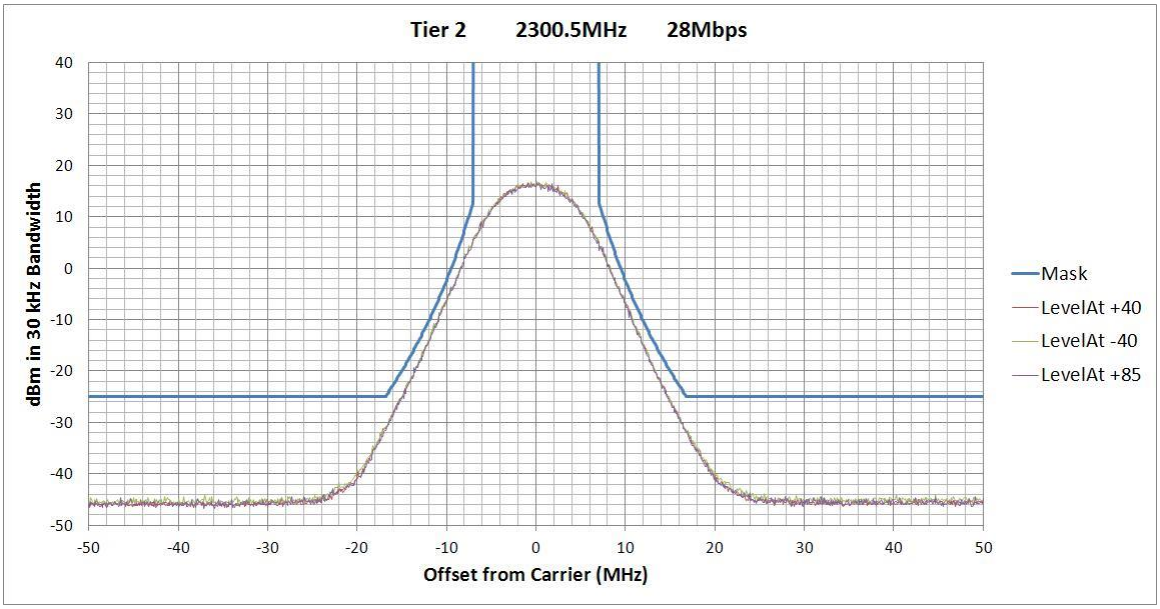


Figure 27: MULTI-h CPM (Tier II) Power Spectral Density with Mask

6.8 Phase Noise Power Spectrum

TIMTER™ phase noise limits are shown in Figure 28.

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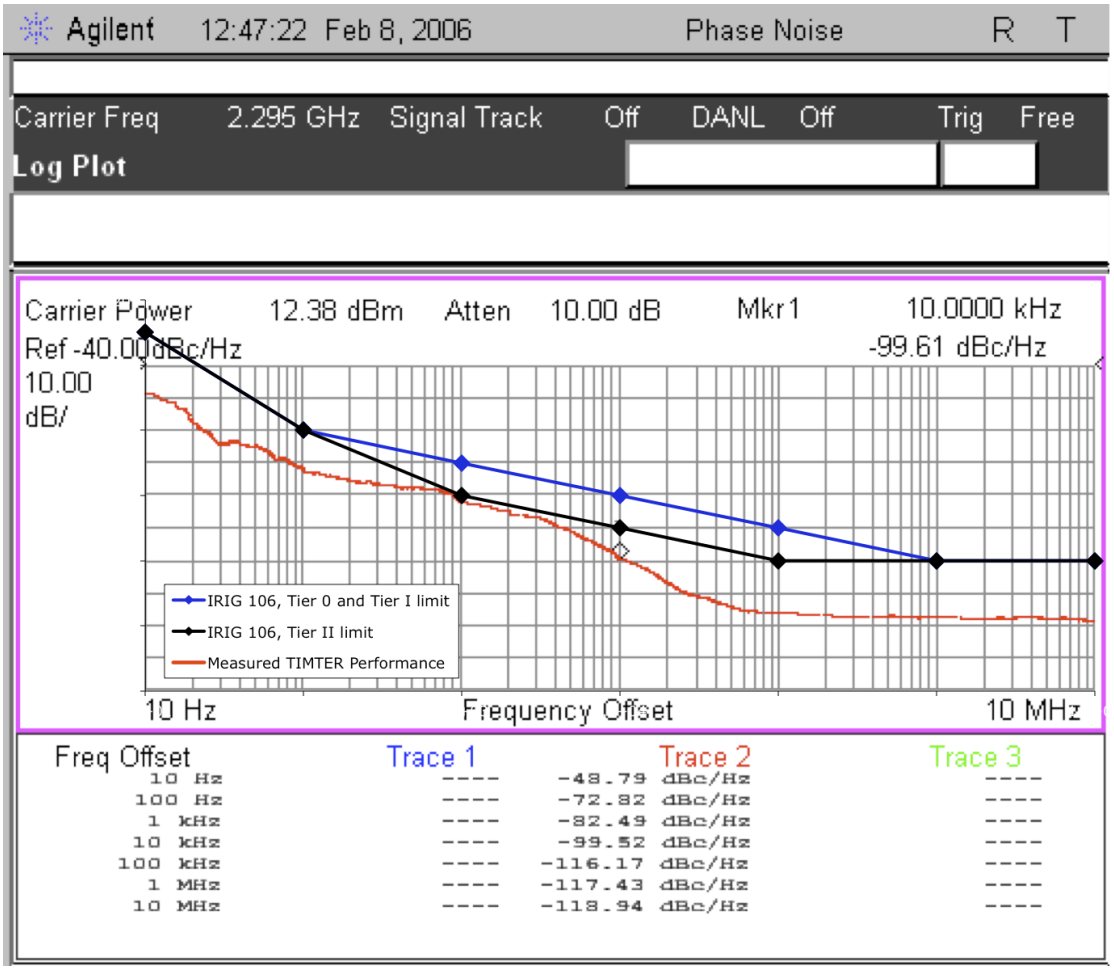


Figure 28: Phase Noise Limit Curve

6.9 Baseplate Temperature

TIMTER™ is designed for efficient heat transfer between internal heat producing sources and the baseplate. The 10 mW, 20 mW, 5 W, and 10 W TIMTER™ versions are rated for operation with baseplate temperatures ranging from -40°C to +85 °C, while the 20W version is rated from -40°C to +70 °C.

6.10 Vibration and Shock

The transmitter is designed and tested to operate normally when subjected to random vibration and shock. The shock and vibe test setup employed by Quasonix is shown in the following figures.

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Figure 29: Vibration / Shock Testing System

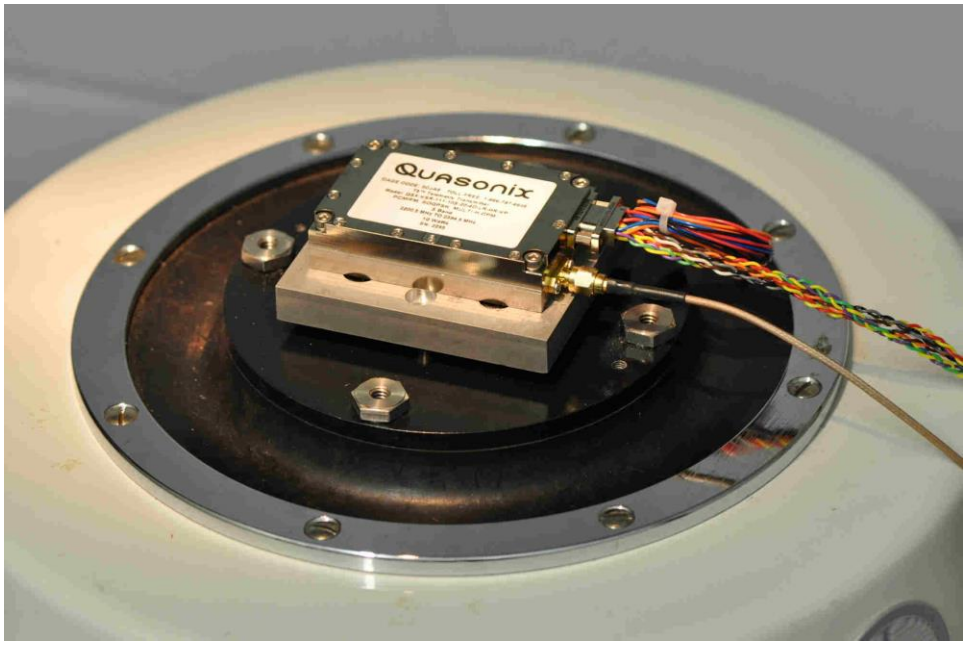


Figure 30: TIMTER™ Mounted for Z-axis Testing

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Figure 31: TIMTER™ Mounted for X-axis Testing

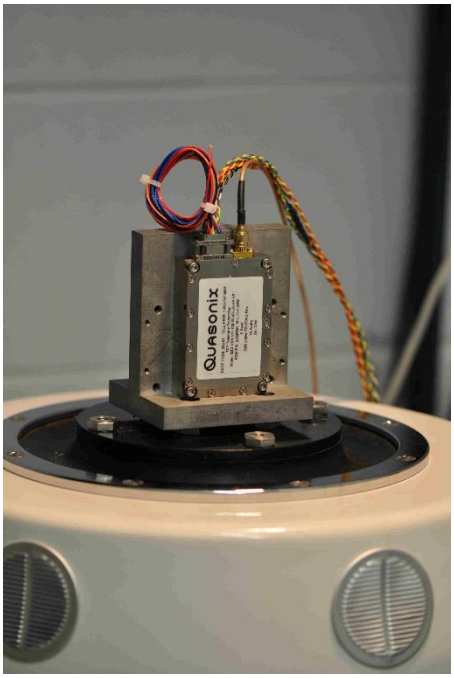


Figure 32: TIMTER™ Mounted for Y-axis Testing

6.10.1 Vibration Testing

Each transmitter is subjected to the random vibration spectrum depicted in Figure 33 and Table 19 prior to shipment.

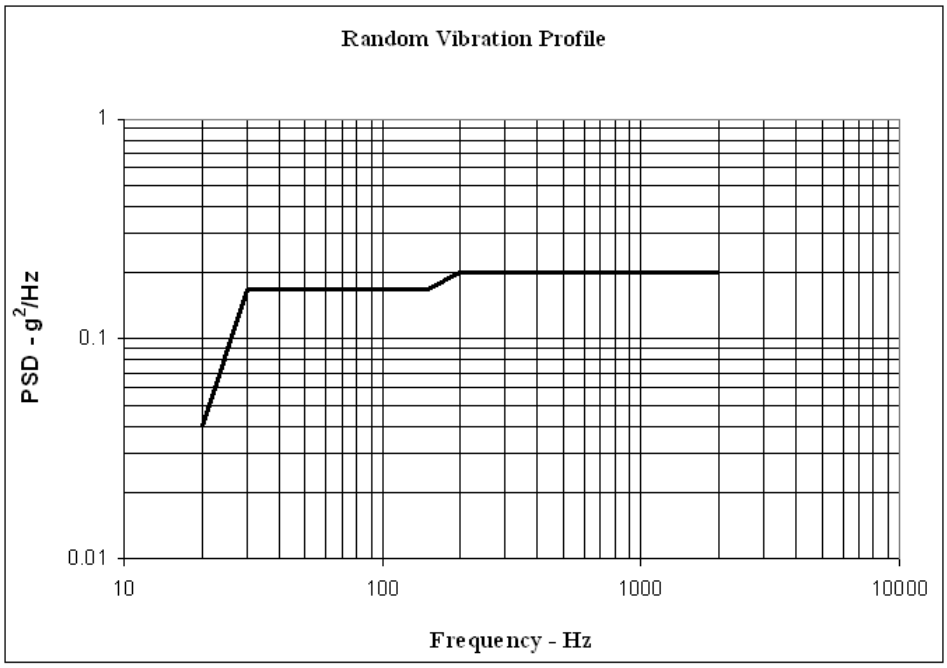


Figure 33: TIMTER™ Vibration Profile

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Table 19: Random Vibration Spectrum

Breakpoints	
Frequency (Hz)	**PSD (g2/Hz)**
20	0.04
30	0.17
150	0.17
200	0.2
2000	0.2
G (RMS) = 19.6	

During flight-qualification testing, the unit under test (UUT) was shaken for 30 minutes in each axis. The results are shown in Figure 34, Figure 35, and Figure 36.

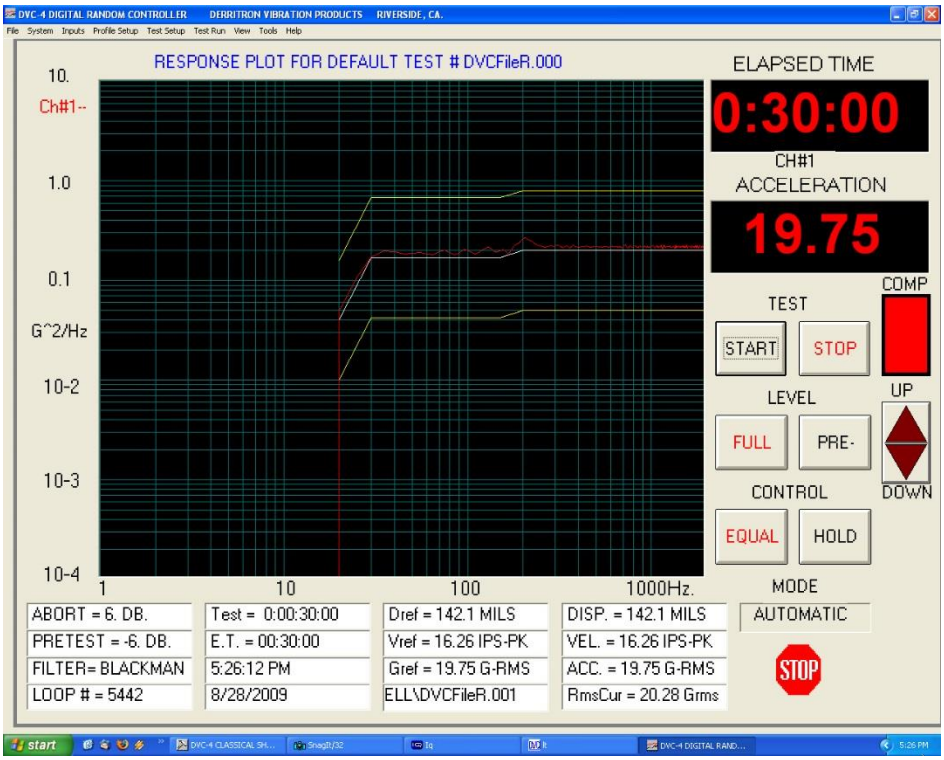


Figure 34: Z-axis Vibration Spectrum

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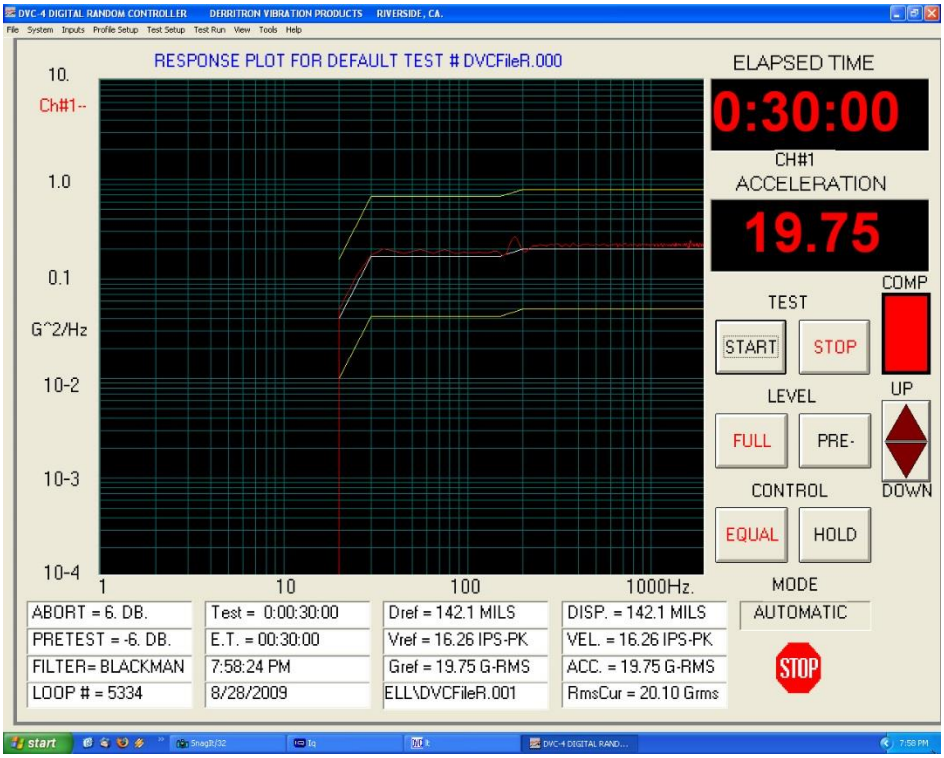


Figure 35: Y-axis Vibration Spectrum

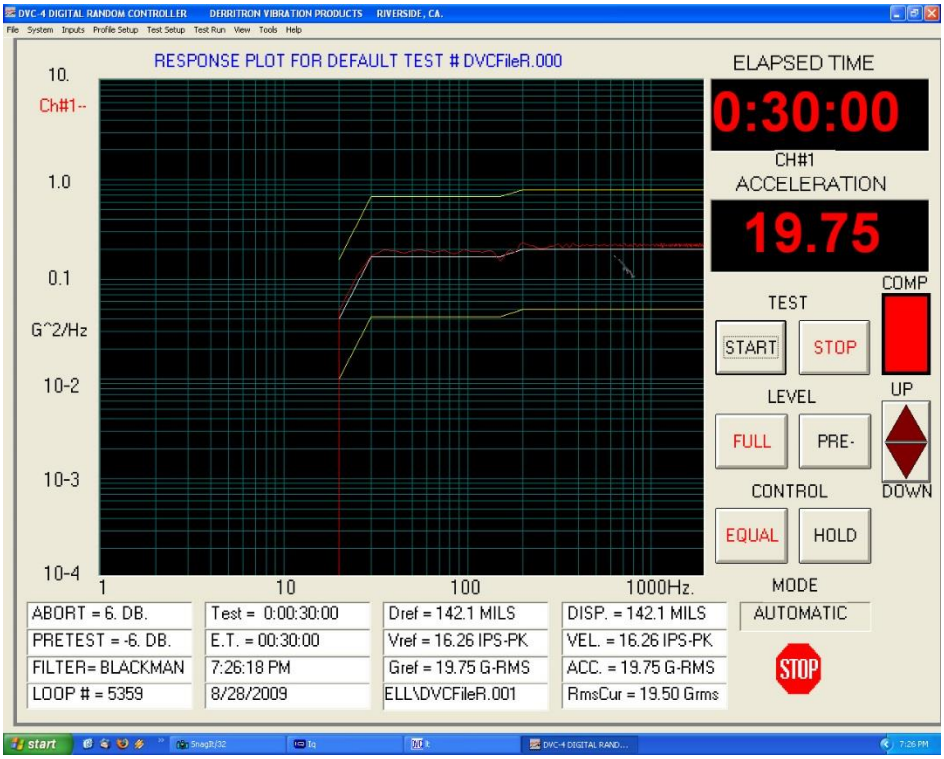


Figure 36: X-axis Vibration Spectrum

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6.10.2 Shock Testing

In addition to vibration testing, the UUT was subjected to shock pulses, as follows:

- Type: Half-sine
- Level: 60 g
- Duration: 5 milliseconds

Application: Three (3) shocks in each direction of the three (3) orthogonal axes both positive and negative, for 18 shocks total

The plots of the positive and negative pulses in each of the three axes are shown in the following figures:



Figure 37: Shock Pulse, Z-axis Positive

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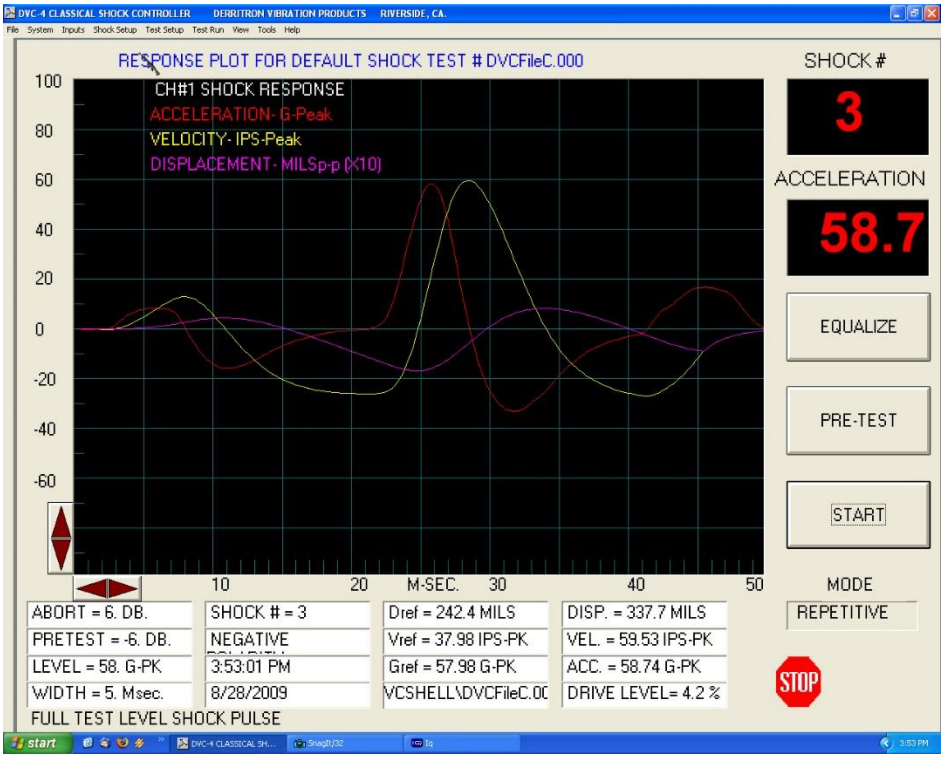


Figure 38: Shock Pulse, Z-axis Negative

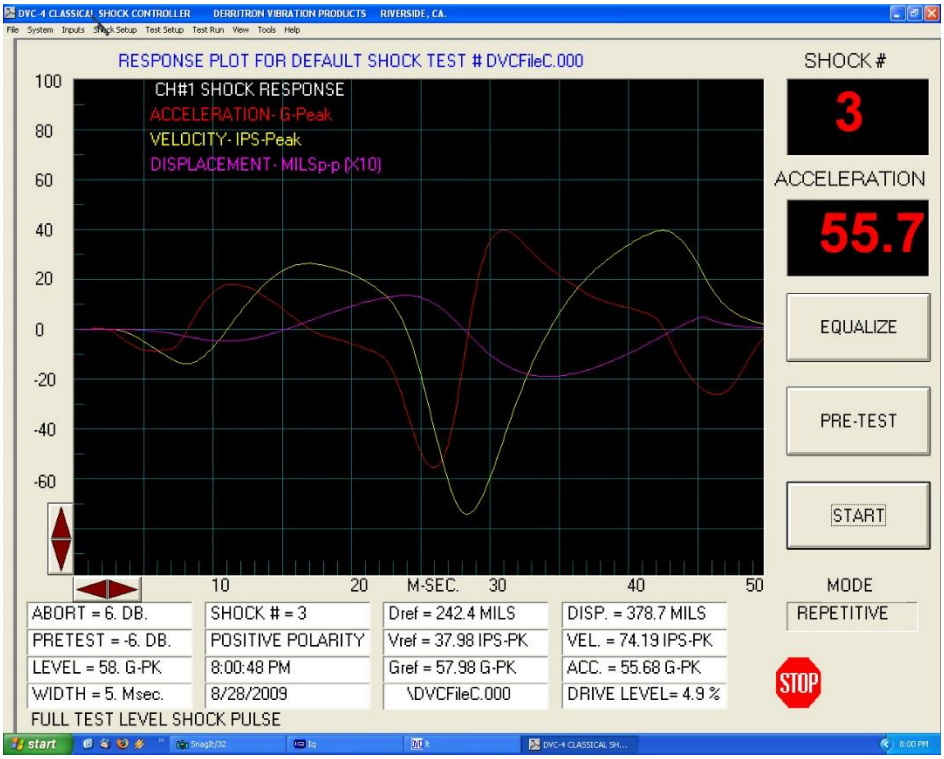


Figure 39: Shock Pulse, Y-axis Positive

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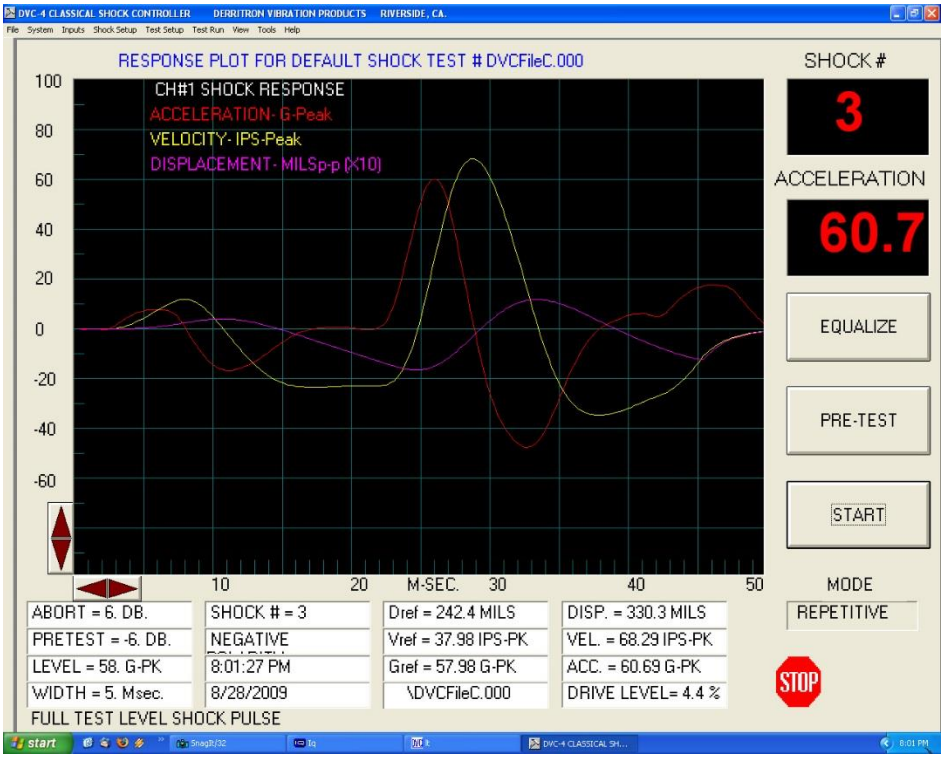


Figure 40: Shock Pulse, Y-axis Negative

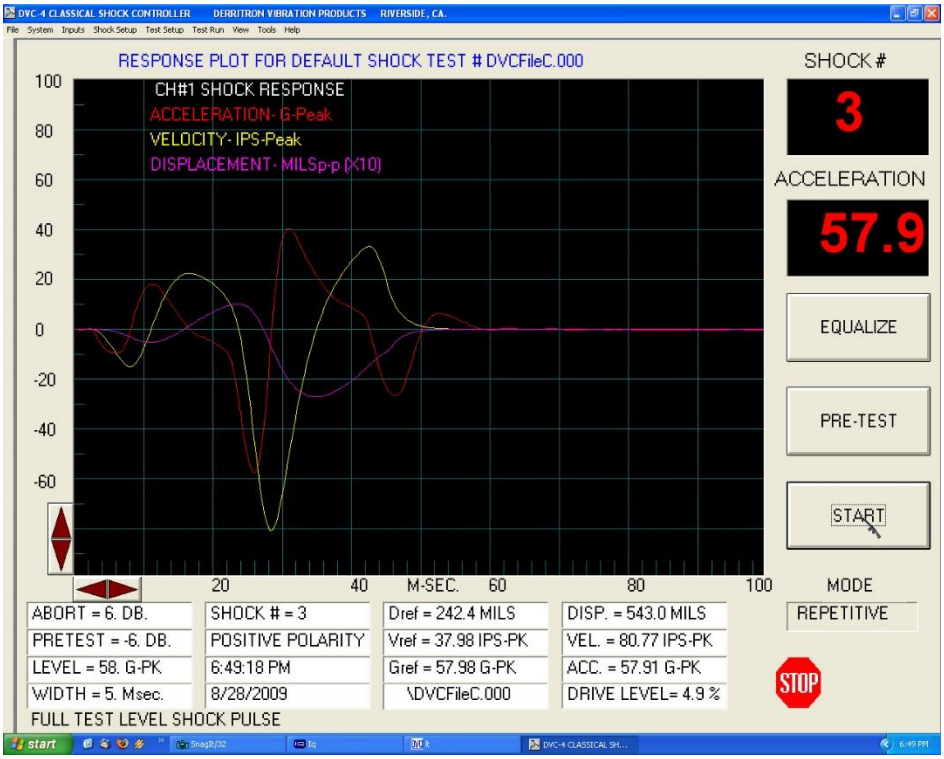


Figure 41: Shock Pulse, X-axis Positive

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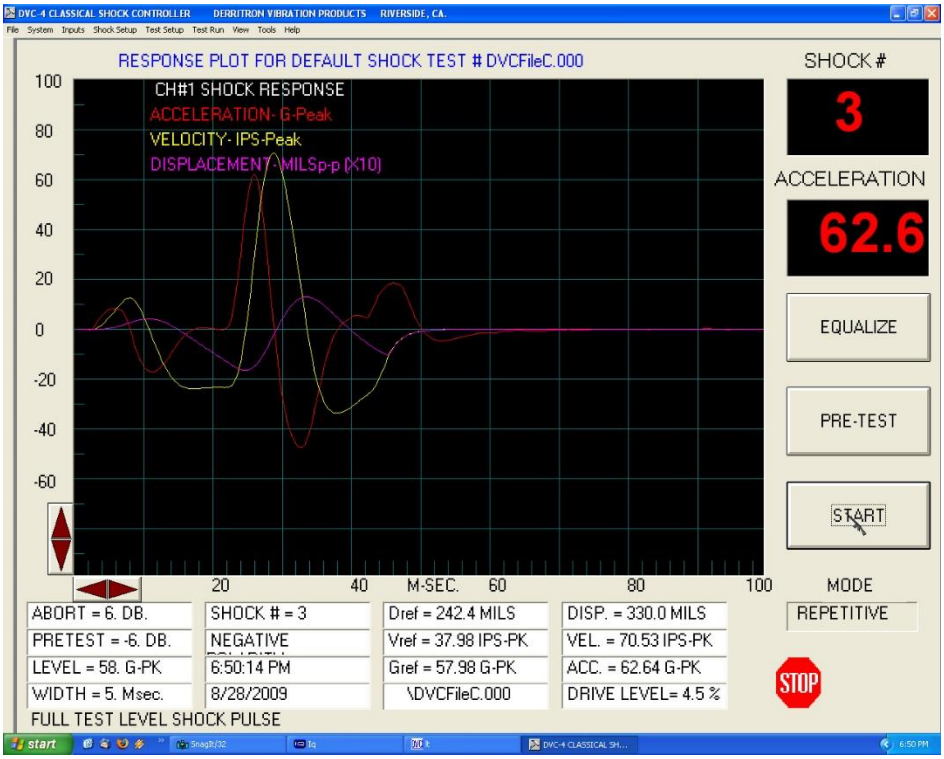


Figure 42: Shock Pulse, X-axis Negative

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7 Maintenance Instructions

The TIMTER™ transmitter requires no regular maintenance, and there are no user-serviceable parts inside.

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8 Product Warranty

The TIMTER™ transmitter carries a standard parts and labor warranty of one (1) year from the date of delivery.

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9 Technical Support and RMA Requests

In the event of a product issue, customers should contact Quasonix via phone (1-513-942-1287) or e-mail (support@quasonix.com) to seek technical support. If the Quasonix representative determines that the product issue must be addressed at Quasonix, a returned materials authorization (RMA) number will be provided for return shipment.

Authorized return shipments must be addressed in the following manner:

Quasonix, Inc.
ATTN: Repair, RMA #
6025 Schumacher Park Drive
West Chester, OH 45069

To ensure that your shipment is processed most efficiently, please include the following information with your product return:

- Ship To – Company name, address, zip code, and internal mail-drop, if applicable
- Attention/Contact person – Name, Title, Department, Phone number, email address
- Purchase Order Number – If applicable
- RMA Number – provided by the Quasonix representative

Please note that Quasonix reserves the right to refuse shipments that arrive without RMA numbers.

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10 Appendix A – Preset Option

The preset feature operates similar to the stored presets in a car radio. The presence of this option is designated by the characters “PS” and a number (2, 4, 8 or 16) appended to the standard model number. Transmitters with the preset option operate as follows:

1. The potential preset selection pins are pins 2, 6, 10, 11, 12 and 13 on the male MDM-15 connector, or pins 3, 7, 11, 12, 13 and 14 on the female MDM-15 connector. Of these pins, up to four may be used for presets depending on the device options. To see which pins are used for presets and which bits they represent, use the ZY command on the transmitter or refer to the documentation that came with your transmitter.
2. Left floating, (the pins are pulled up to 3.3 VDC internally), a pin represents a “0”, grounded is a “1”.
3. The 0000 state (all pins floating) provides normal operation.
4. The (up to) 15 other states (one or more pins grounded) select one of the presets.
5. Each preset stores a carrier frequency, modulation type, and various configuration values like randomizer, data inversion, differential encoding, etc. These settings can be viewed with the LC (list configurations) command from a terminal.
6. The preset pins are read only at power up. Changing the preset pins after power-on has no effect.
7. The presets are set (in your lab) from the 0000 state, using the “PS” or "SV" command. Storing a preset is done by configuring the device as you wish it to operate, then saving the setup toa particular preset. The save is performed by typing the following command:

   SV x [name]

   where x is the preset number (1-15 depending on the options) and name is an optional setup name stored with the setup. Alternatively, issue the “PS” command with a single-digit parameter (1 thru 15). So, “PS 5”, for example will store the current frequency and modulation setting in preset 5. “PS”, with no numeric value after it, reports the state of all presets. The LC command displays names for all setups or, if a setup number is entered, all the settings for that particular configuration.
8. Electrical connection note: The preset pins are connected directly to the FPGA in the unit, so it is important that the voltage on those pins never get outside the range of zero to 3.3 VDC. Voltages outside this range can cause permanent damage. Also, the internal pull-up is through a 25k Ohm resistor inside the FPGA, so it is important that the pins have a high impedance to ground (> 1 M Ohm) when the pins are floating. A true switch closure is ideal, although a transistor switch can be used as long as its “Off” impedance is sufficiently high.

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11 Appendix B – Acronym List

Acronym	Description
A	Amperes (amps)
AC	Automatic Carrier Wave option
AM	Amplitude Modulation
AQPSK	Variant of Quadrature Phase Shift Keying
ARTM	Advanced Range Telemetry
AUQPSK	Variant of Quadrature Phase Shift Keying
BER	Bit Error Rate
BNC	Bayonet Neill-Concelman Connector (RF Connector)
BPSK	Binary Phase Shift Keying
CF	Clock Free option
CG	Clock Generator option
CPM	Continuous Phase Modulation
DB	Data Bias Level option
DB-9	D-subminiature 9 pin Serial Connector
DD	Debounce Delay
DE	Differential Encoding
DDS	Direct Digital Synthesizer
DP	Data Polarity option
DP	Dual Power
DS	Data Source option
FPGA	Field Programmable Gate Array
FS	Frequency Step
HR	High Bit Rate
ID	Internal Data
kbps	Kilobits per second
KHz	Kilohertz
LC	List Configurations option
LR	Low Bit Rate

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Acronym	Description
LS	Lower S-band
MA	Modulations Allowed option
mbps	Megabits per second
MHCPM	multi-h Continuous Phase Modulation
MHz	Megahertz
MO	Modulation
mwatt	Megawatt
N	(connector type) Threaded RF connector
OQPSK	Offset Quadrature Phase Shift Keying
PCMFM	Pulse Code Modulation/Frequency Modulation
PF	Parallel Port Frequency
PL	Power Level
PM	Parallel Port Mode
PM	Phase Modulation
PSK	Phase Shift Keying
PW	Parameter Write option
QPSK	Quadrature Phase Shift Keying
QT	Query Temperature option
RC	Recall Configuration option
RF	Radio Frequency
RG	Reverse Gender option
RJ-45	Ethernet Connection Jack
RN	Randomizer option
RS-232	Recommended Standard 232 (Serial Communications)
SC	Startup Configuration option
SN	Serial Number
SOQPSK	Shaped Offset Quadrature Phase Shift Keying
SOQPSK-TG	Shaped Offset Quadrature Phase Shift Keying –Telemetry Group
SV or PS	Preset Save option

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Acronym	Description
TIMTER	Tier I Missile Test Transmitter
TRL	Tracking Loop
TTL	Transistor Transistor Logic
UDP	User Datagram Protocol
UQPSK	Unbalanced Quadrature Phase Shift Keying
US	Upper S-band
USB	Universal Serial Bus
UUT	Unit Under Test
VAC	Voltage Alternating Current
VDC	Voltage Direct Current
VP	Variable Power option
VR	Variable Reference Level
VSWR	Voltage Standing Wave Ratio
W	Watt
WAN	Wide Area Network
WV	Wide Input Voltage Range option

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