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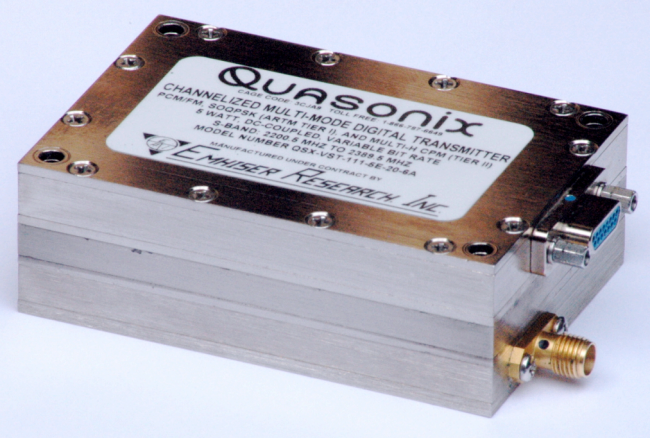
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Find the *Quasonix QSX-VSR-110-10S-20-6A* at our website: ***Click HERE***

Quasonix

Installation and Operation Manual

Enhanced ARTM Tier I Missile Test Transmitters (E-TIMTER)



Version 2.0e
11 November 2005

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1.0 INTRODUCTION

1.1 Description

This document describes the Installation and Operation of Quasonix' Enhanced Tier I Missile Test Transmitters (E-TIMTER). The transmitters are designed to transmit airborne telemetry data from a test article to ground stations.

The E-TIMTER is manufactured by:

Quasonix, LLC
7313 Overland Park
West Chester, OH 45069
CAGE code: 3CJA9

1.2 Nomenclature

The E-TIMTER is available in a number of variations, depending on the Options specified at the time of order. Table 1 describes the types and options.

Quasonix Model	Customer Type	Description
QSX-VLT-xyz-p-m20-6A	VLT	Transmitter, Missile Test, L-Band, TTL
QSX-VLR-xyz-p-m20-6A	VLR	Transmitter, Missile Test, L-Band, RS422
QSX-VST-xyz-p-m20-6A	VST	Transmitter, Missile Test, S-Band, TTL
QSX-VSR-xyz-p-m20-6A	VSR	Transmitter, Missile Test, S-Band, RS422

Options	
Variable Character	Feature
x	Tier 0 (PCM/FM) modulation: 0 = No, 1 = Yes
y	Tier I (SOQPSK-TG) modulation: 0 = No, 1 = Yes
z	Tier II (Multi-h CPM) modulation: 0 = No, 1 = Yes
p	RF output power: "00" = 5 mW, "5E" = 5 Watts, "10E" = 10 Watts
m	Minimum bit rate: m = no character: minimum bit rate = 620 kbps (Tier 0 and Tier I only) m = 1: minimum bit rate = 1 Mbps (Tier 0 and Tier I only) Minimum bit rate is always 5 Mbps in Tier II mode

Table 1. Transmitter Types and Options

The options installed in each unit are identified in the model number. For example, a model QSX-VST-110-10E-120-6A is identified as follows:

QSX	Quasonix product
V	Variable bit rate
S	S-band
T	TTL interface
110	Tier 0 present, Tier I present, Tier II absent
10E	10 Watt RF output, high efficiency design
120	Minimum bit rate = 1 Mbps, maximum bit rate = 20 Mbps
6A	6 cubic inch package, A configuration

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2.0 INSTALLATION INSTRUCTIONS

2.1 Mechanical

The E-TIMTER is designed to be mounted by four (4) 6-32 screws through the holes in the four corners, as depicted in Figure 1.

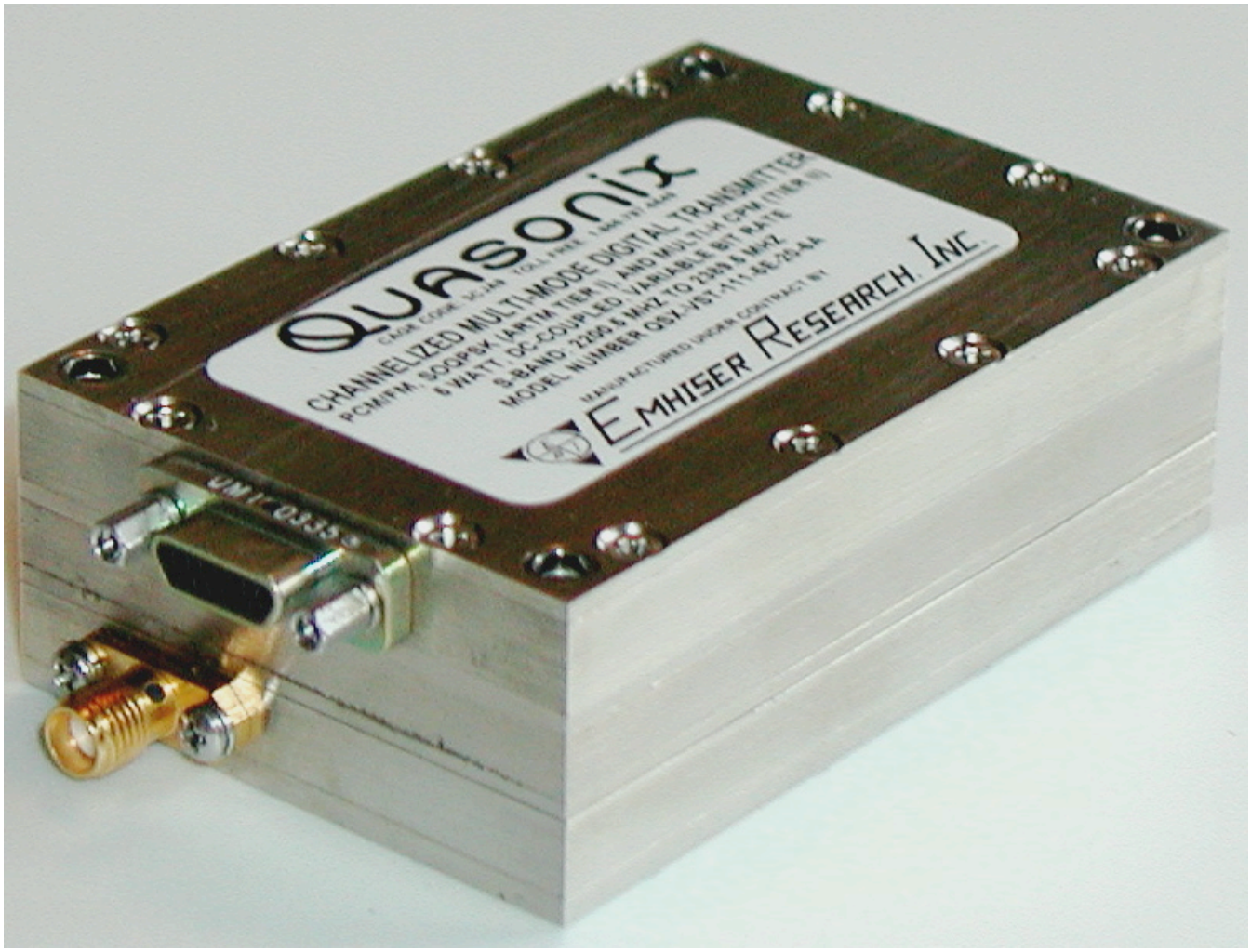


Figure 1. E-TIMTER

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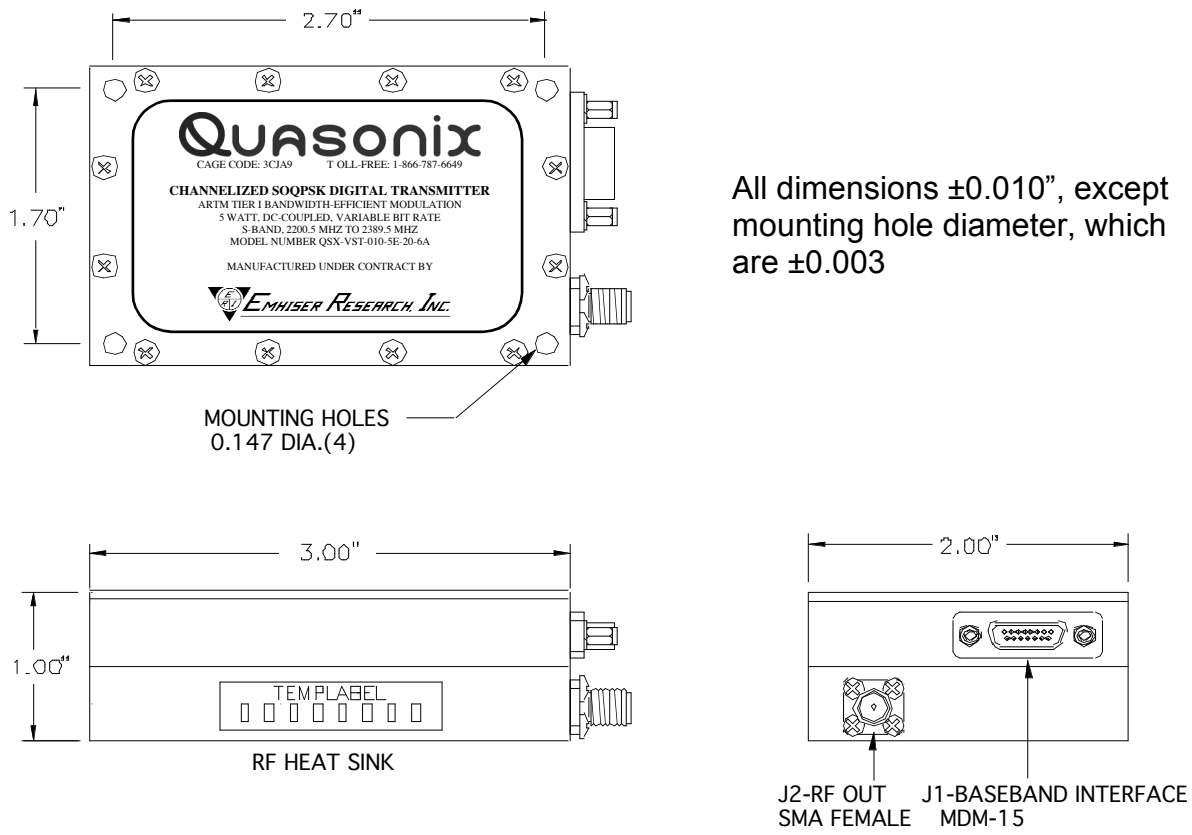


Figure 2. Outline Drawing, E-TIMTER Telemetry Transmitter

2.2 Thermal

It is important that the bottom surface (on the face opposite the product label) be securely attached to a baseplate capable of sinking approximately 35 watts of heat.

WARNING: DO NOT OPERATE THE UNIT WITHOUT A PROPER HEATSINK.

A Wakefield Engineering model 392-180AB has been found to be adequate, without forced air cooling.

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2.3 Electrical

The E-TIMTER has two external connectors, an MDM-15 for all baseband interfaces, and an SMA female for the RF output connection.

The pin numbering and wiring for the MDM-15 male connector (TTL interface) is shown in Figure 3, and the numbering and wiring for the MDM-15 female connector (TIA/EIA-422 interface) is shown in Figure 4.

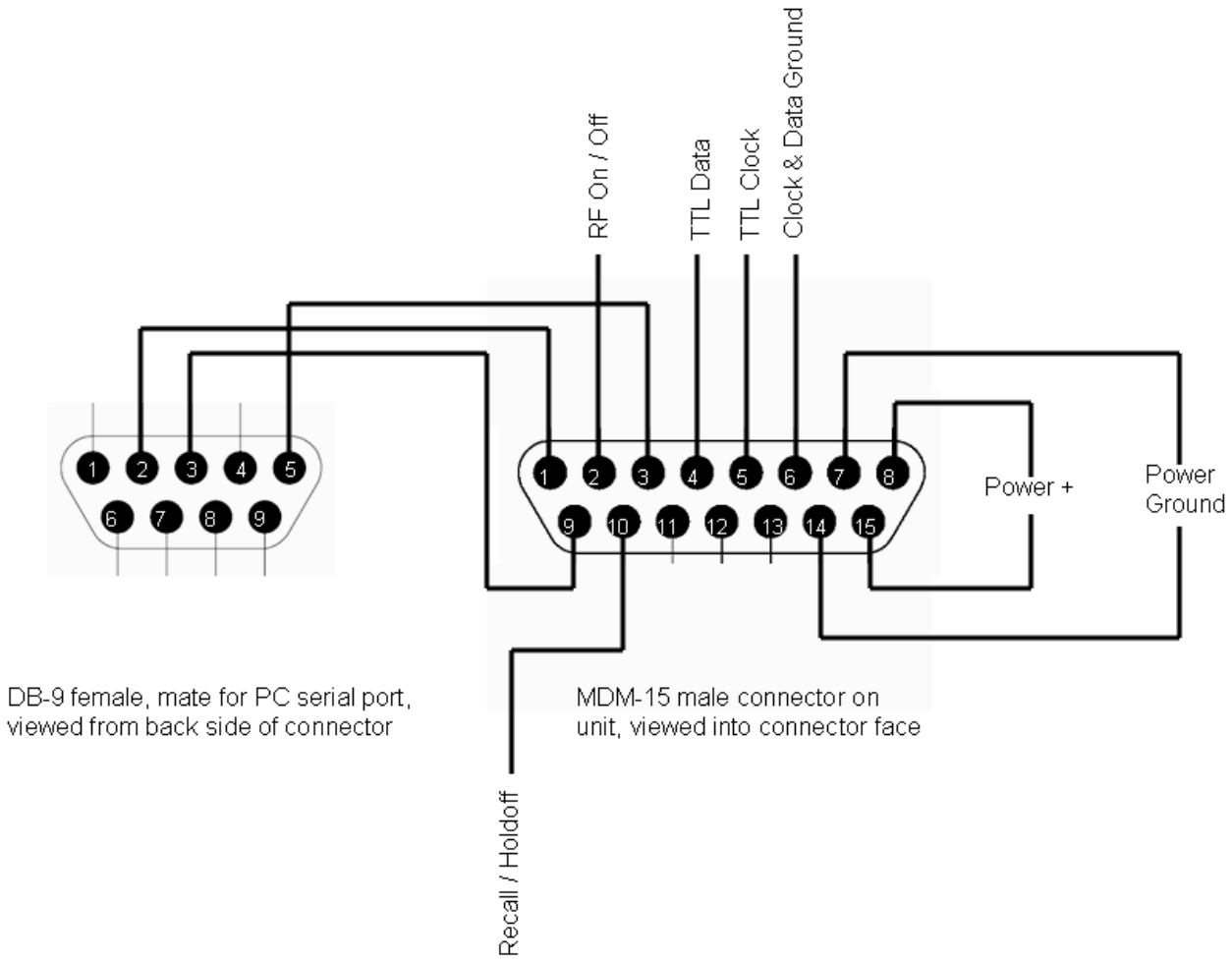


Figure 3. MDM-15 male pin numbering, TTL interface.

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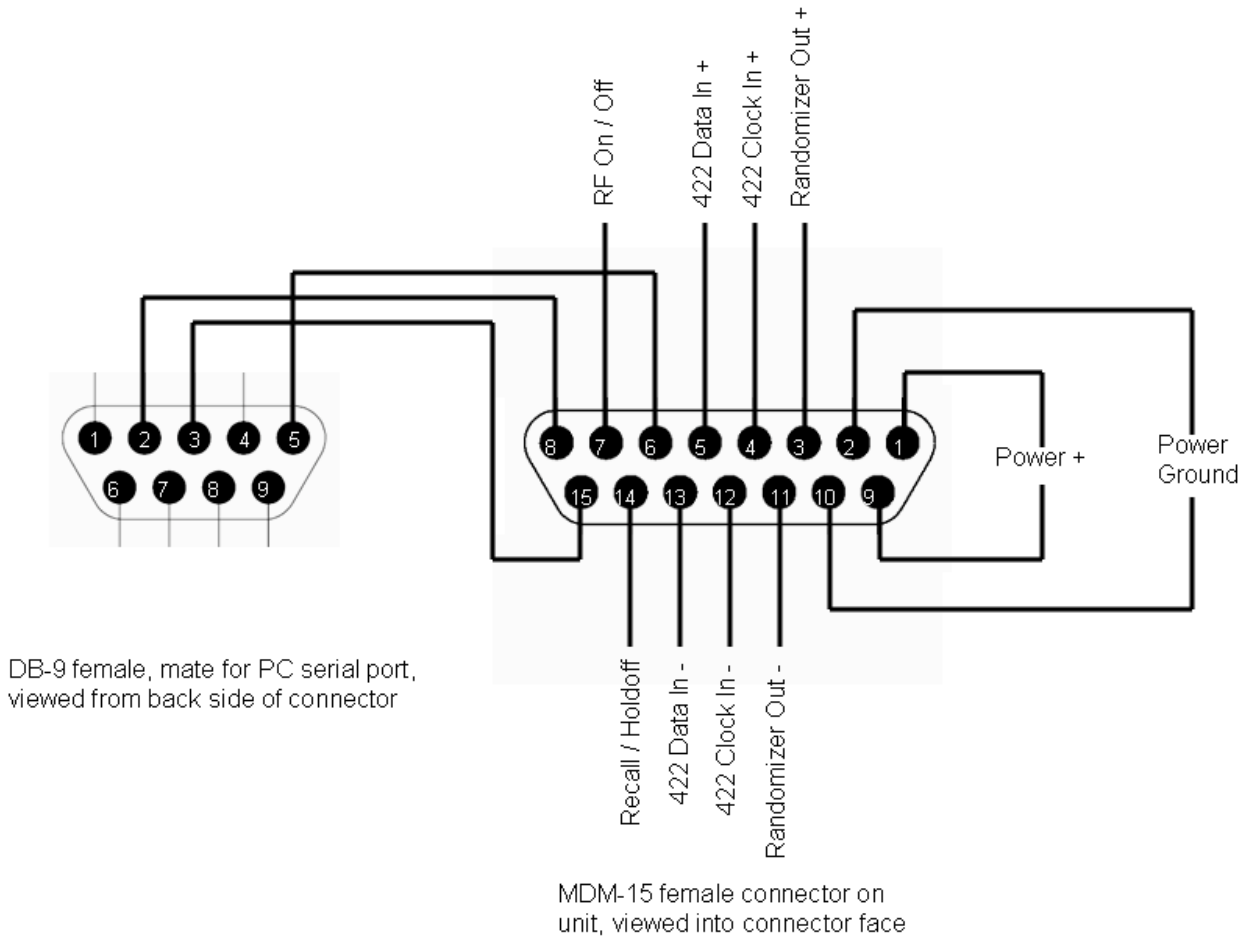


Figure 4. MDM-15 female pin numbering, TIA/EIA-422 interface.

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The pin assignments for the both interfaces are listed in Table 2.

Pin	TTL Interface MDM-15 Male	TIA/EIA 422 Interface MDM-15 Female
1	Serial Control Reply	Power +
2	RF On / Off	Power Ground
3	Serial Control Ground	422 Randomizer Out +
4	TTL Data	422 Clock +
5	TTL Clock	422 Data +
6	Data/Clock Ground	Serial Control Ground
7	Power Ground	RF On / Off
8	Power +	Serial Control Reply
9	Serial Control Input	Power +
10	Recall / Holdoff	Power Ground
11	N/C	422 Randomizer Out -
12	N/C	422 Clock -
13	N/C	422 Data -
14	Power Ground	Recall / Holdoff
15	Power +	Serial Control Input

Table 2. Transmitter pin assignments.

The data is sampled on the falling edge of the clock, as shown in Figure 4a.

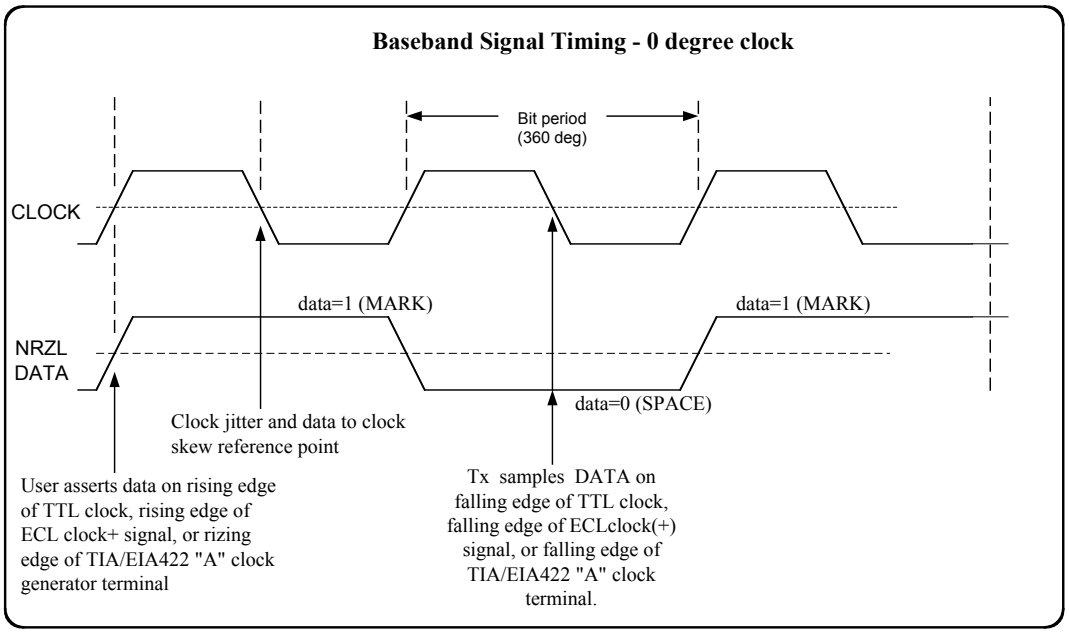


Figure 4a. Baseband Signal Timing.

The schematic, including component part numbers, for the baseband interface is shown in Figure 5.

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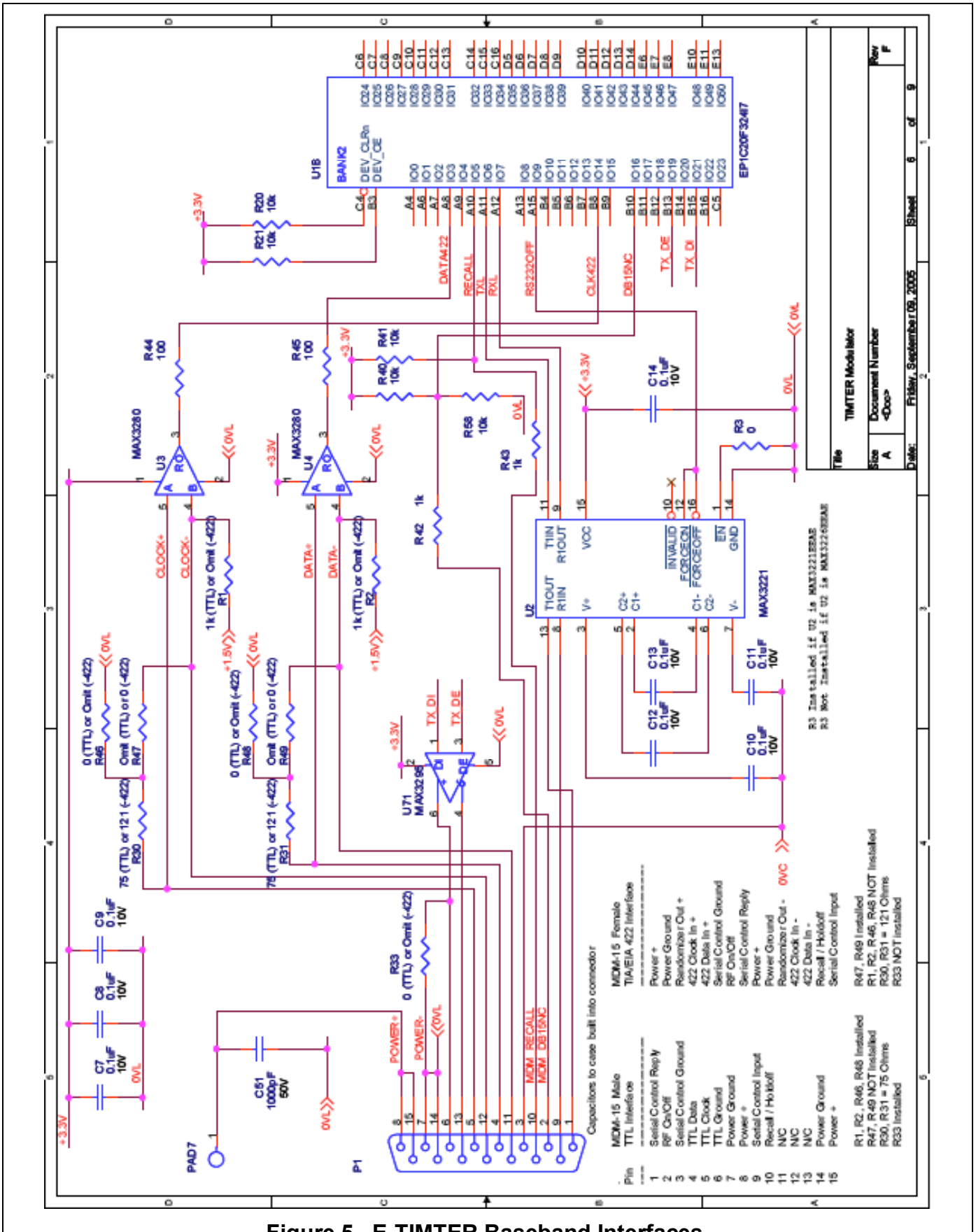


Figure 5. E-TIMTER Baseband Interfaces.

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3.0 OPERATING INSTRUCTIONS

3.1 Power-on operation

When the E-TIMTER powers up, it first loads the stored parameters. If the parameters appear to have never been initialized, it initializes the parameters to their defaults, and then stores them.

Next, it samples the "recall/holdoff" input pin, which specifies "recall mode" or "holdoff mode." The recall/holdoff pin is pulled up internally, so if not driven, it is interpreted as a 1.

DB15 pin 10 state	Grounded, logical 0	Holdoff Mode
	Pulled high or floating, logical 1	Recall Mode

In recall mode, the TX operates with no need for any serial communications. In this mode, regardless of the stored settings, the data and data's clock are set to external source, and RF output is turned on immediately. In recall mode, the unit supplies RF output within 240 mS of application of power.

If in "holdoff mode", all parameters are loaded, but RF output is set to 0, so transmission does not start until the "RF 1" command is received.

3.2 Stored Parameters

The following parameters are stored in the unit's flash memory. The table below lists their descriptions and default values.

Parameter Name	Description	Default Value
Frequency	This is the desired frequency of the transmitter in MHz.	1450.5 MHz, 1800.5 MHz, or 2370.5 MHz for LL band, UL band, or S band respectively. If the unit is configured to support all three bands, its default setting is LL band.
Band	This is the band the unit operates in. Values are LL, UL, or S	The unit defaults to the band determined by the configuration resistors. If configured to support all three bands, it defaults to LL band.

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Modulation	This is the modulation method used. Values are: SOQPSK, PCMFM, MHCPM	The modulation methods are individually configured to be enabled or disabled. The default modulation is SOQPSK, PCMFM, and then MHCPM in that order.
Differential Encoding	1 or 0, depending whether differential encoding is on. This is only meaningful for SOQPSK modulation. Note: IRIG 106-04 stipulates the use of differential encoding, so operation without differential encoding is only possible with a demodulator operating in a “non-IRIG 106” mode.	1 (differential encoding on)
RF output	1 or 0, depending on whether the RF output should be on. When in “recall mode” this setting is ignored; the unit will power up and begin transmitting immediately. When in “holdoff mode”, the unit’s RF output only turns on upon receipt of an “RF 1” command via the serial port.	1 (RF output on)
Randomizer	1 or 0, denoting randomizer on or off, respectively	0 (randomizer off)
Polarity inverted	1 or 0, denoting data polarity inverted or not, respectively	0 (inversion off)
Data Source	1 if data source is internal, 0 if data source is external	0 (external data)
Internal Data Type / Pattern	This may be one of four specified patterns (PN6, PN11, PN15, PN23), or a preset pattern of 16 bits (specified in hexadecimal). This setting is only used if “Internal Data Source” is set to 1 (internal data).	PN15
Clock Source	1 means clock is internal; 0 means clock is external	0 (external clock)
Internal Clock Frequency	Digitally synthesized internal clock frequency. Range is 0.150MHz – 22.0 MHz, in steps of approximately 1424.15 Hz. Exact values available are N * 93.333 / 65536 (in MHz)	5.0 MHz

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Heartbeat on	1 means the heartbeat is on; 0 means the heartbeat is off. If the heartbeat is on, the unit transmits an ACK character (0x06) over the serial port once every second. If the heartbeat is off, it does not transmit the ACK character. Further, it shuts off the RS232 transmitter's power supply after 50ms of no transmission activity. This is a noise reducing measure.	0 (heartbeat off)
Frequency Step	The frequency step (in MHz) caused by sending the left square bracket "[" or right square bracket "]".	10 MHz

3.3 E-TIMTER Serial Control Protocol

The E-TIMTER is controlled via a simple three-wire serial interface (transmit, receive, and ground). Configure your controller's serial port to a baud rate of 57600, 8 bits, no parity, 1 stop bit. For setup and configuration via a standard Windows-based PC, Quasonix recommends the use of HyperTerminal, included with the standard Windows installation (Start -> All Programs -> Accessories -> Communications -> HyperTerminal).

If you have your terminal program active when you apply power to the E-TIMTER, you will see a welcome message as shown in Figure 6. At this point, you can verify that your serial connection is active in both directions by issuing the Query Temperature command, "QT". If the unit responds with a report of the internal temperature, as shown in Figure 6, then your serial communications are working correctly.

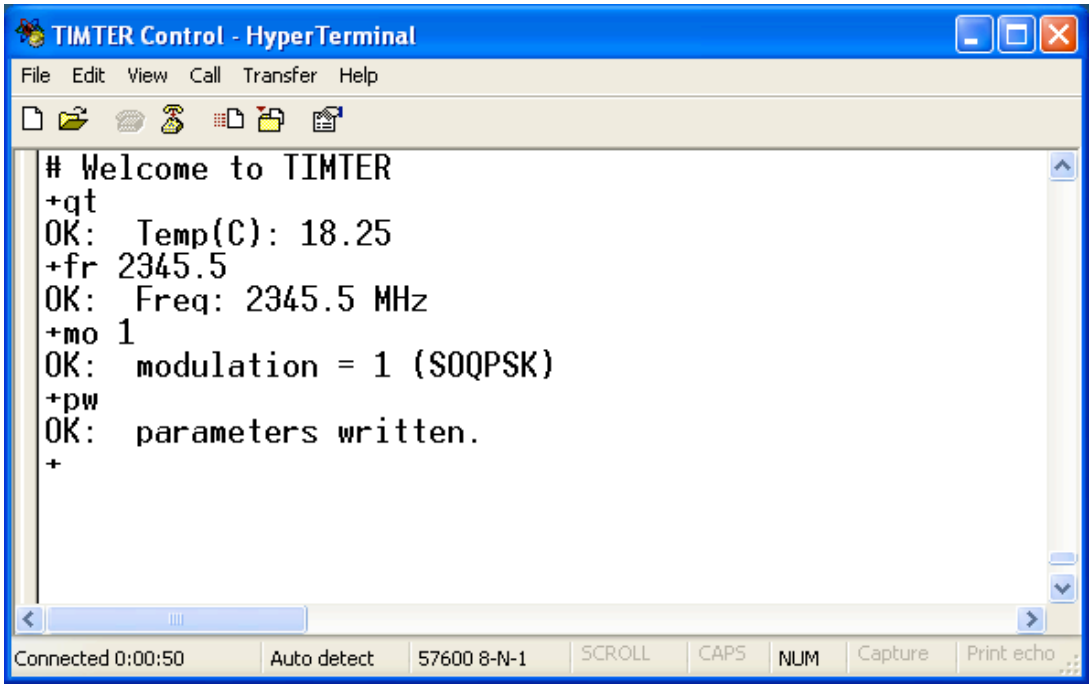


Figure 6. E-TIMTER Control Through HyperTerminal.

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All commands are 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.

Mnemonic	Name	Description
[	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.
]	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.
FS	Frequency Step	If no argument is passed, it reports the current frequency step. If an argument is passed, it commands to set the frequency step induced by the left and right square bracket keys. The argument specifies the frequency step in MHz.
FR	Frequency	If no argument is passed, it commands to report the frequency. If an argument is passed, it commands to set the frequency. The argument specifies the frequency in MHz. This command rounds the frequency to the nearest 0.5 MHz. If the rounded frequency is within one of the transmitter's allowed band's range, it sets it to that frequency and reports OK. If the transmitter is configured to only allow one band, and the frequency is outside of that range, this command will place it to the band's default frequency and report ERR, indicating the frequency was not set as commanded. If the transmitter is configured to allow all three bands, and the frequency is outside each of the three bands' ranges, then this command will not set the frequency, and reports ERR. Examples: `FR` Command to report frequency `FR 1436.5` Command to set freq. to 1436.5MHz

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MO	Modulation	Report or set modulation setting. Examples: `MO` Report the modulation setting `MO 0` Set modulation to PCMFM `MO 1` Set modulation to SOQPSK `MO 2` Set modulation to MHCPM
DE	Differential Encode	Report or set differential encoding Examples: `DE` Report the differential encoding setting `DE 0` Set differential encoding off `DE 1` Set differential encoding on
RF	RF Output	Report or set RF output state Examples: `RF` Report the RF output state `RF 0` Set RF output off `RF 1` Set RF output on
RN	Randomizer	Report or set randomizer output state Examples: `RN` Report the randomizer state `RN 0` Set randomizer off `RN 1` Set randomizer on
DP	Data Polarity	Report or set data polarity inversion state Examples: `DP` Report the polarity inversion state `DP 0` Set data inversion off `DP 1` Set data inversion on
DS	Data Source	Report or set data source state Examples: `DS` Report the data source state `DS 0` Set data source to external `DS 1` Set data source to internal
CS	Clock Source	Report or set data's clock source state Examples: `CS` Report the clock source state `CS 0` Set clock source to external `CS 1` Set clock source to internal

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IC	Internal Clock Rate	Report or set the internal clock rate. This rate is used if the clock source is set to internal. If no argument is passed, the unit reports the clock frequency. If an argument is passed, it sets the clock frequency. The argument is in Mbps. Examples: `IC` Command to report the internal freq. `IC 4.95` Command to set int. freq. to 4.95MHz Specified clock rates are rounded to the nearest integer multiple of 93.333 / 65536 MHz (approximately 1424.15 Hz). Valid range is 0.150MHz – 22.0 MHz
ID	Internal Data Gen	Report or set the internal data pattern. This setting is used if the Data Source is set to internal. 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.
PW	Parameter Write	Command to write the parameters. See description later.
HB	Heartbeat	Report or set heartbeat state Examples: `HB` Report the heartbeat state `HB 0` Set heartbeat off `HB 1` Set heartbeat on
QT	Query Temperature	Command to report the temperature in degrees Celsius
RV	FPGA revision	Command to report the FPGA code revision
H or ?	Help	Displays abbreviated list of available commands

All commands generate a response of one or more lines. The last response line always starts out with "OK:" or "ERR:" which indicate successful completion of the command or an error.

After a command's response, the transmitter generates the character "+" as a prompt which may be interpreted as meaning that the radio is ready to accept new characters.

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4.0 FREQUENCY BANDS

Band	Minimum Freq	Maximum Freq	Default freq
Lower L (LL)	1435.5	1534.5	1450.5
Upper L (UL)	1755.0	1850.0	1800.5
S	2200.5	2389.5 or 2394.5 *	2370.5

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5.0 RF OUTPUT NOTES

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

RF On / Off command – From the control terminal, type “RF” to query the current state of the RF on / off variable. If it is zero, type “RF 1” to turn it back on.

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 will automatically shut off. When the data clock comes back, the RF output will then automatically turn on. The lag from data clock state change to RF output change is about 0.1 seconds.

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.

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6.0 FUNCTIONAL BLOCK DIAGRAM

A block diagram of the E-TIMTER appears in Figure 8. The E-TIMTER employs a direct digital synthesizer (DDS) to create the modulated waveform. Both the carrier frequency and The phase deviation at the output of the DDS are reduced by a factor of N at the DDS output, and an analog multiplier chain provides a multiplication by N function, thereby setting the carrier frequency and the phase deviation to the correct value at the RF output.

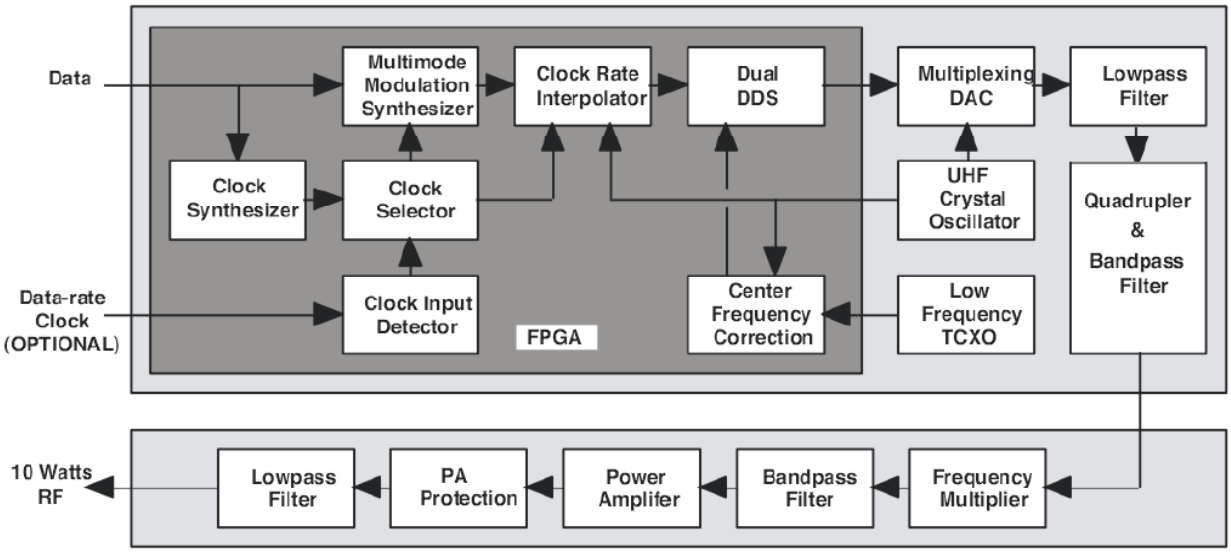


Figure 8. E-TIMTER Block Diagram

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7.0 PERFORMANCE SPECIFICATIONS

7.1 RF Output

The minimum RF output power is 5 Watts (10 Watts with either Option 09 or Option 10). when the RF load VSWR is < 2:1 at all phase angles from 0 to 360 degrees.

7.2 Electrical Current

The transmitter electrical current drain does not exceed 1.8 amps (2.5 amps with either Option 09 or Option 10).

7.3 Carrier Frequency Tuning & Error

The carrier frequency is selectable in 0.5 MHz steps from 2200.5 MHz to 2389.5 MHz (S-band) or 1435.5 MHz to 1534.5 MHz (L-band). The frequency error is less than ±20 ppm over all combinations of temperature, voltage, and aging (up to five years).

7.4 Bit Error Rate

The transmitter meets the following BER limits, when tested with the Nova Engineering MMD-44 Telemetry Demodulator.

BER	Maximum E_b/N_0 (dB)		
	Base unit (SOQPSK-TG, Tier I)	Option 01 (PCM/FM, Tier 0)	Option 02 (Multi-h CPM, Tier II)
10^{-3}	9.5	7.5	11.0
10^{-4}	11.5	9.0	12.5
10^{-5}	13.0	10.0	13.5
10^{-6}	14.5	11.0	14.5

Table 3. Transmitter BER specifications.

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7.5 Modulated RF Power Spectrum

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

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

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 (5 Watts, except for units with Option 09 or Option 10, which are rated at 10 Watts)

and the values of K and m are as tabulated below:

	K	m
Base unit (SOQPSK-TG, no options)	-61	4
Option 01 (PCM/FM, Tier 0)	-28	2
Option 02 (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 Figures 9, 10, and 11.

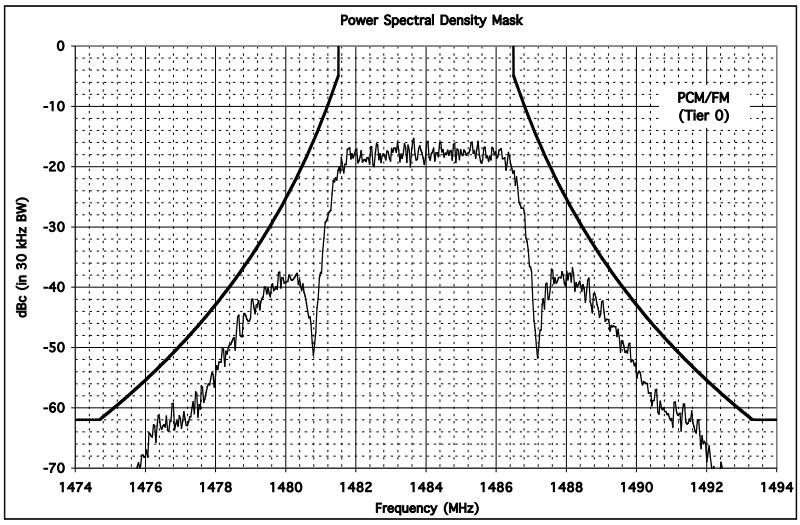


Figure 9. PCM/FM (Tier 0) PSD and mask.

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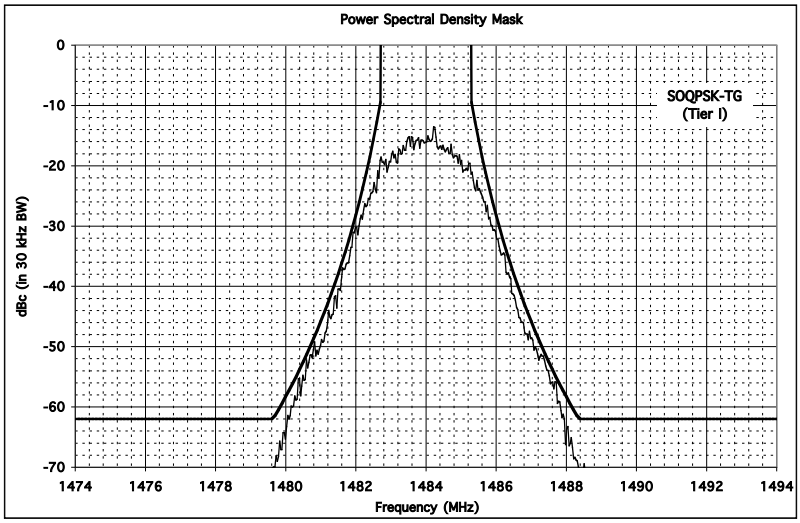


Figure 10. SOQPSK-TG(Tier I) PSD and mask.

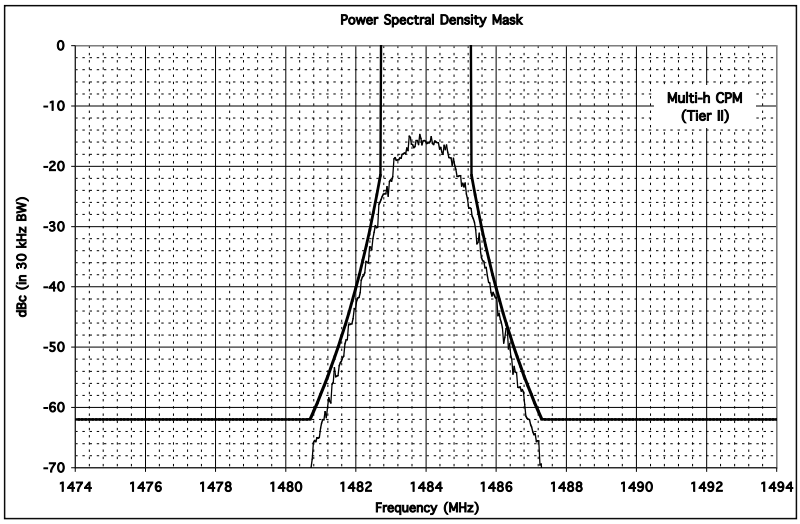


Figure 11. Multi-h CPM (Tier II) PSD and mask.

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7.6 Phase Noise Power Spectrum

TIMTER phase noise limits are shown in Figure 12.

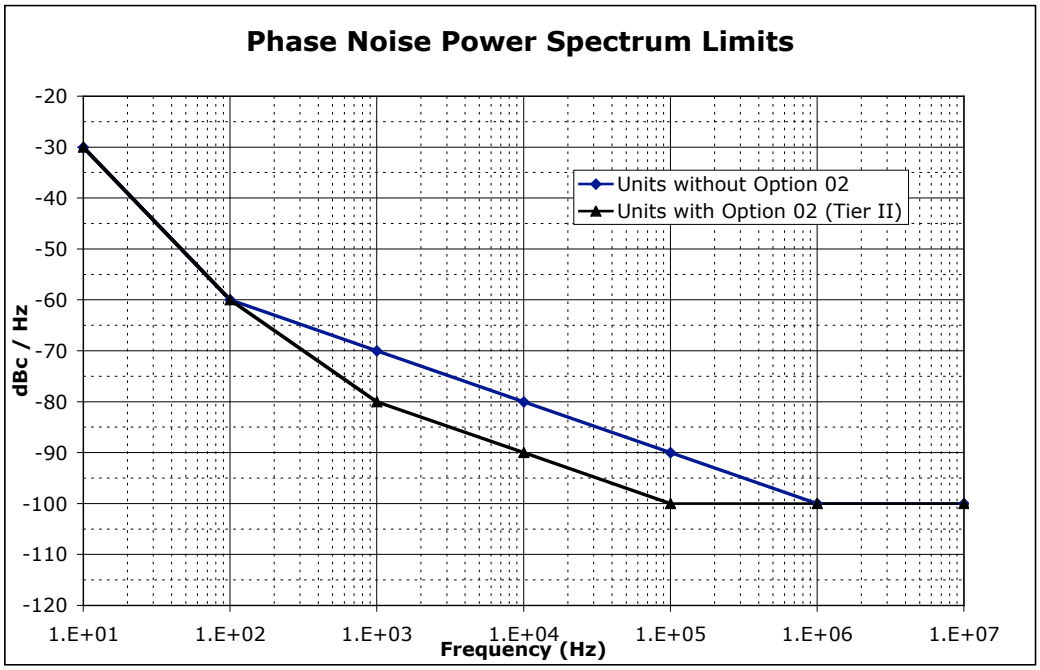


Figure 12. Phase Noise Limit Curve

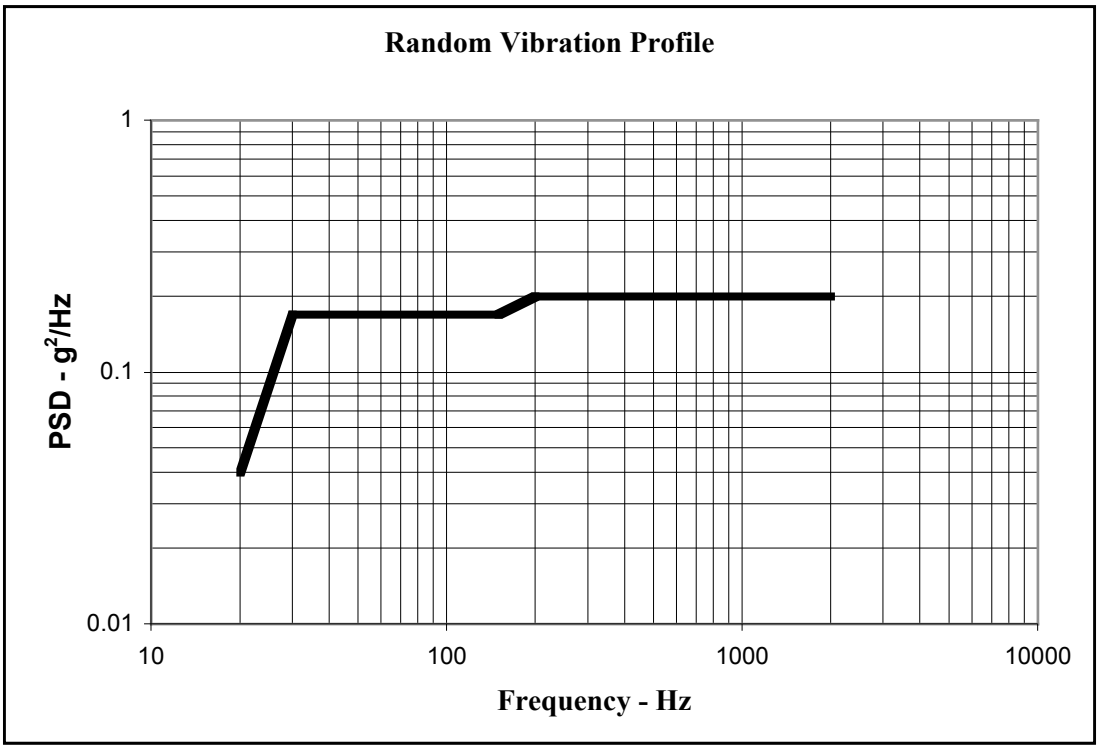
7.7 Baseplate Temperature

The E-TIMTER is designed for efficient heat transfer between internal heat producing sources and the baseplate. It is rated for operation with baseplate temperatures ranging from -40°C to +85 °C, except for units with Option 09 or Option 10, which are specified to operate from –40°C to +70°C.

7.8 Vibration

The transmitter is designed and tested to operate normally when subjected to the random vibration spectrum depicted in Figure 13.

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Breakpoints	
Frequency (Hz)	PSD g^2/Hz
20	0.04
30	0.17
150	0.17
200	0.2
2000	0.2
G (RMS) = 19.6	

Figure 13. Random vibration spectrum.

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8.0 MAINTENANCE INSTRUCTIONS

The E-TIMTER requires no regular maintenance, and there are no user-serviceable parts inside. Please consult the factory for any maintenance, upgrade, or repair requirements.

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