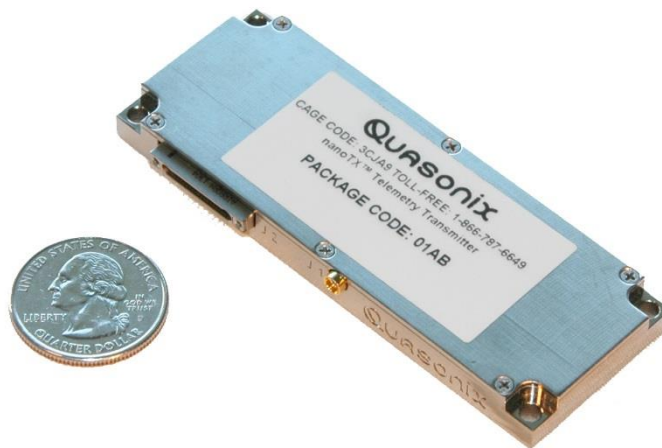# Installation and Operation Manual

nanoTX™ Telemetry Transmitter

Quasonix, Inc.
6025 Schumacher Park Dr.
West Chester, OH 45069
21 March, 2025

Revision 3.4.19

MADE IN USA

Specifications subject to change without notice.

All Quasonix transmitter products are under U.S. Department of Commerce jurisdiction and categorized as EAR99; not covered by ITAR.

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1 Introduction

1.1 Description

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

<div align="center">

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

</div>

1.1.1 Nomenclature

The nanoTX™ and nanoPuck™ models are 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 11. Detailed information for packages other than 01AA is located in the TIMTER™ Transmitter Packages document, available at the Quasonix web site. For questions about specific packages, please contact Quasonix.
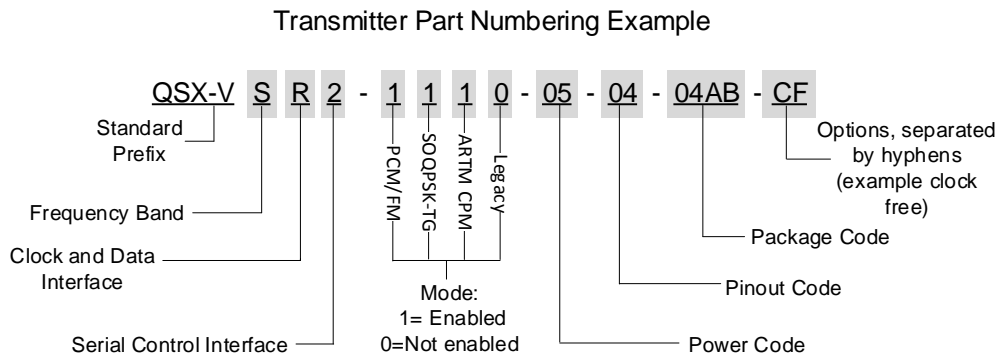
Figure 1: Model Number Construction Description for nanoTX™ and nanoPuck™

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.

Information in this manual applies to all nanoTX™ and nanoPuck™ models, unless otherwise specified. Other TIMTER™ transmitter models are covered in separate user manuals, available for download from the company website: www.quasonix.com.

The nanoTX™ and nanoPuck™ are available with the following software and hardware options. Refer to section 1.2 for detailed descriptions of each option.

- AC   Automatic carrier wave output

- ACS   Auto carrier save

- BRx   Non standard baud rate for serial protocol

- C7   Quasonix interpretation of IRIG 106-17 Appendix 2-C serial control protocol

- CE   Convolutional encoder (includes NRZ-M encoding)

- CF   Clock-free baseband interface

- DP   Dual power (Ability to set a low and a high setting, hardware controlled*

- FO   Frequency Offset

- GN   GPS notch filters to meet -147 dBm/Hz at L1 and L2 – Include this hardware option with order

- HR   Increases max bit rate up to 46 Mbps (23 Mbps for PCM/FM) (20 Mbps max for Clock Free mode)

- ID   Internal Clock and Data can be saved as a power-up default

- IN   Inmarsat frequency band range

- INH   Inmarsat frequency extended band high limit

- INL   Inmarsat frequency extended band low limit

- 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) (50 kbps min for Clock Free mode)

- MA   Below Lower S band (for Space Operations and Space Research applications)

- MAH   Below Lower S band extended band high limit

- MAL   Below Lower S band extended band low limit

- MS   Modulation scaling

- PS   Enable hardware presets (specify 2, 4, 8, or 16 – PS2, PS4, PS8, PS16)

- STDN   Supports Spacecraft Tracking and Data Network (PM/BPSK) mode

- VF   Variable FIFO Depth

- VP   Variable power (32 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 nanoTX™ options or for information regarding upgrades to nanoTX™ units that you may already own.

The model number identifies the configuration of the unit. For example, model number QSX-VSTT-1100-01-N1-01AA-CF-WV defines a unit configured as follows:

Table 1: Model Configuration Example

Identifiers	Description
QSX	Quasonix Product
V	Variable bit rate
S	S band
T	TTL clock and data interface
T	TTL serial control interface code
1100	Tier 0 present, Tier I present, Tier II absent, Legacy absent
01	1 Watt RF output
N1	Pinout code
01AA	nanoTX™ package code
CF	Clock-free baseband interface option
WV	Wide Voltage option

1.2 Model Number Field Codes

1.2.1 Frequency Band

Frequency band codes are listed in Table 2. All frequency bands may be tuned 0.5 MHz above or below the stated frequency, except for units with the FO (frequency offset) option.

Table 2: Frequency Band Codes

Frequency Band Code	Band	Minimum Frequency	Maximum Frequency	Default Frequency	Tuning Steps
A	Lower S	2200.5 MHz	2300.5 MHz	2250.5 MHz	0.5 MHz
N	Upper S	2300.5 MHz	2394.5 MHz	2370.5 MHz	0.5 MHz
S	S	2200.5 MHz	2394.5 MHz	2370.5 MHz	0.5 MHz

1.2.2 Clock and Data Interface

Clock and data interface codes are listed in Table 3.

Table 3: Clock and Data Interface Codes

Clock and Data Interface Code	Baseband Clock and Data Interface	Defaults
H	TTL (10k ohms to ground)	TTL 10k ohms
L	LVDS (Low Voltage Differential Signal)	LVDS
R	RS-422 (120 ohms differential)	422 120 ohms
T	TTL (75 ohms to ground)	TTL 75 ohms

1.2.3 Serial Control Interface

Serial control interface codes are listed in Table 4.

Table 4: Serial Control Interface Codes

Serial Control Interface Code	Serial Control Interface
2	RS-232
T	TTL

1.2.4 ARTM Tier 0 (PCM/FM)

ARTM Tier O codes are listed in Table 5.

Table 5: ARTM Tier 0 Codes

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

1.2.5 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

1.2.6 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

1.2.7 Legacy

Legacy modes include BPSK, QPSK, and OQPSK. Legacy codes are listed in Table 8.

Table 8: Legacy Codes

Part Number Code	Legacy Modes
0	Absent
1	Present

1.2.8 Output Power

All nanoTX™ models are available with 1 W to 10 W output power, as shown in Table 9. The nanoPuck™ models are available with 1 W, 2 W, or 5 W output power.

Table 9: Output Power Codes

Power Code	RF Output Power
01	1 Watt (+30 dBm), minimum
02	2 Watt (+33 dBm), minimum
05	5 Watt (+37 dBm), minimum
10	10 Watt (+40 dBm), minimum

The input current and standard input voltages for all nanoTX™ and nanoPuck™ models are listed in Table 10.

Table 10: Power Supply DC Input Current at Standard Input Voltage

nanoTX™ or nanoPuck Model	Input Current
S band, 1 Watt	450 mA max., 350 mA typ. @ 28 VDC
S band, 2 Watt	570 mA max., 480 mA typ. @ 28 VDC
S band, 5 Watt	1.0 A max., 850 mA typ. @ 28 VDC
S band, 10 Watt (nanoTX™ only)	1.4 A max., 1.1 A typ. @ 28 VDC

1.2.9   Packages

Package codes are listed in Table 11.

Table 11: Package Codes

Model Number Code	Package Dimensions (Excluding Connectors)
01Ax	1.275 in^3 1.250" x 3.400" x 0.300" (H)
01Bx	1.275 in^3 1.250" x 3.400" x 0.340" (H)
01Px	1.280 in^3 2.300" (Dia) x 0.325" (H)

1.2.10   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.

1.2.11   Auto Carrier Save Option – ACS

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, just like the AC option. ACS uses the saved setting of AC on power up instead of forcing AC on like the legacy option.

1.2.12   Baud Rate Option – BRx

The BR option changes the serial communications default baud rate on the transmitter to the one selected. A number from 0-8 follows the BR option request. Corresponding values are as follows: 0 = 57600 (Standard default for all Quasonix transmitters); 1 = 4800; 2 = 9600; 3 = 19200; 4 = 38400; 5 = 56000; 6 = 57600; 7 = 115200, 8 = 230400.

1.2.13   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.

1.2.14 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 2.
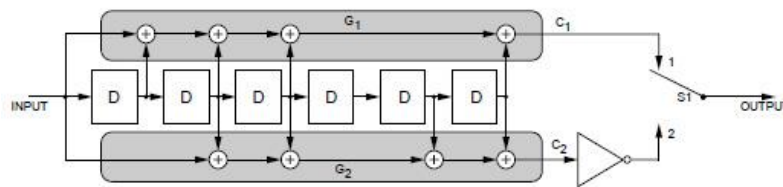
Figure 3-1: Basic Convolutional Encoder Block Diagram

"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 2: CCSDS 131.0-B-1 Rendering of Basic Convolutional Encoder Diagram

1.2.15 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 using the SV command, and if so, it will be restored at power-on. When the CF option is used, the bit rate range is 0.1 to 35 Mbps 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, and the ID option for Internal Clock and Data.)

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 supplies only valid data. Refer to Table 13 for user commands.

1.2.16 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.

1.2.17 Frequency Offset Option – FO

This option is used to set frequencies that are NOT aligned to the synthesizer step size for their units, typically 500 kHz. If the FO option is present, the resolution is 1 Hz (0.000001 MHz). The desired offset may be typed with the frequency using the FR command.

1.2.18 GPS Notch Option – GN

Use this option to specify GPS notch filters to meet -147 dBm/Hz at L1 and L2 (hardware note). Available for S band only. Consult Quasonix for pricing and availability.

1.2.19 High Bit Rate Option – HR

The standard nanoTX™ supports bit rates from 0.1 to 28 Mbps in SOQPSK-TG and MULTI-h CPM modes, 0.05 to 14 Mbps in PCM/FM (Tier 0) mode and in all modes included with the PSK option. The HR option increases the bit rate to a maximum of 46 Mbps (23 Mbps for PCM/FM). (The maximum bit rate with a Clock Free transmitter is 35 Mbps for SOQSPK-TG and MULTI-h CPM modes; 23 Mbps for PCM/FM and all legacy PSK modes.) Refer to the CF option for information about the Clock Free option. Refer to Table 12 for bit rate comparisons by mode.

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

*Maximum data rates on Quasonix transmitters are limited by the equipment used to test the transmitter. Experiments and simulations suggest that the transmitters can generate "high fidelity" PCM/FM up to about 40 Mbps, and SOQPSK and ARTM CPM up to about 80 Mbps. However, our test station demodulators cannot run above the specified 23 Mbps and 46 Mbps rates, so performance above those rates is unspecified.

1.2.20 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.

1.2.21 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 pin option.

1.2.22 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.

1.2.23 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

1.2.24 Low Bit Rate Option – LR

The standard nanoTX™ supports bit rates from 0.1 to 28 Mbps in SOQPSK-TG and MULTI-h CPM modes, 0.05 to 14 Mbps in PCM/FM (Tier 0) mode and in all modes included with the PSK option. The LR option decreases the bit rate to a minimum of 50 kbps (25 kbps for PCM/FM). (The minimum bit rate with a Clock Free transmitter is 50 kbps for all modes.) Refer to the CF option for information about the Clock Free option. Refer to Table 12 for bit rate comparisons by mode.

1.2.25 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.

1.2.26 Hardware Preset Option – 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 more information, refer to Appendix A – Preset Option.

1.2.27 Spacecraft Tracking and Data Network Option – STDN

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

1.2.28 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.

1.2.29 Variable Power Option – VP

The standard TIMTER™ operates at its full rated RF output power. The software-based VP option provides 32 discrete power level settings, spanning a range of as much as 24 dB. The steps are non-uniform, but steps are typically no larger than 1.1 dB.

1.2.30   Wide Input Voltage Range Option – WV

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

Voltage Ranges with WV Option
+8.0 to +34 VDC for 1 Watt version
+8.0 to +34 VDC for 2 Watt version
+12 to +34 VDC for 5 Watt version
+21 to +34 VDC for 10 Watt version

2   Accessories

Quasonix offers a number of optional accessories for the nanoTX™ transmitter, including a fan-cooled, bench heat sink, 15 pin Nano-D and 21 pin Nano-D connectors, complete Nano-D cable assemblies, an MMCX to SMA cable, a ruggedized handheld programmer, and a USB to serial converter cable. Regardless of the heat sink, Quasonix strongly suggests using a thermal pad, such as Q-Pad® II from Bergquist. Refer to section 3.2, for additional thermal information.

Contact Quasonix for pricing and availability of nanoTX™ accessories.

2.1   Bench Heat Sink (for ground applications only)

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 3. The heat sink is shown with a mounted nanoTX™ in Figure 4.

Figure 3: Bench Heat Sink and Power Supply

Figure 4: Bench Heat Sink with nanoTX™

2.2   Pre-wired 15 Pin Nano-D TTL Connector

Part Number: QSX-AC-NANO15-36PT

A 15 pin Nano-D connector with 36" color-coded pigtail is shown in Figure 5.
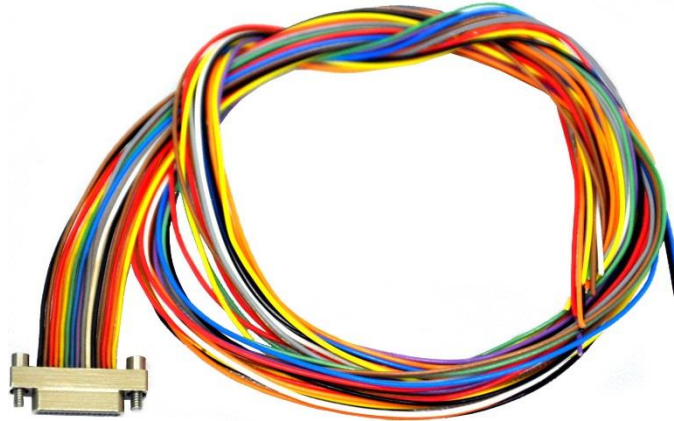
Figure 5: Pre-wired 15 Pin NANO-D with 36" Pigtails

2.3   Pre-wired 21 Pin Nano-D

Part Number: QSX-AC-NANO21-36PT

A 21 pin Nano-D connector with 36" color-coded pigtail cables is shown in Figure 6.
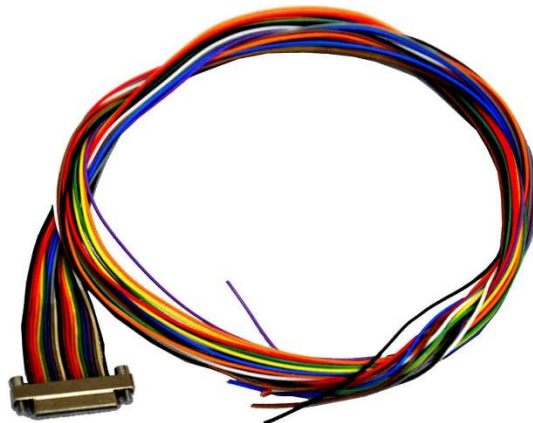
Figure 6: Pre-wired 21 Pin Nano-D with 36" Pigtails

2.4 15 Pin Nano-D Wiring Harness

Part Number: QSX-AC-NANO15-HARNESS

A 15 pin Nano-D wiring harness for connecting to transmitters with TTL clock and data baseband interface is shown in Figure 7. 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 7: 15 Pin Nano-D Cable Harness
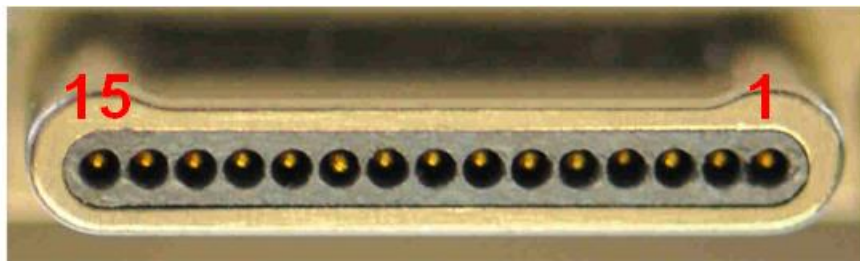
Figure 8: 15 Pin Nano-D Cable Male Harness Pins

2.5 21 Pin Nano-D Wiring Harness

Part Number: QSX-AC-NANO21-HARNESS

A 21 pin Nano-D wiring harness for connecting to transmitters with RS-422 clock and data baseband interface is shown in Figure 9. It includes banana plugs for power and ground, BNC connectors for clock and data, and a DB-9 connector for serial control and is 33 to 36 inches long depending on the connectors.
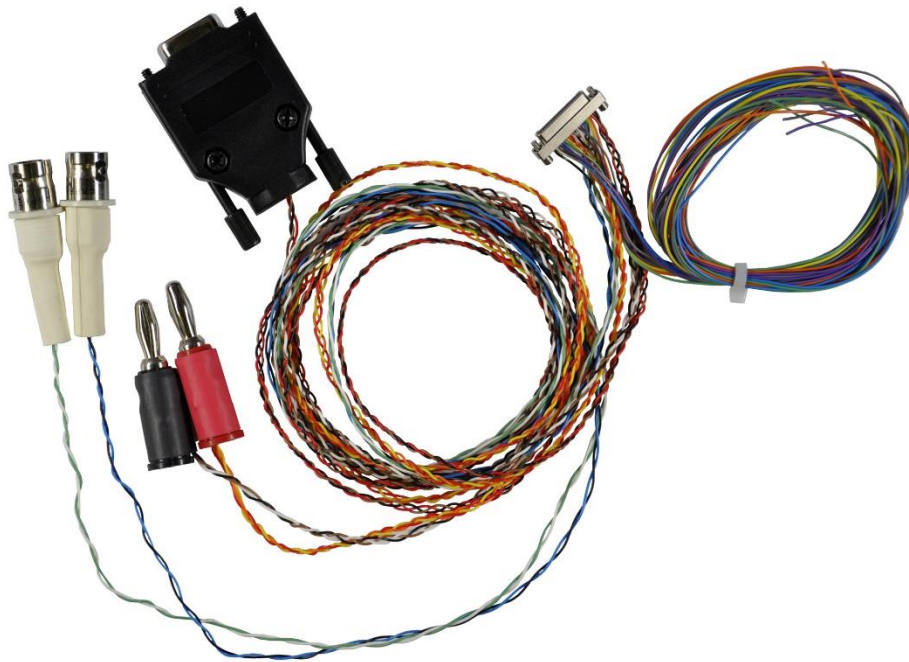
Figure 9: 21 Pin Nano-D Cable Harness

2.6   MMCX to SMA Adapter Cable

Part Number: QSX-AC-MMCX-SMA-R-R-34

A 13.5 inch long MMCX to SMA adapter cable with an RG-316 coax connector, right angle MMCX, and right angle SMA, is shown in Figure 5.
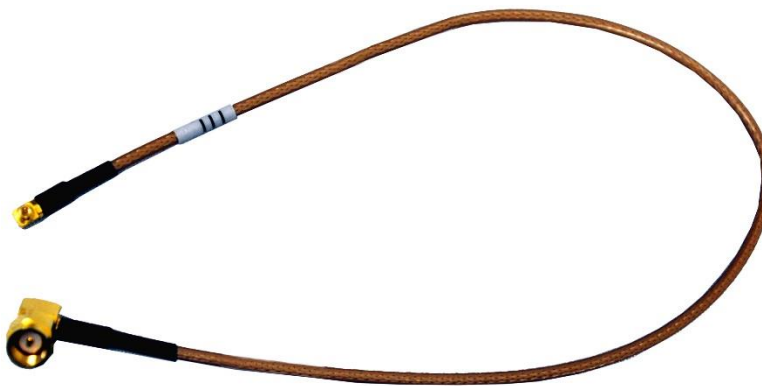
Figure 10: MMCX to SMA Adapter Cable

2.7 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 11. An 18 inch cable is also available.

Figure 11: USB to Serial Converter Cable

3   Installation Instructions

3.1   Mechanical

This section describes the more common nanoTX packages. For more information about nanoTX and nanoPuck pinouts, refer to Section 3.3.

3.1.1   01AA Package

The 01AA package, shown in Figure 12, measures 1.250" x 3.400" x 0.300" and provides a TTL interface. It uses a female 15 Pin nano interface connector and a female MMCX RF connector.

The standard 1.3 cubic inch nanoTX™ ("01AA" package) is designed to be mounted by four (4) 4-40 screws through the holes in the four corners, as depicted in Figure 13. The latest drawings for all nanoTx and nanoPuck packages are located on the Quasonix web site: https://www.quasonix.com/resources/#drawings.

Figure 12: 1.275 in^3 nanoTX™ – 01AA Package
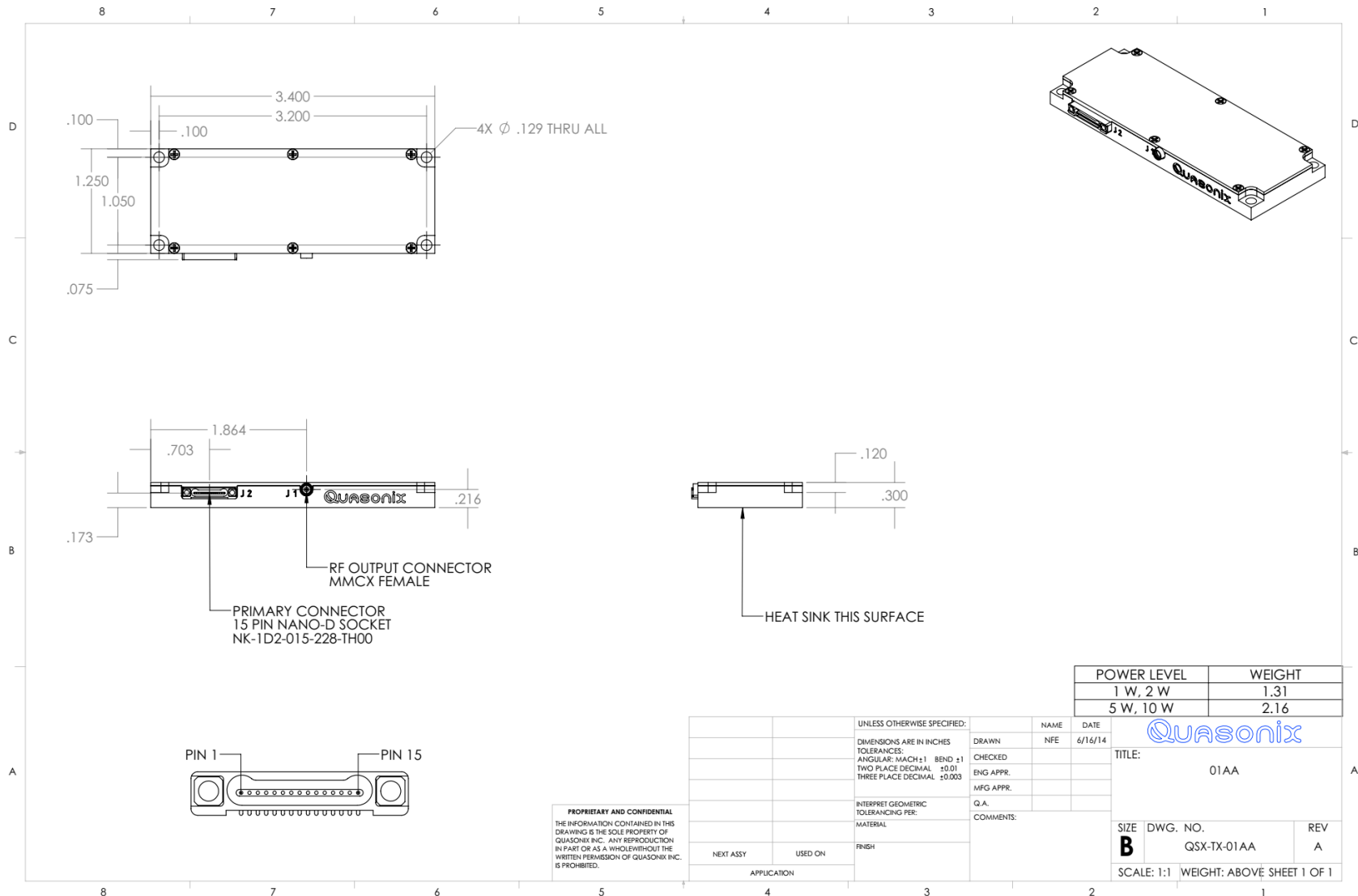
Figure 13: Outline Drawing, nanoTX™ Telemetry Transmitter – 01AA Package

3.1.2   01AB Package

The 01AB package, shown in Figure 14, measures 1.250" x 3.400" x 0.300" and provides an RS-422 interface. It uses a female 21 Pin nano interface connector and a female MMCX RF connector.

The latest drawings for all nanoTx and nanoPuck packages are located on the Quasonix web site: https://www.quasonix.com/resources/#drawings.

Figure 14: 1.275 in^3 nanoTX™ - 01AB Package
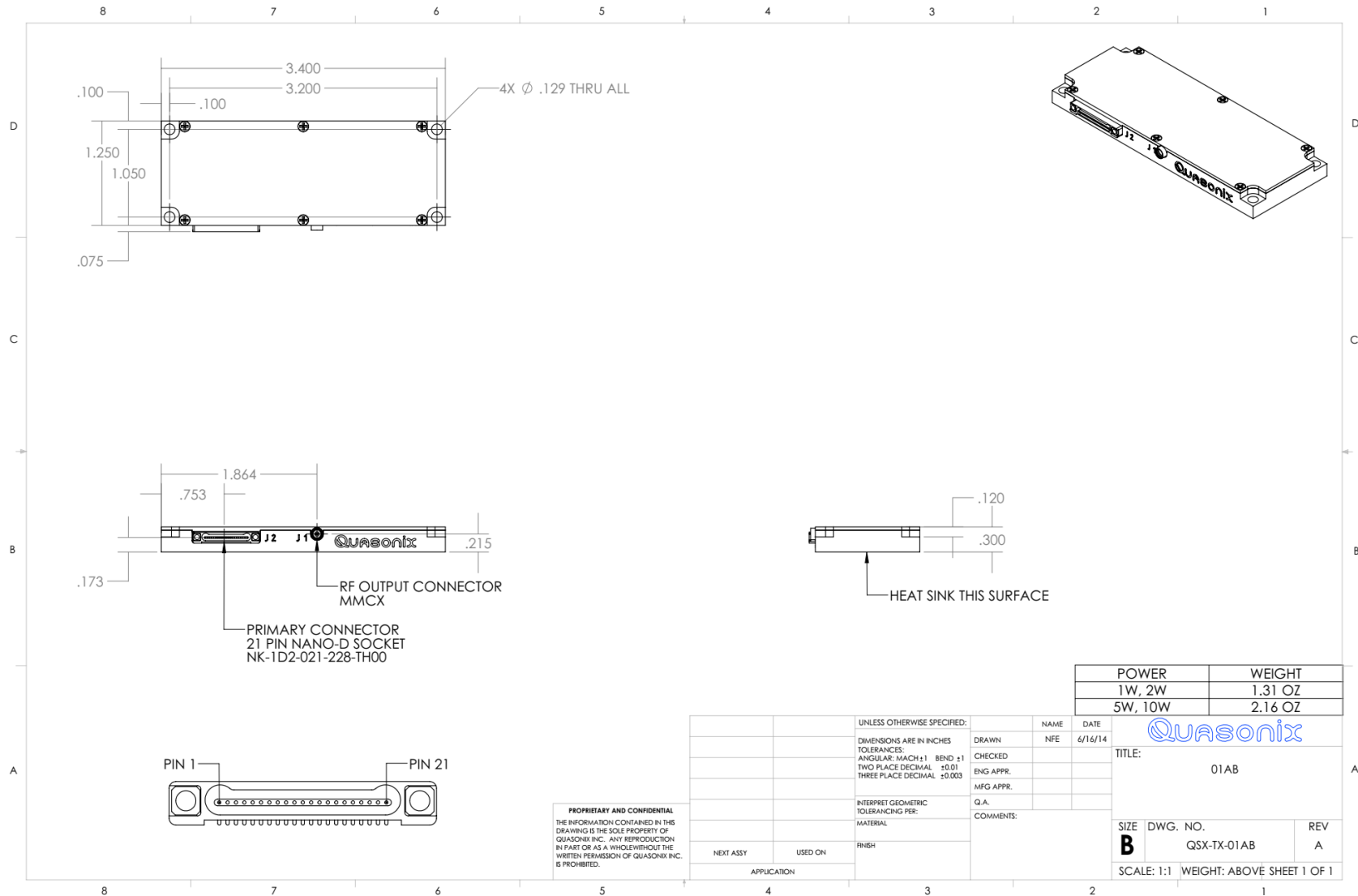
Figure 15: Outline Drawing, nanoTX™ Telemetry Transmitter – 01AB Package

3.1.3   01PE Package

The 01PE package, shown in Figure 16, measures 2.3" x 0.325 = 1.35 in^3 and provides a TTL or RS-422 interface. It uses a female SAMTEC FTSH-108-04-F-D 16 pin nano interface connector and a female MMCX RF connector. The latest drawings for all nanoTx and nanoPuck packages are located on the Quasonix web site: https://www.quasonix.com/resources/#drawings.

Figure 16: 1.35 in^3 nanoPuck™ - 01PE Package
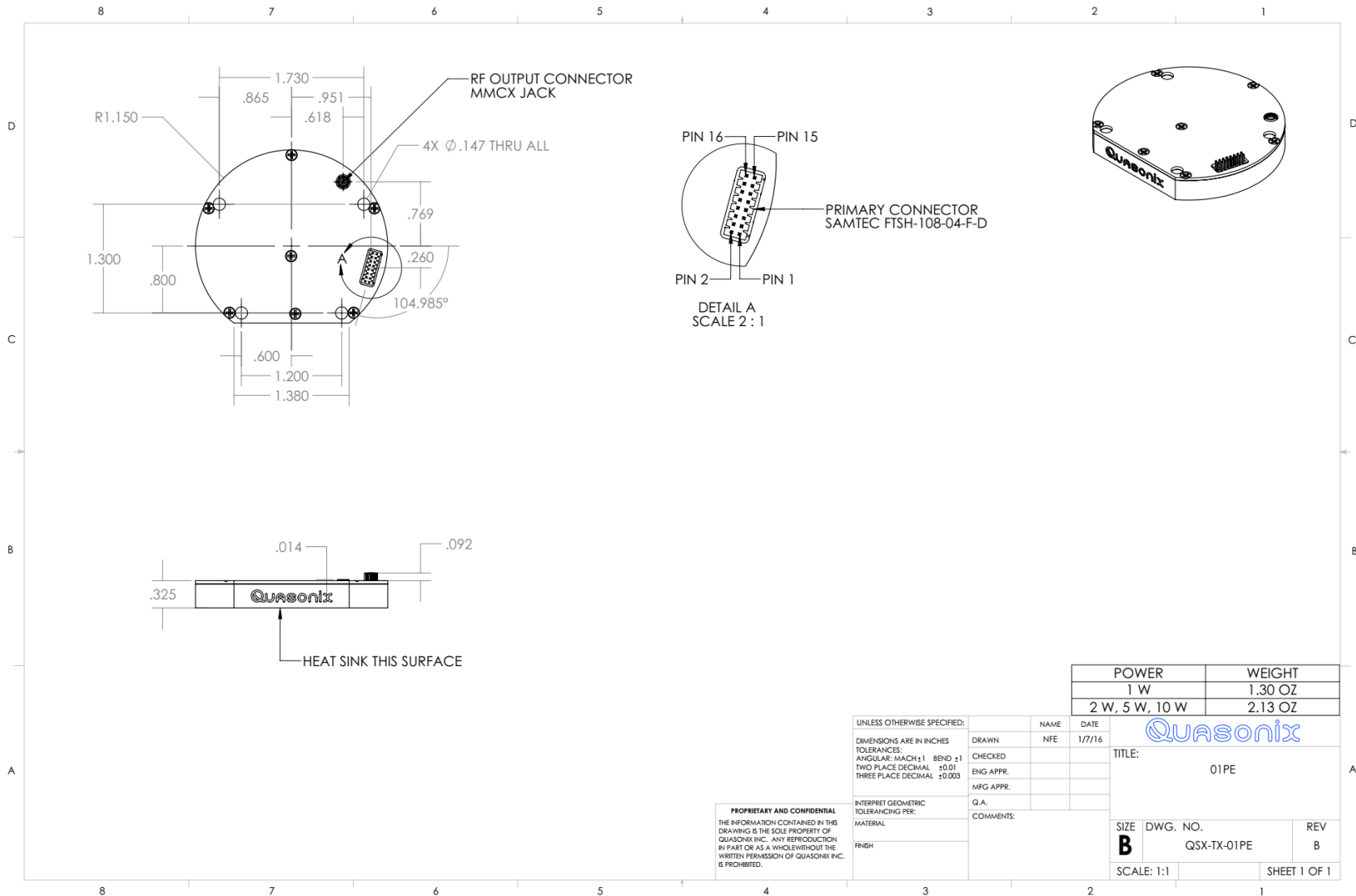
Figure 17: Outline Drawing, nanoPuck™ Telemetry Transmitter – 01PE Package

3.1.4   01PD Package

The 01PD package, shown in Figure 18, measures 2.3" x 0.325 = 1.35 in^3 and provides a TTL interface. It uses a female SAMTEC FTSH-108-04-F-D 16 pin nano interface connector and a female MMCX RF connector. The latest drawings for all nanoTx and nanoPuck packages are located on the Quasonix web site: https://www.quasonix.com/resources/#drawings.
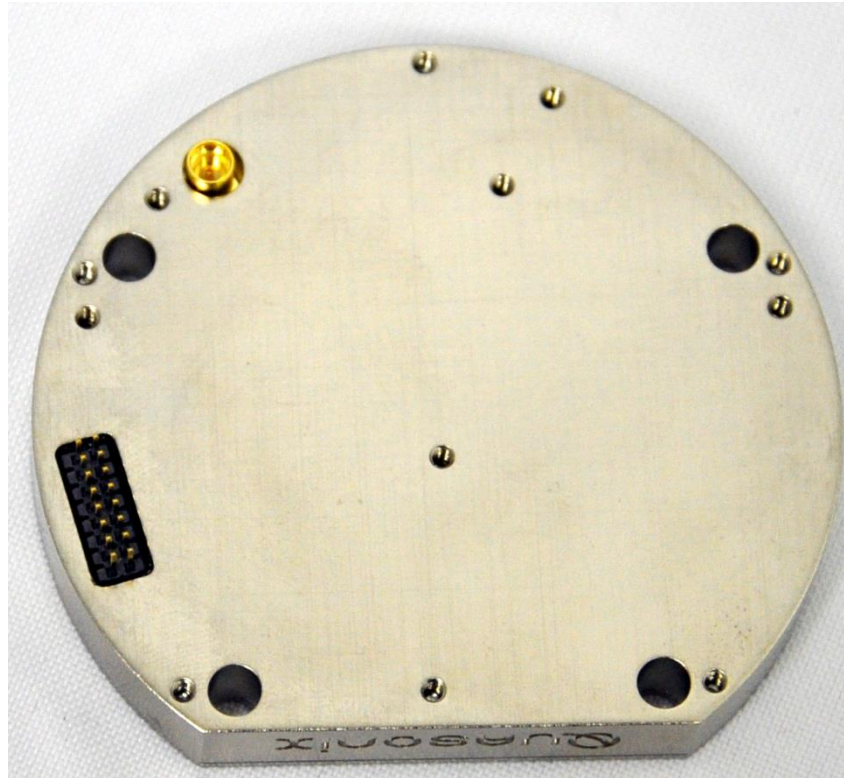
Figure 18: 1.35 in^3 nanoPuck™ - 01PD Package

Figure 19: Outline Drawing, nanoPuck™ Telemetry Transmitter – 01PD Package
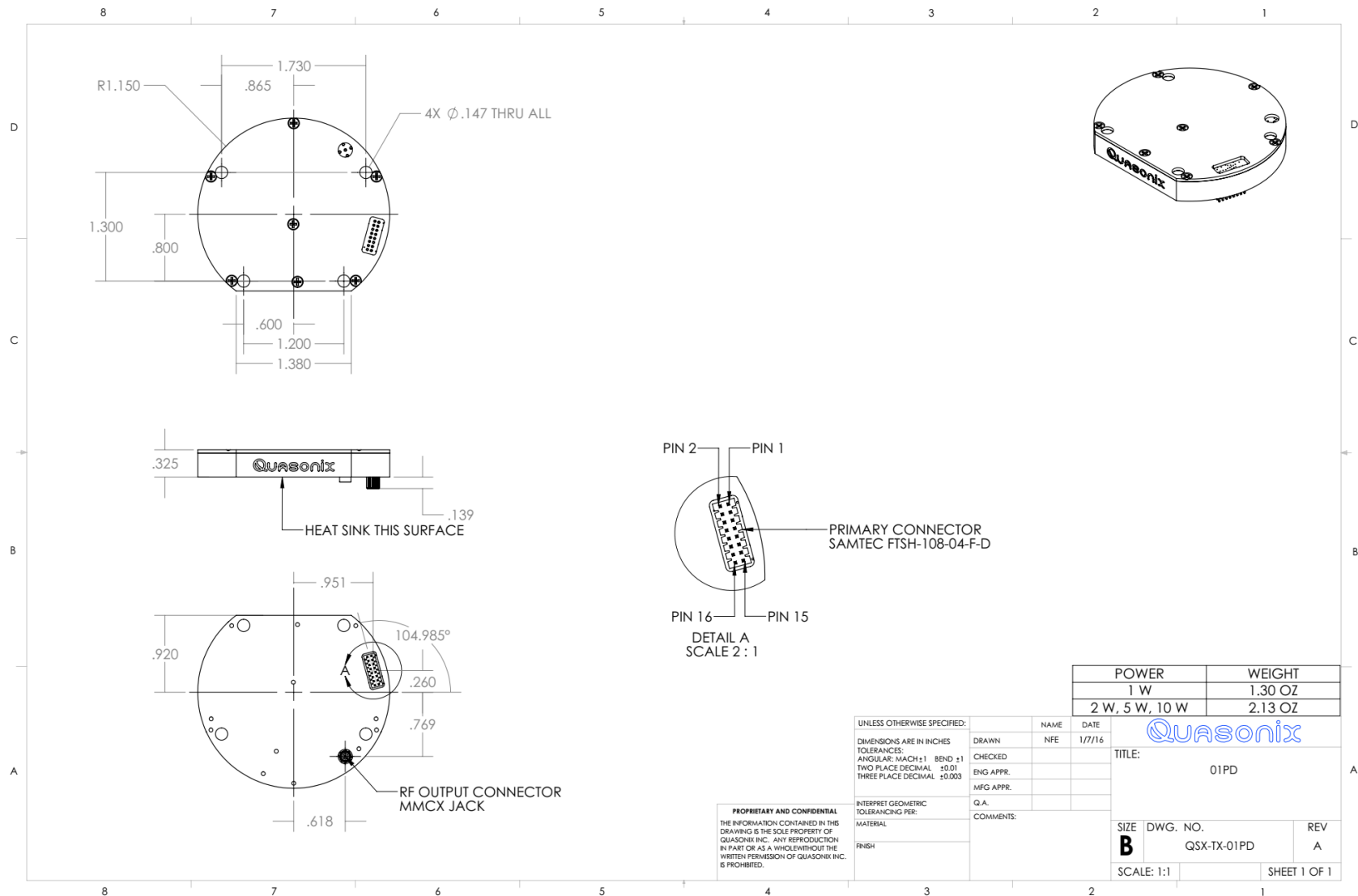
3.2   Thermal

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

Quasonix strongly suggests using high thermal conductivity grease or a thermal pad, such as Q-Pad® II from Bergquist, between the transmitter and the heat sink or baseplate to ensure adequate heat dissipation.

> **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 a fan-cooled heat sink, as shown in Figure 3. Please contact Quasonix for heat sink recommendations for your particular nanoTX™ transmitter.

3.3   Electrical

The standard nanoTX™ has two external connectors, a 15- or 21-pin single-row nano-D baseband connector, and a right-angle through-hole MMCX RF connector. The 15-pin nano-D is only available for TTL-level clock and data inputs (standard 01AA package). RS-422 clock and data inputs require the 21-pin nano-D connector (01AB package).

The pin numbering and pin assignments for the transmitter connectors vary depending on the interface type, connector gender, and options ordered. A pinout *code* is assigned based on transmitter type and options. Section 1.1.1 describes the nomenclature/part number breakdown for nanoTX™ transmitters.

Each pinout drawing contains the pinout code, a description of the connector (such as Female 15-pin Nano), a photograph of the connector with the pins numbered appropriately, and a table showing the designated pin assignments, drawing name, and revision. Drawings may contain more than one connector depending on the application.

A sample pinout drawing is shown in Figure 20. This is only an example. Pinout drawings for all transmitters may be obtained from the Quasonix web site. Customers with security rules that prevent Internet access or file downloads may contact Quasonix Customer Service for assistance.

For pinout drawings, go to www.quasonix.com.

1. Select Resources from the menu bar.
2. Click on Product Drawings.
3. Select Product Category > Transmitters, Drawing Type > Pinouts.
4. Type the pinout code in the Search box and press Enter.
5. Click on the link or the pdf icon in the list.

When you click on the pinout link in the list, it should open the file in a new tab in the same browser window. Some applications may only allow downloads, but most browsers allow viewing, depending on the local settings. Most browsers allow you to right click on the link and determine how to open it or print it, regardless of the default setting.

TRANSMITTER PINOUT CODE N1
Connector: Female 15-pin Nano

Pin	Function
1	Serial Control Ground
2	Serial Control Reply from Transmitter
3	Control Input to Transmitter
4	N/C
5	N/C
6	TTL Data
7	TTL Clock
8	TTL Clock and Data Ground
9	RF On/Off
10	DC Power Return
11	DC Power Return
12	DC Power Return
13	DC Power In
14	DC Power In
15	DC Power In

DRAWING	qsx_pcn1.docx		
REVISION	B		
DRAWN	MRE	DATE	08-22-2018
VERIFIED	DEF	DATE	08-22-2018
APPROVED	DEF	DATE	08-22-2018

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Figure 20: Example Quasonix Pinout Drawing

3.3.1 Signal Timing

The data is sampled on the falling edge of the clock, as shown in Figure 21.
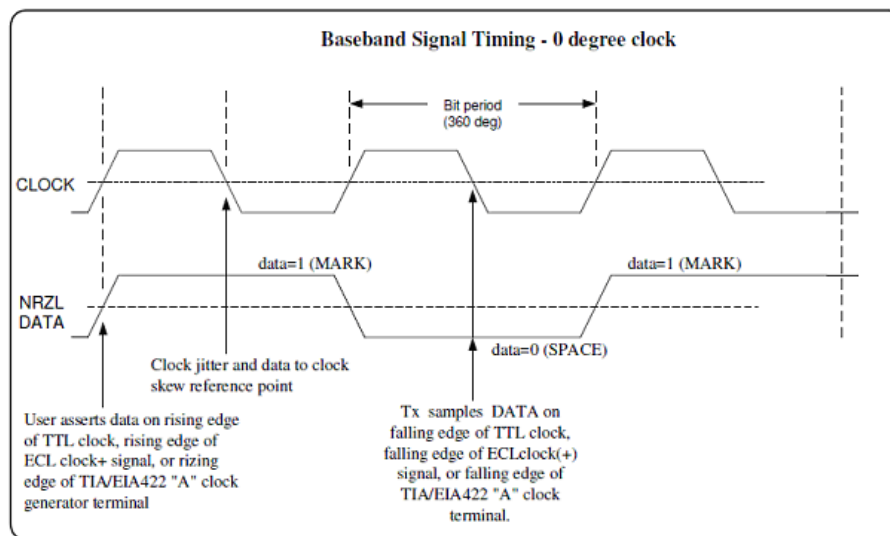
Figure 21: Baseband Signal Timing

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.

4.2   nanoTX™ Serial Control Protocol

The nanoTX™ 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 22. 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.

```
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 Build: 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 22: nanoTX™ Welcome Message

4.2.1   Command Set: Standard and Optional Commands

All standard user commands in Table 13 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. 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.

All settings can be changed via the serial control port. Changes made by the user 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 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.

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

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 Refer to section 4.2.1.1.1 for additional AC command detail	AC ACS	N Y	AC 1
BBCK	Check BB Clock	Displays the current baseband clock value and source Example: BBCK BB clock rate = 0.999998 Mbps, src = Int Clk Refer to section 4.2.1.1.2 for related BBCK command detail	Standard	N/A	N/A
BD	Display Bias Data	Display the most recent drain current, drain voltage, drive bias voltage, and final bias voltage	Depends on Tx version	N/A	N/A

Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
BR	Bit Rate	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 range is 50 kbps to 20 Mbps for all waveform modes Examples: BR Report the bit rate BR 5 Set the bit rate to 5 Mbps BR A Set the bit rate automatically Refer to section 4.2.1.1.3 for additional BR command detail	CF	Y	BR 5
BT	Baseband Interface Type	Report or set baseband interface type 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 baseband interface type BT T Set the baseband type to TTL single ended, bias 1.65V BT R Set the baseband type to RS-422 differential input Refer to section 4.2.1.1.4 for related BT command detail. Refer to Table 3 for Clock/Data Interface codes.	VR	Y	BT R

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 Refer to section 4.2.1.1.5 for additional CC command detail.	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 Also refer to Appendix B – Understanding Clock/Data, AC, and BR	CF	Y	CF 1
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 (firmware V2.xxx) CP 0 (firmware V1.xxx)
CR	Current Preset Read	Reports the currently selected software preset being used by the transmitter	Standard	N/A	N/A

Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
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. Also refer to Appendix B – Understanding Clock/Data, AC, and BR	Standard	N	CS 0
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 DE is not valid with MC enabled. Examples: DE Report the differential encoding setting DE 0 Set differential encoding OFF DE 1 Set differential encoding ON	Standard	Y	DE 1
DIOR	Display I/O Register Addresses	Displays I/O addresses of machine registers to make it easier to debug Example: DIOR Displays I/O addresses	Standard	N/A	N/A

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

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. If the FO option is present, the resolution is 1 Hz (0.000001 MHz). Examples: FR Display the current frequency FR ? Display allowed frequency ranges FR 1436.5 Set frequency to 1436.5 MHz Refer to section 4.2.1.1.6 for additional FR command detail.	Standard	Y	FR 1436.5

Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
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. Valid range is 0.000000 MHz to 3000.000000 MHz Examples: FS Display the current frequency step FS 1 Frequency step = 1 MHz	Standard	Y	FS 10
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 0-31 in 1 dB steps or 0-31.5 in 0.5 dB steps, depending on the transmitter 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

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). 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 Clock-free is enabled. 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 MHz. Examples: IC Display current internal clock rate IC 4.95 Set internal clock rate to 4.95 MHz Valid range is 0.002 MHz – 46.000 MHz Observes same bit rate limits as HR/LR commands (PCM/FM half) Refer to section 4.2.1.1.7 for additional IC command detail	Standard	Y	IC 5

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 USER 5555 or ID USER AAAA will result in an unmodulated carrier, at the nominal carrier frequency.	Standard	Y	ID PN15
IMN	Internal Model Number	Display the internal model number for the transmitter	Standard	N/A	N/A
IMP	Impedance Control	Allows user to change impedance of the clock and data inputs from 75 ohms to 10k ohms Examples: IMP 0 Set impedance to 10k input IMP 1 Set impedance to 75 ohms Refer to Table 3 for Clock/Data Interface codes.	Clock/Data interface code of A	Y	IMP 0
INF	Transmitter Information	INF does a large information dump providing the results of the following commands: SN, VE A, RFS, SS, ZZ, ZF, ZS, ZCP, ZC, ZR, ZY, SCP, SY, etc. This is typically to capture the state of the unit for debug.	Standard	N/A	N/A

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 4.2.1.1.8 for additional IS command detail	Standard on all 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

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 4.2.1.1.9 for additional LD command detail	LD, LD6	Y	LD 0
LP	Low Power	Report or set low power level Valid range is 0-31 in 1 dB steps or 0-31.5 in 0.5 dB steps, depending on the transmitter 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

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
MO	Modulation	Report or set modulation setting Mode 6, Carrier only, is present on every transmitter Examples: 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 6 Carrier only, no modulation	Standard	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
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 128.01	MS	Y	MS 1

Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
OC	Overtemperature Control	Enable Enables or disables overtemperature control OC 0 Disable Overtemperature Control OC 1 Enable Overtemperature Control Refer to section 4.2.1.1.10 for additional OC command detail. **Note:** Highly recommended NOT to disable this feature.	Standard	Y	OC 1
OTA	Over-the-Air Rate	Displays the current baseband and over-the-air bit rates on each channel. This information is also displayed on the RFS output. OTA Display over-the-air rate	Standard	N/A	N/A
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 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
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	Standard	N/A	N/A
QT or TE	Query Temperature	Report the temperature in degrees Celsius	Standard	N/A	N/A

Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
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
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 Refer to section 4.2.1.1.11 for additional RF command detail	Standard	Y	RF 1 (if option CP07, default is RF 0)

Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
RFS	RF Output State	Displays information used to determine whether RF and modulation are actually On in the format Refer to section 4.2.1.1.12 for related RFS command detail	Standard	N/A	N/A
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" The default polarity on most Quasonix transmitters is *high*. The RF On/Off pin is a hard OFF control. No matter what state everything else is in, setting this switch input to the inactive state will turn RF Off.	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
SD	Digital Pot	Report the value of the digital pot for HVA on the transmitter. Range is 0 to 255	Standard	N/A	255

Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
SI	Spectral Inversion	Sets the modulation scaling to -1 * whatever the current scaling is in order to invert the spectrum This is in ADDITION to any changes in modulation scaling factor. That is, if you enter a negative MS and then turn SI on, you will have a NON_inverted spectrum. Examples: SI Report spectral inversion status SI 0 No inversion SI 1 Invert the spectrum	Standard	Y	SI 0
SN	Serial Number	Report the serial 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

Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
SW	Frequency Sweep	Sweeps the transmitter frequency between provided limits, with provided step size, at a fixed rate Examples: SW Displays current status SW ? Displays command help with status SW 1 Start the sweep SW 0 Stop the sweep SW 1 2200.5 2394.5 1.0 Sweep channel 1 between 2200.5 MHz and 2394.5 MHz in 1.0 MHz steps Refer to section 4.2.1.1.13 for additional SW command detail	Standard	N/A	N/A
SY	System Status	Displays the system status of the transmitter The first argument specifies the period, in seconds, 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 5000 Sets status output period to 5 seconds SY 5000 100 Sets status header output once every 100 status updates Refer to section 4.2.1.1.14 for additional SY command detail	Standard	N/A	N/A
TD	Temperature Compensation Display	Displays the temperature compensation table and/or the attenuator compensation table Examples: TD Displays both tables TD 1 Displays temperature compensation table only TD 2 Displays attenuator compensation table only	Standard	N/A	N/A

Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
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 when the transmitter is powered off 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
VP	Variable Power	Report or set variable power level Valid range is 0-31 in 1 dB steps or 0-31.5 in 0.5 dB steps, depending on the transmitter 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 Max
ZA	Modulation Control Register	Reads and displays the modulation control register	Standard	N/A	N/A

Mnemonic Command	Name	Description	Option (s) Required	Setting Saved?	Factory Default
ZC	Show Configuration Parameters	Display all configuration parameters If there is no argument, then the current params are displayed. If there is an argument (0-15), then that preset is displayed. If 'C' for current is entered, then the current params in memory are displayed. Examples: ZC Display all parameters ZC 2 Display preset 2 params ZC C Display current params in memory	Standard	N/A	N/A
ZF	Show Detailed Options	Displays the current hardware configuration and detailed state of the options on the transmitter	Standard	N/A	N/A
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
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.

4.2.1.1   Additional Command Set Details

4.2.1.1.1   Automatic Carrier Output – AC

This command requires the AC or ACS option. These options 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.

If the AC *option* is present, the AC command is always enabled (1) even if a preset is saved with AC = 0.

If the ACS *option* is present, the saved setting of the AC command (preset 0) is used on power up instead of forcing AC = 1.

Also refer to Appendix B – Understanding Clock/Data, AC, and BR.

4.2.1.1.2   Baseband Clock Rate – BBCK

The BBCK command displays the actual current baseband clock rate and source.

If Clock Free (CF command) is enabled, and the bit rate (BR command) is fixed at 5.5 Mbps:

> 1>BBCK

> BB clock rate = 5.465334 Mbps, src = CF Man (Man indicates the bit rate was set manually)

If Clock Free is enabled, and the bit rate is set to Auto:

> 1>BBCK

> BB clock rate = 7.699997 Mbps, src = CF Data (bit rate determined based on the input stream)

If Clock Free is disabled, and the bit rate is set to anything (doesn't matter since CF is disabled):

> 1>BBCK

> BB clock rate = 7.699997 Mbps, src = Ext Clk (external clock)

For details about specific commands, refer to AC, BR, CF, or IC.

Also refer to Appendix B – Understanding Clock/Data, AC, and BR.

4.2.1.1.3   Clock Free Bit Rate – BR

The Clock Free Bit Rate is the bit rate used when the Clock Free (CF) option is specified and internal transmitter clock is in use. The BR command reports the bit rate. It also allows the user to set the hard bit rate on a clock free transmitter, or set the clock free bit rate to Automatic.

When set to Automatic, the internal transmitter logic determines the correct bit rate from the input data stream. For Automatic to work, the input data stream must be sufficiently randomized. The bit rate must be below 35 Mbps to use automatic bit rate detection.

Do not confuse the BR command with "IC", which sets the rate of the internally generated clock.

Syntax: BR [A / rate]

where A is:

Automatic

where rate is:

A bit rate in Mbps that matches the input data rate

Examples:

BR   Report the bit rate

BR 5   Set the bit rate to 5 Mbps

BR A   Set the bit rate automatically

BR A D   Set the bitrate mode to Auto and Disable warning

BR A E   Set the bitrate mode to Auto and Enable warning

Suppose this sequence of commands are issued:

1>BR A

CF Bitrate Mode set to Auto

1>BR

CF Bitrate Mode currently Auto

CF Bitrate currently 7.700 Mbps (CF Operation Enabled)

The rate shown is the rate determined by the bit sync looking at the data input.

Instead of using the automatic setting, the next example uses a manually set clock free data rate:

1>BR 6

CF Bitrate set to 6.000 Mbps fixed

1>BR

CF Bitrate currently 5.000 Mbps (CF Operation Enabled)

Since BR is set to a fixed rate, the displayed rate *is* the fixed rate. There could be garbage if the manually set fixed rate does not match the actual incoming data rate.

Next, assume the transmitter is NOT in clock free mode:

1>CF 1

CF Disable set to 1 (Normal)

1>BR A

CF Bitrate Mode set to Auto

> 1>BR
>
> CF Bitrate Mode currently Auto
>
> CF Bitrate currently 7.700 Mbps (CF Operation NOT Enabled)

Since the current setting is BR Auto, the rate shown is what would be used (as determined by the measured data input) if clock free were enabled.

If BR is set to a fixed value and clock free is disabled:

> 1>BR 6.1
>
> CF Bitrate set to 6.100 Mbps fixed
>
> 1>BR
>
> CF Bitrate currently 6.100 Mbps (CF Operation NOT Enabled)

This example set BR to a fixed rate, but since clock free is not enabled, it is not used.

Use the BBCK command to see the actual current clock rate being used.

Also refer to Appendix B – Understanding Clock/Data, AC, and BR.

For details about specific commands, refer to AC, BBCK, CF, or IC.

4.2.1.1.4   Baseband Interface Type - BT

BT sets the baseband interface type using the following options:

> T = TTL single ended, bias 1.65V
>
> R = RS422 differential input

This command is only valid if the transmitter has the VR option which now includes interface types D, M, or S.

If the unit has the EG option, the BT command and the VR option are not allowed.

4.2.1.1.5   Convolutional Encoder – CC

Convolutional encoding is a form of legacy forward error correction. It requires more bandwidth than all but the lowest rate LDPC codes, and its error correcting performance is inferior to LDPC. If possible, LDPC is the preferred FEC. CC is mainly used with legacy PSK modes.

4.2.1.1.6   Frequency – FR

When the FO option is installed, the desired offset may be typed with the frequency using the FR command. The frequency offset range +/- 1 MHz with a resolution of 1 Hz (0.000001 MHz).

The FO option offsets the synthesizer +X MHz and the FPGA -X MHz.

Examples:

Frequency Offset Using FR command:
1>FR 2200.2

Freq set to 2200.0 MHz

Freq offset set to 0.200000 MHz

Actual Output Freq set to 2200.200000 MHz

4.2.1.1.7   Internal Clock Rate – IC

This rate is used if the clock source is set to internal (CS 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 Clock-free is enabled.

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 MHz.

The units used to describe the internal bit rate are sometimes used interchangeably, and may cause confusion. Megahertz (MHz) and Hertz (Hz) are cycles per second units, while Mbps (megabits per second) and bps (bits per second) are data rate units.

The internal clock is referred to as "clock," so Hz or MHz is often used as the unit, since "clock" is a frequency.

If the clock is used to "clock" the bits at X MHz, then the throughput in bits is X Mbps. In other words, the internal clock also sets the baseband bitrate. That is why, in this case, units of Hz are equated with units of bps.

For example, 5,000,000 Hz or bps may be rewritten as 5.000 MHz or 5.000 Mbps.

4.2.1.1.8   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 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

  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

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)

- XX.xxx for ethernet clock with ic = XX.xxx

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

Notes:

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.

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.

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	Sets unit to 'normal' mode expecting external TTL clock and data to be applied to the unit 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

4.2.1.1.9 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 (for example, all *PSK modes default to DE On.)

LDPC cannot be enabled if CC (convolutional encoding) is enabled.

LDPC cannot be set with MC enabled (NRZ-L only).

LDPC is disabled when a mode change occurs. This is true for all mode changes, *PSK or other modes. There are two exceptions: If preset 0 has LDPC enabled, it stays enabled after a power cycle. Any preset that has LDPC enabled, stays enabled after the preset is recalled (RC command).

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).

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

4.2.1.1.10 Overtemperature Control – OC

OC is the overtemperature control enable command. The default value is enabled (set to 1).

The transmitter contains an internal thermal shutdown feature that gradually reduces transmit output power up to 6 dB below maximum as the internal temperature rises from approximately 100°C to 108°C. Transmitting automatically resumes when the temperature falls below these thresholds.

Note: This feature is not production tested and is intended as a last-ditch attempt to prevent damage. Exercising this feature can only be done by deliberately overheating the unit, which voids the warranty.

Contact Quasonix for the default overtemperature value specific to your transmitter. Refer to the technical guide "Quasonix Transmitter Overtemp Control Operation" on the Quasonix website for additional information.

4.2.1.1.11 RF Output – RF

RF enables or disables the RF power output from the transmitter. A 1 enables the output and a 0 disables it. If no parameter is entered, the current state displays.

Note that just turning the RF output on does not guarantee that RF is output. If there is not a valid clock (or in clock free, if there is no valid data (transitions) from which to derive a clock), then the RF output is Off (unless the unit has the AC option and the AC command is enabled, in which case a carrier on the current center frequency is output).

Also, if the unit has an RF On/Off pin that is pulled into the Off state (determined by the current setting of RZ), then there is no RF output.

Also refer to Appendix B – Understanding Clock/Data, AC, and BR.

4.2.1.1.12 RF Output State – RFS

The RFS command may display the following information, depending on available options, about the connected transmitter:

RFS

```
ModCtrlReg shdw = 00007013h            ModCtrlReg      = 00007013h
       GPIO_In_reg    = 7E00005Fh
BB_ctl_reg     = 78004AF5h             CF_auto_ctl_reg = 00000000h
GPIO_Out_reg   = 00000000h
MO 1        FR 2200.5    RF 1          RZ 1 (high = RF on)
RF pin = 1   DE 0         MC 0         RA 1        SI 0
CP A         DP 0         DS 1         CS 1
HP 31.0         LP  0.0              PL 1        BR  1.000 Mbps (NOT Auto)
IC 5.000     VP 10.0            SD 130        MS 1.000
bb_clk_okay: 1       clock free bitrate: N/A
DL: 2214     I gn: 7292    Q gn: 7292
Synth Lock = 1             RF pin = 1
CF option  1, CF state 1 (Normal)
EN option  0, EN state 0
AC option  1, AC state disabled
ACS option 0, AC state disabled
AI option  0, AI state disabled
FO option  0, FO = 0.000000 MHz
CE option  0, CC state 0
RH option  0, NRF option 0
P62 option 0, RAM option 0, Freq_plug_invalid state 0
desired_rf_state = 1 (On)  need_to_change_rf = 0      PA_RF_state = 0
current pwr lvl = 10.0 dB  T3 Atten = 21.0 dB  PA Atten2 = 0.00 dB
       Detected baseband rate: 5.000 Mbps
       Detected over-the-air rate: 7.813 Mbps
```

4.2.1.1.13 Frequency Sweep – SW

When a frequency sweep is started, it will run continuously until manually stopped, except for the following circumstances.

- If a mode change or recall preset occurs, the sweep is automatically terminated.

- If invalid sweep parameters are entered, or an error message occurs while a sweep is running, the sweep will terminate.

This is to ensure the integrity of the transmitter frequency during the parameter changes. For example, if the mode changes to SOQPSK while a sweep is running, the sweep is automatically terminated, then the new parameters are copied. Another example: if a sweep is running and the user attempts to change the sweep to "SW 1 1300 1400 1", the transmitter recognizes an invalid frequency and disables the sweep.

It is possible to change sweep parameters while a sweep is running. Entering new sweep parameters such as "SW 1 1435.5 1442.5 1" seamlessly restarts the sweep with the new frequencies.

The valid step size range is >= 1 kHz to <= 1000 MHz.

Examples:

SW ?   Help (syntax)

SW   Show the sweep status

SW 1 1435.5 1442.0 1   Set channel to enable (On), the start frequency is 1435.5 MHz, the stop frequency is 1442.0 MHz, sweep frequency step size is 1 MHz

4.2.1.1.14 System Status Command – SY

The status reporting period must be > 200 ms or zero (0) to disable. Items in the SY command are defined with the SZ command. The minimum update period is 200 ms (about 5 times per second).

For example:

SY 5000 (sets status period to 5 seconds)

SY 5000 100 (sets status header output once every 100 status updates

The SY command is defined as follows.

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).

This example display shows selected parameters for one channel.

CRateB0 (b/s)	CFRate1 (b/s)	Mode 1	Freq 1 (Hz)	Temp 1 (C)
7812666	0	0	1852000000	32.5

5   RF Output Notes

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

6. 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.

7. 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 AND the unit is not running in Clock Free mode, the RF output automatically shuts OFF (unless the AC or ACS option is present, in which case the RF output switches to just a carrier at the center frequency with no modulation on loss of clock). 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, but varies based on settings.

   If the unit IS running in Clock Free mode, no clock is required, but the loss of data transitions is detected. This will cause the RF to shut OFF (or if AC or ACS option and AC is set to 1, change to a carrier on center frequency). When the data transitions begin again (or when an external clock is reapplied if NOT in Clock Free mode), the RF output turns on again.

8. RF On / Off pin – The RF On / Off pin is a hard OFF control for the RF output. The polarity of this pin is selectable using the RZ command. The RF On /Off pin (in the inactive state) forces RF OFF; the RF On /Off pin can only allow RF to turn on, but it cannot force it to turn on.

   If RZ = 1 then a high level on the RF On / Off pin allows RF On.

   If RZ = 0, then a low level (ground the RF On / Off pin) allows RF On.

   The RZ command is described in section 4.2.1.

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.

   Is the output present now? If so, go on to Part 2 below. If not, call Quasonix for technical support.

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.

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.

<div align="center">

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

</div>

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).

6   Performance Specifications

6.1   RF Output

The minimum RF output power is one of the following: 1 W, 2 W, 5 W, or 10W 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 nanoTX™ and nanoPuck™ transmitters is provided in Table 14.

Table 14: DC Input Current at Standard Input Voltage

Band Type	Wattage	Maximum Amps	Typical Amps @ 28 VDC
S	1 W	450 mA	350 mA
S	2 W	570 mA	480 mA
S	5 W	1.0 A	850 mA
S (nanoTX™ only)	10 W	1.4 A	1.1 A

6.3   Environmental Specifications

The nanoTX™ meets the following environmental requirements.

Table 15: nanoTX™ Environmental Specifications

Environmental Specifications	Description
Operating temperature (1 W, 2 W, and 5 W)	-40°C to +85°C
Operating temperature (10 W)	-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.

6.3.1   EMI Performance

Every Quasonix transmitter is designed to operate reliably and unobtrusively in the most challenging environments. This includes electromagnetic interference and compatibility (EMI/EMC) requirements. More specifically, all Quasonix transmitters in the nanoTX™ and nanoPuck™ family have been designed to comply with the following requirements of MIL-STD-461G, when installed as recommended by Quasonix.

Table 16: nanoTX™ EMI Compatibility

Requirement	Description
CE101	Conducted Emissions, Audio Frequency Currents, Power Leads
CE102*	Conducted Emissions, Radio Frequency Potentials, Power Leads
CE106	Conducted Emissions, Antenna Port
CS101*	Conducted Susceptibility, Power Leads
CS114*	Conducted Susceptibility, Bulk Cable Injection
CS115*	Conducted Susceptibility, Bulk Cable Injection, Impulse Excitation
CS116*	Conducted Susceptibility, Damped Sinusoidal Transients, Cables and Power Leads
RE101**	Radiated Emissions, Magnetic Field
RE102**	Radiated Emissions, Electric Field
RS101**	Radiated Susceptibility, Magnetic Field
RS103**	Radiated Susceptibility, Electric Field

Quasonix transmitters have been tested for compliance with these standards approximately annually since 2004. However, such testing is only performed as part of a qualification program, and the test results are the exclusive property of the customer who paid for them. If you need EMI testing on a particular part number, please contact sales@quasonix.com for a quote.

*For certain nanoTX™ or nanoPuck™ models, external filtering on the power leads may be required to meet the requirements marked with a *.

**For certain nanoTX™ or nanoPuck™ models, additional RF sealing (option ES) or shielding may be required to meet the requirements marked with **.

6.4 Carrier Frequency Tuning

The carrier frequency is selectable in 0.5 MHz steps, except for units with the FO (frequency offset) option. Frequencies supported by the nanoTX™ are listed in Table 17.

Table 17: Carrier Frequencies (MHz)

Frequency Band Code	Band	Minimum Frequency	Maximum Frequency	Default Frequency	Tuning Steps
A	Lower S	2200.5 MHz	2300.5 MHz	2250.5 MHz	0.5 MHz
N	Upper S	2300.5 MHz	2394.5 MHz	2370.5 MHz	0.5 MHz
S	S	2200.5 MHz	2394.5 MHz	2370.5 MHz	0.5 MHz

6.5   Carrier Frequency Error

The frequency error is ± 6 ppm for all causes, including aging over five (5) 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 18: Transmitter BER Specifications

BER	Maximum Eb/N0 (dB)		
	PCM/FM, Tier 0	**SOQPSK-TG, Tier I**	**Multi-h CPM, Tier II**
10-3	7.5	9.5	11.0
10-4	9.0	11.5	12.5
10-5	10.0	13.0	13.5
10-6	11.0	14.5	14.5

6.7   Modulated RF Power Spectrum

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

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

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 19.

Table 19: 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 23, Figure 24, and Figure 25.
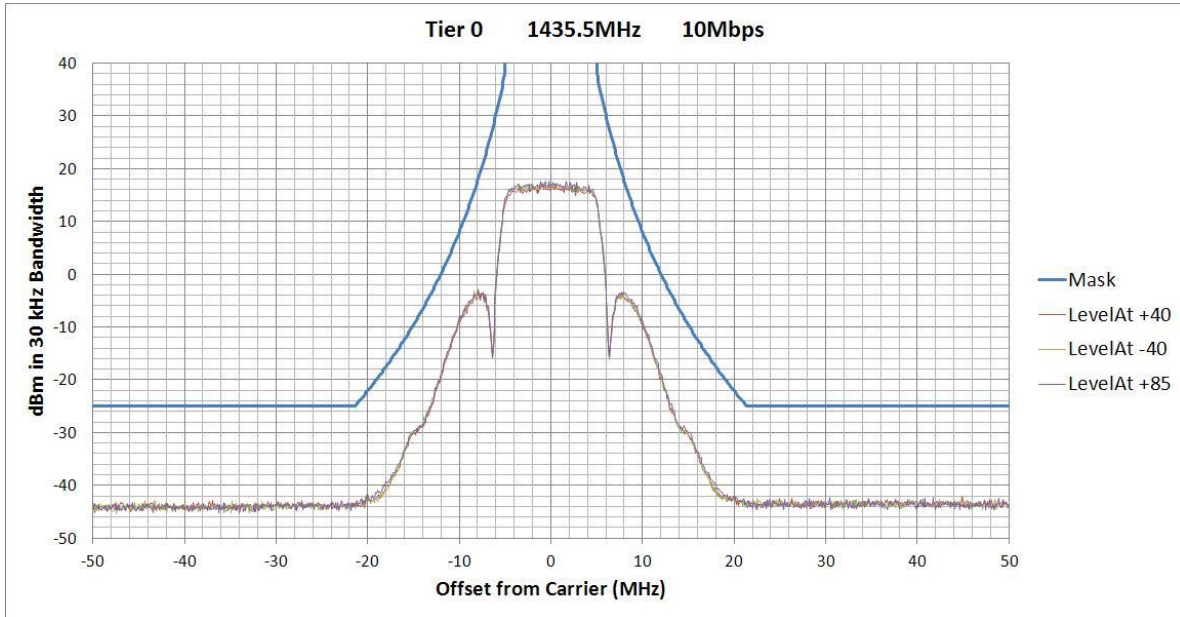

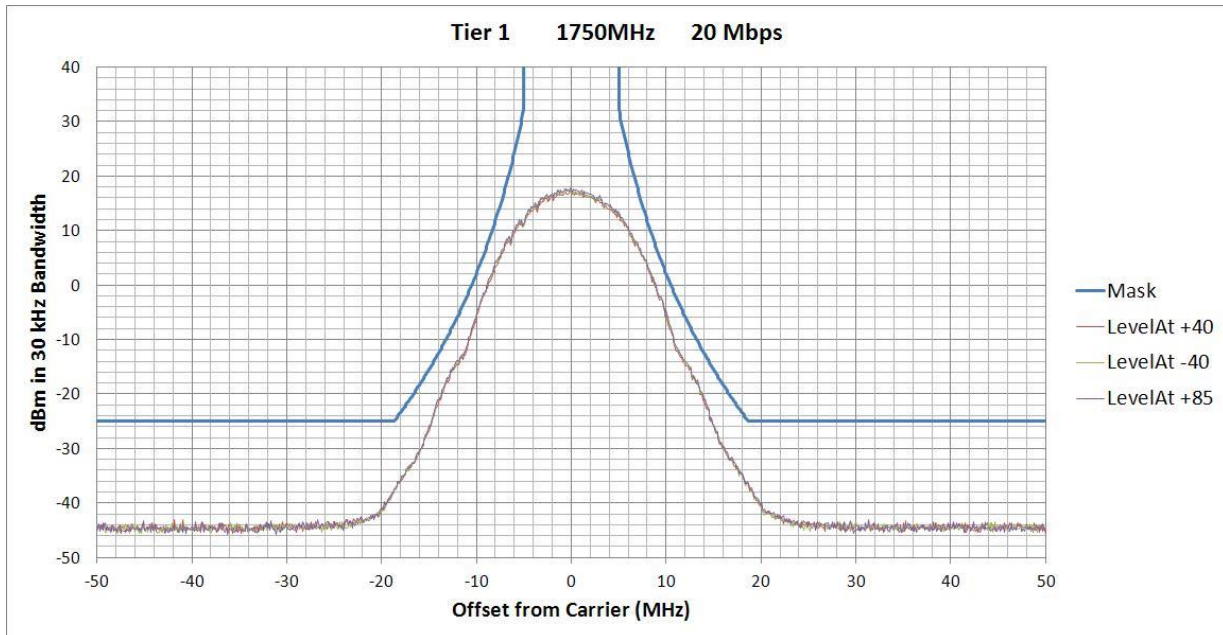
Figure 23: PCM/FM (Tier 0) PSD and Mask
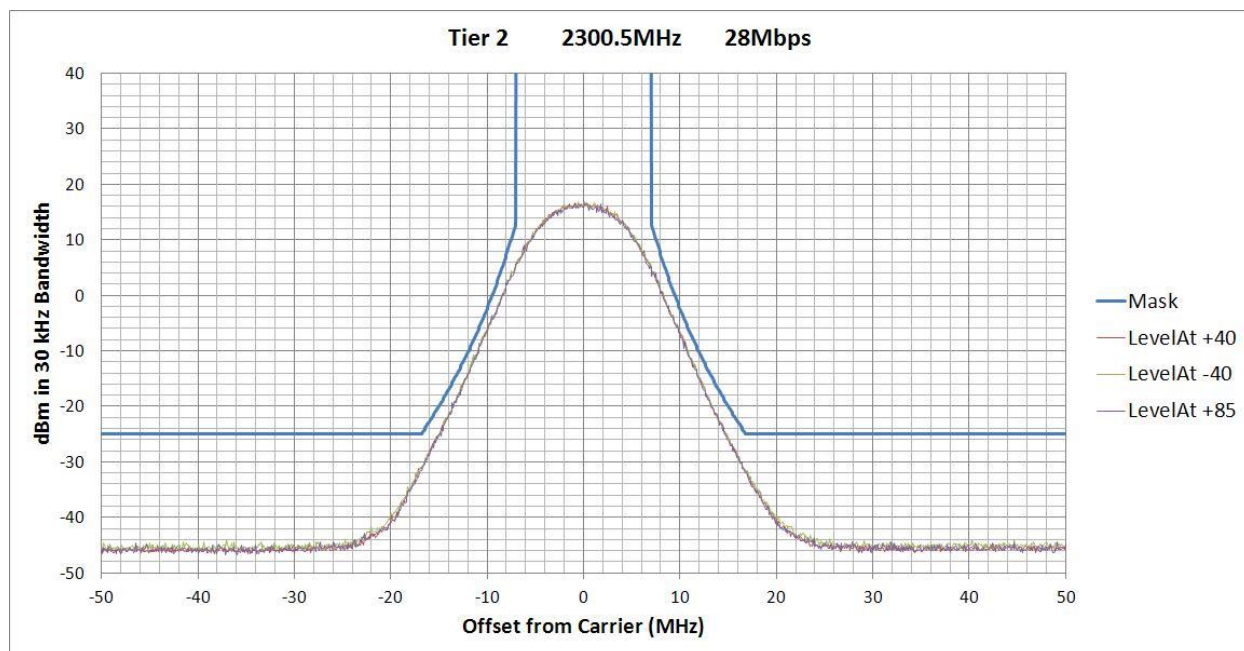

Figure 24: SOQPSK-TG (Tier I) PSD and Mask

Figure 25: Multi-h CPM (Tier II) PSD and Mask

6.8   Phase Noise Power Spectrum

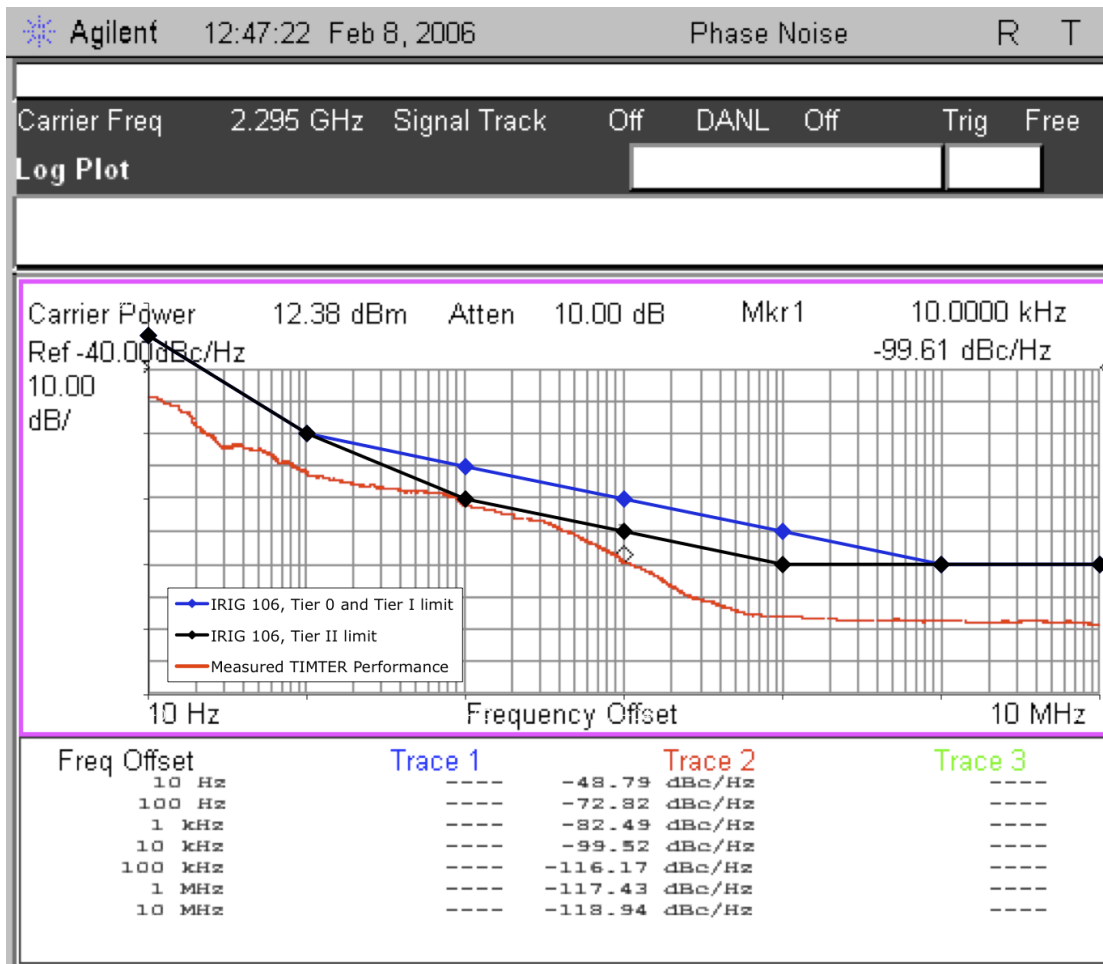TIMTER™ phase noise limits are shown in Figure 26.

Figure 26: Phase Noise Limit Curve

6.9   Baseplate Temperature

The nanoTX™ is designed for efficient heat transfer between internal heat producing sources and the baseplate. The 1 W, 2 W, and 5 W models are rated for operation with baseplate temperatures ranging from -40°C to +85 °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.
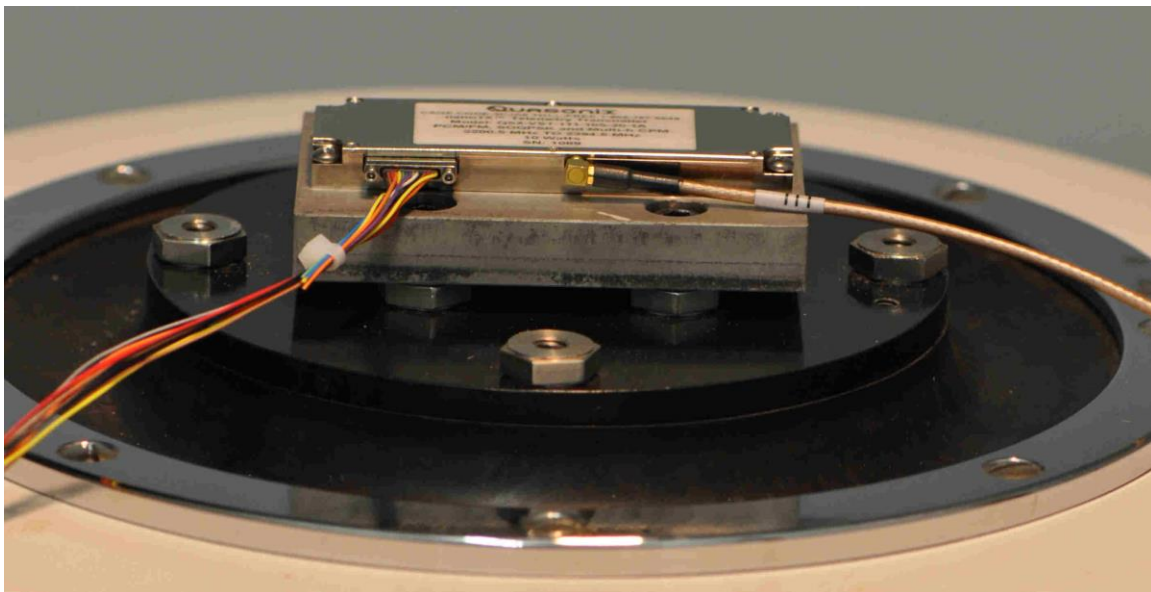
Figure 27: Vibration / Shock Testing System

Figure 28: nanoTX™ Mounted for Z-axis Testing

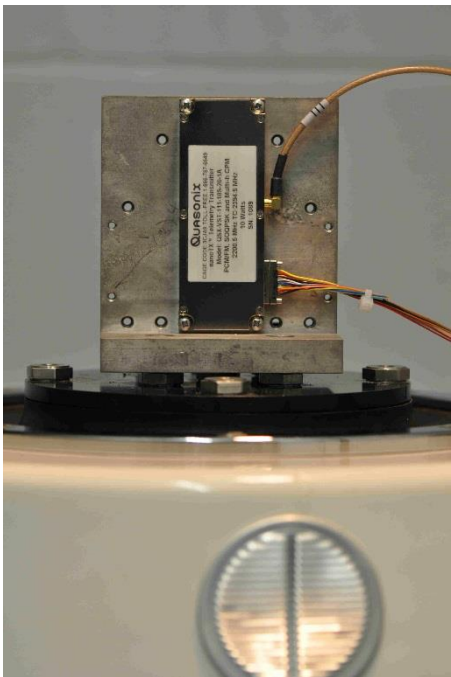**Figure 29: nanoTX™ Mounted for X-axis Testing**

Figure 30: nanoTX™ Mounted for Y-axis Testing

6.10.1 Vibration Testing

Each transmitter is subjected to the random vibration spectrum depicted in Figure 31 and Table 20 prior to shipment.

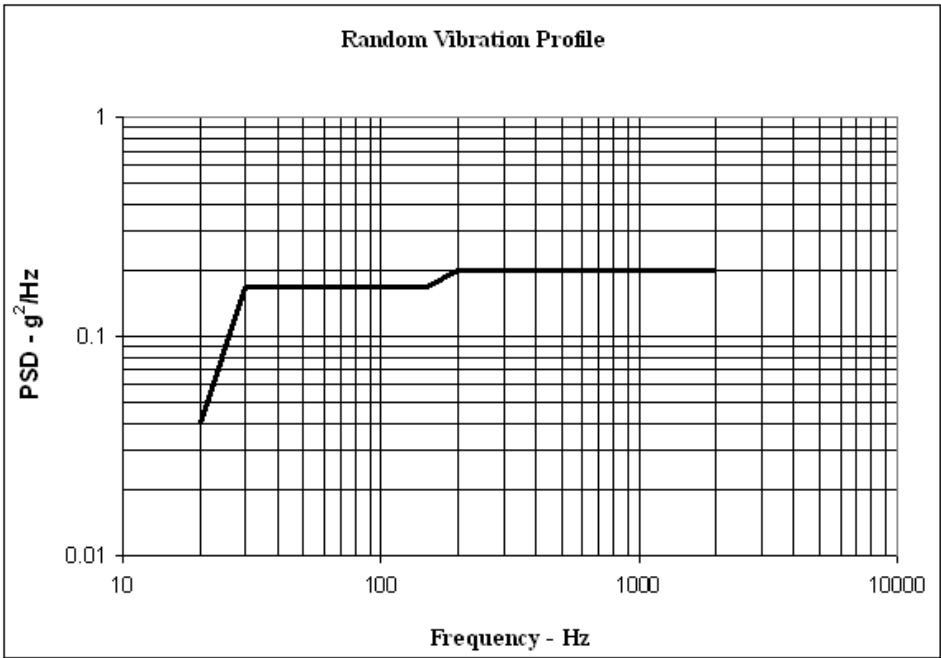**Figure 31: TIMTER™ Vibration Profile**

Table 20: 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. Results are shown in Figure 32, Figure 33, and Figure 34.
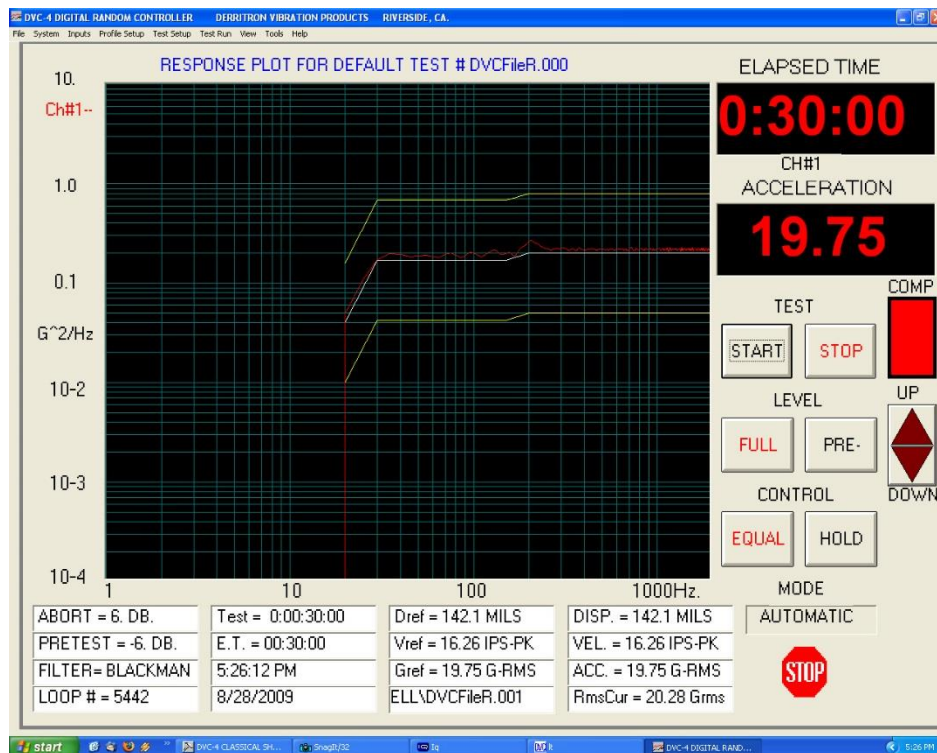

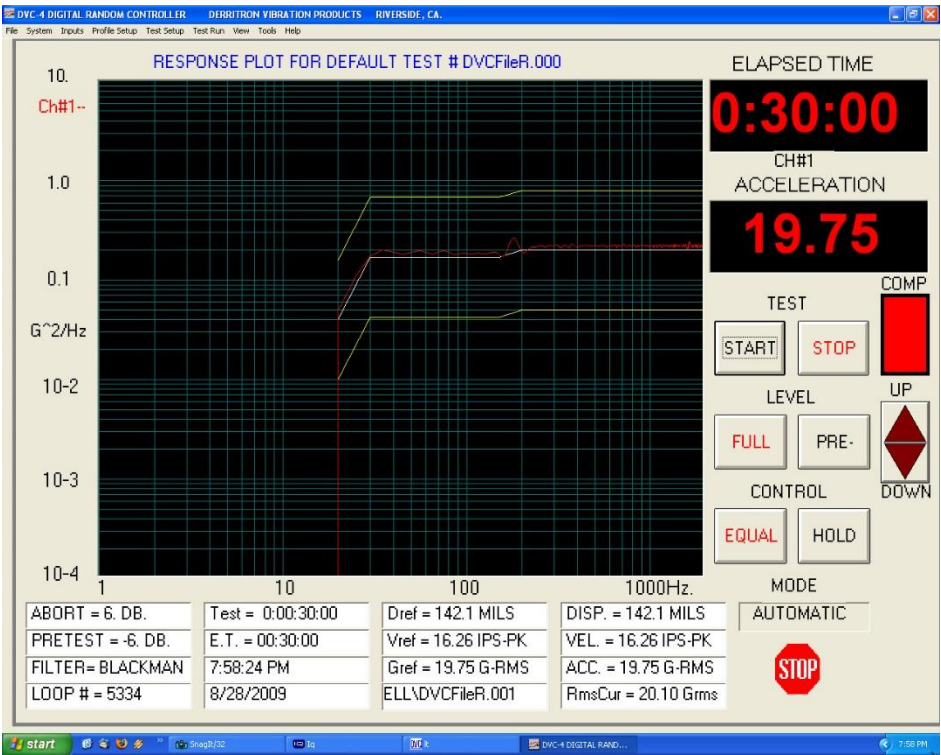
Figure 32: Z-axis Vibration Spectrum

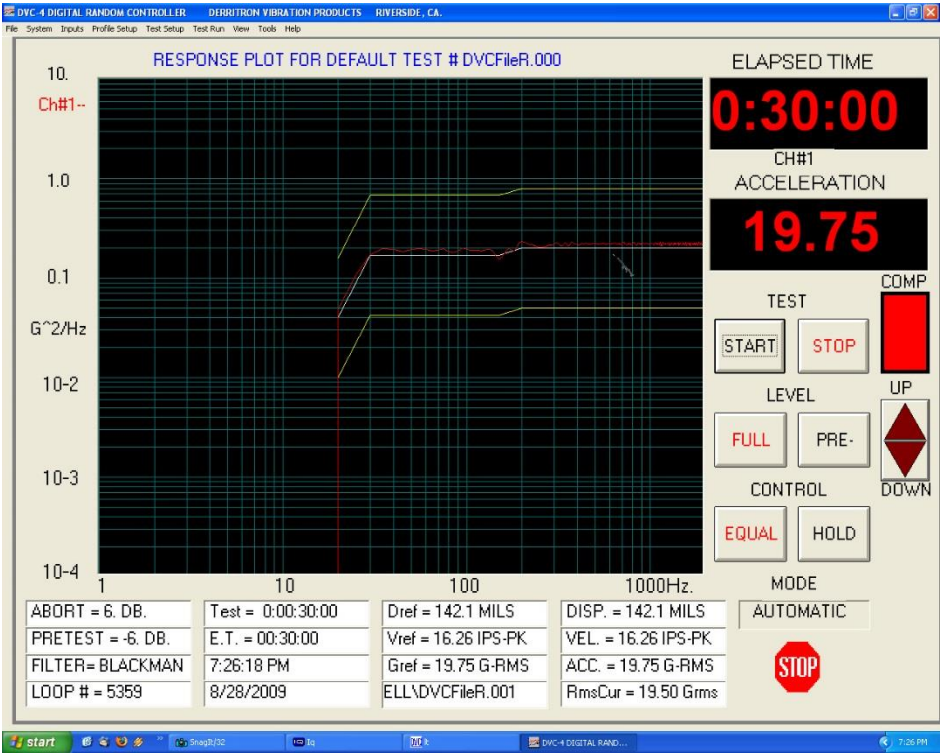**Figure 33: Y-axis Vibration Spectrum**

Figure 34: X-axis Vibration Spectrum

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 35: Shock Pulse, Z-axis Positive

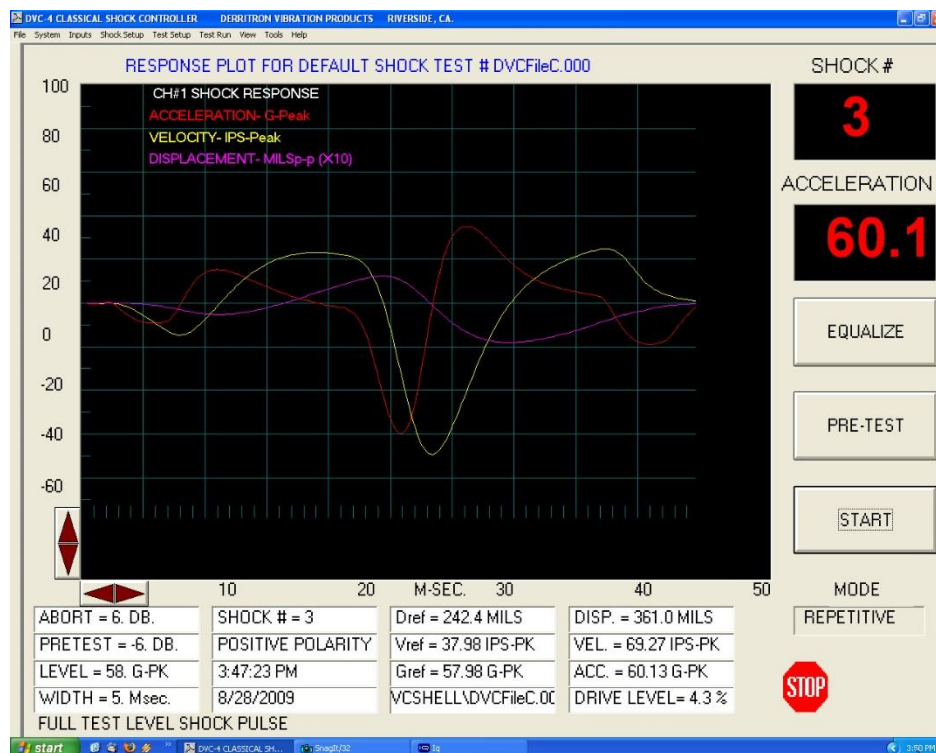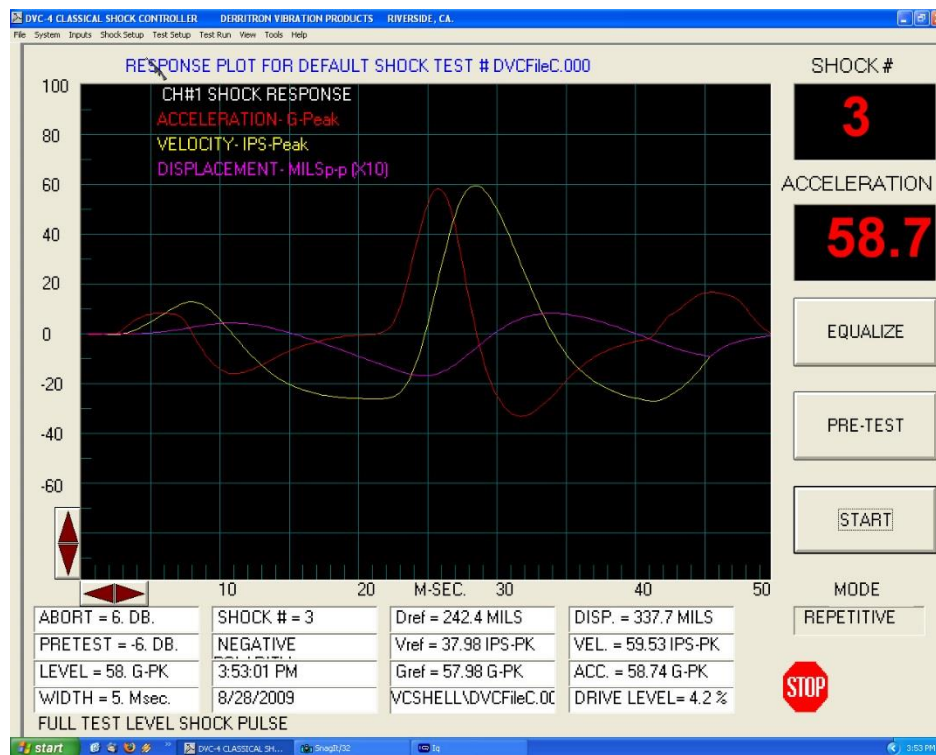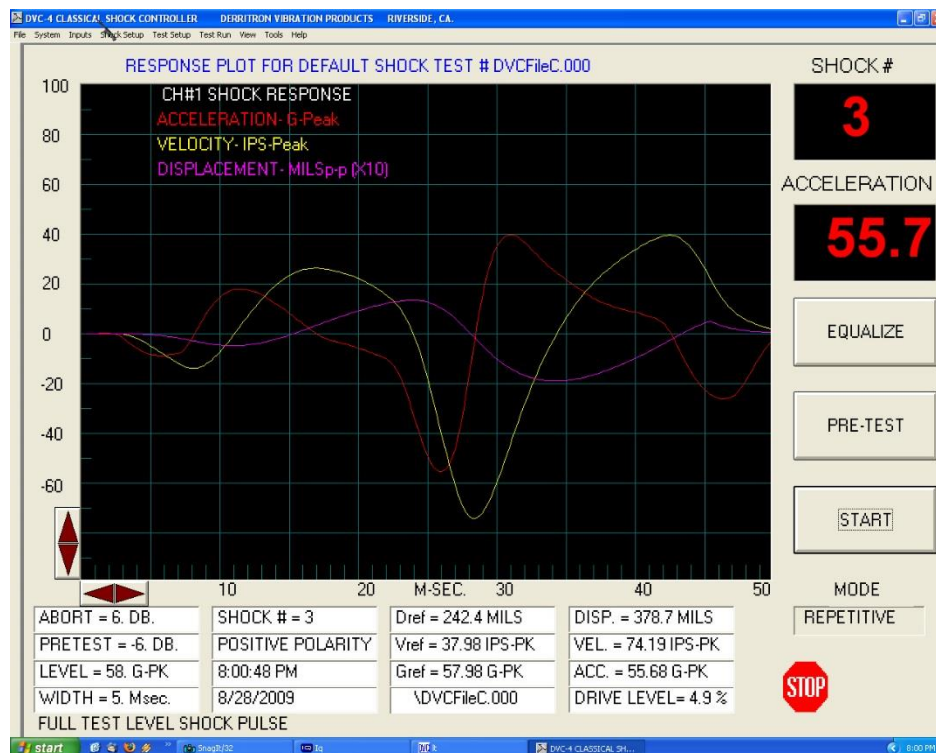**Figure 36: Shock Pulse, Z-axis Negative**

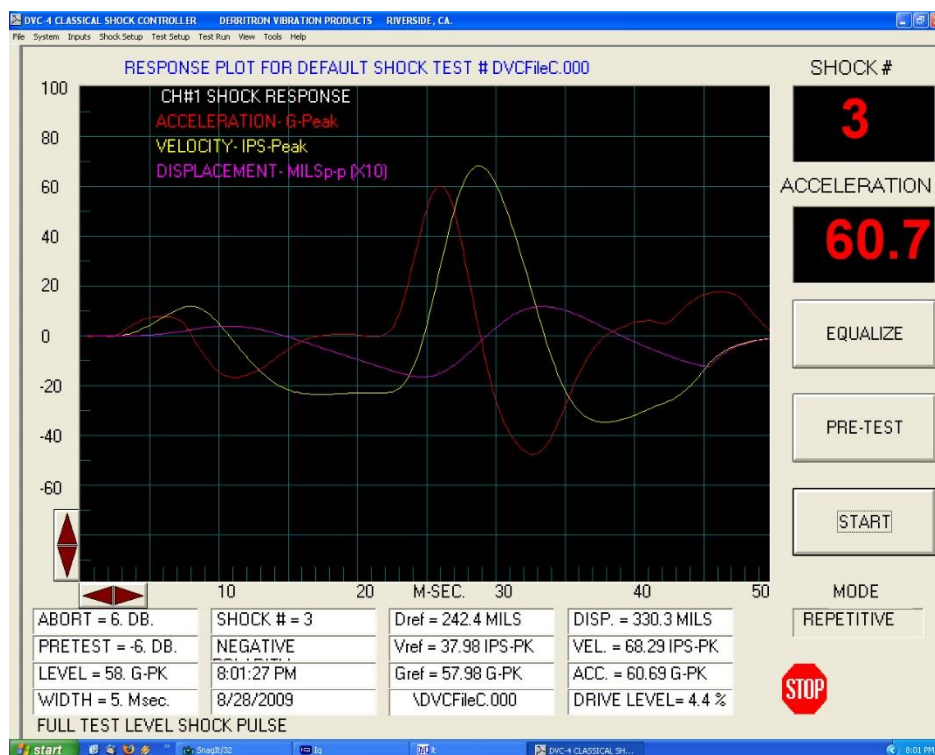**Figure 37: Shock Pulse, Y-axis Positive**

Figure 38: Shock Pulse, Y-axis Negative

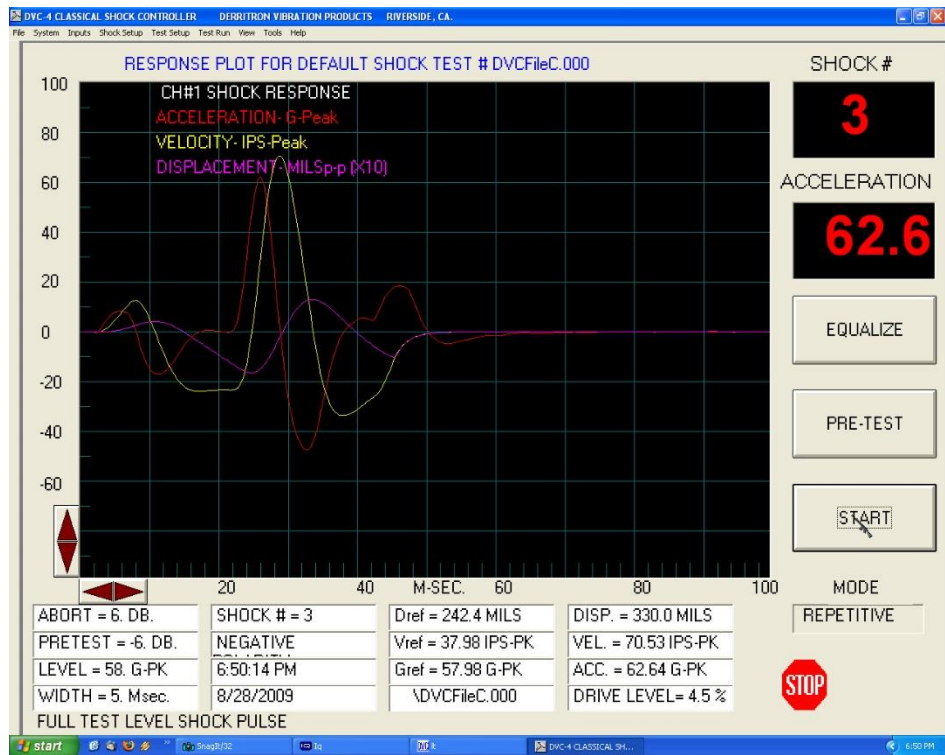**Figure 39: Shock Pulse, X-axis Positive**

Figure 40: Shock Pulse, X-axis Negative

7   Maintenance Instructions

The nanoTX™ Telemetry Transmitter requires no regular maintenance, and there are no user-serviceable parts inside.

8   Product Warranty

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

8.1   Quasonix Limited Warranty Statement

This Limited Warranty Statement (this "Limited Warranty") applies to all hardware and software products and internal components of such products (the "Products") sold by Quasonix, or its representatives, authorized resellers, or country distributors (collectively referred to herein as "Quasonix"). EXCEPT AS EXPRESSLY SET FORTH IN THIS LIMITED WARRANTY, QUASONIX MAKES NO OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO ANY PRODUCTS SOLD BY IT. Quasonix expressly disclaims all warranties and conditions not stated in this limited warranty. There are no warranties which extend beyond the description on the face hereof. Capitalized terms not otherwise defined herein shall have the meaning set forth in those certain General Terms and Conditions of Sale for Standard Product, as amended from time to time.

Quasonix warrants to customer that for one (1) year from the date of shipment of the Products by Quasonix (the "Warranty Period"), such Products purchased from Quasonix or its authorized affiliate will materially conform to the specifications set forth in the applicable Quasonix Specifications, if any, and are free from defects in materials and workmanship under normal use during the Warranty Period. As used herein, "normal use" means the intended use of the Products for which it was designed by Quasonix.

This Limited Warranty extends only to the original purchaser of the Products and is not transferable to anyone who obtains ownership of the Products from the original purchaser.

Quasonix's software, whether incorporated into the Products or sold separately, is warranted solely to the extent that problems or "bugs" are found in the software and affect the functional operation of the Products. At no time shall requests for changes in the software architecture or visual esthetics be considered a warranty item.

The Products are manufactured using new materials only. Replacement parts may be new or equivalent to new. Replacement parts are warranted to be free from defects in material or workmanship for thirty (30) days or for the remainder of the Warranty Period of the Products in which they are installed, whichever is longer.

During the Warranty Period, Quasonix will repair or replace the defective Products. All components or hardware products removed from the Products under this Limited Warranty become the property of Quasonix. All warranties are limited to the repair or replacement of the Products.

In no event shall Quasonix be liable for any special, consequential, incidental or indirect damages of any kind, including, without limitation, loss of profits, loss of data, "down-time," loss of use or damage to other equipment, or personal injury or death, whether or not Quasonix has been advised of the possibility of such loss.

Notwithstanding anything to the contrary herein, Quasonix's entire liability hereunder from any cause whatsoever and regardless of the form of action shall be limited to the amount actually received by Quasonix.

Quasonix shall not be liable for a breach of the warranty set forth in this Limited Warranty unless: (i) the customer gives written notice of the defect, reasonably described, to Quasonix's Contracts Administrator within thirty (30) days of the time when customer discovers or ought to have discovered the defect and obtains a Return Materials Authorizations ("RMA") number; (ii) Quasonix is given a reasonable opportunity after receiving the notice to examine such Products and customer (if requested to do so by Quasonix) returns such Products to Quasonix's facility in Moorpark, CA, unless otherwise approved by Quasonix; and (iii) Quasonix reasonably verifies customer's claim that the Products are defective.

Subject to the foregoing, with respect to any such Products during the Warranty Period, Quasonix shall, in its sole discretion, either: (i) repair or replace such Products (or the defective part) or (ii) credit or refund the price of such

Products at the pro rata contract rate provided that, if Quasonix so requests, customer shall, at Quasonix's expense, return such Products to Quasonix.

The customer is responsible for all costs associated with packaging and shipping of the defective Products to Quasonix's facility and clearly marking or affixing the given RMA number on the shipping label. Quasonix is not responsible for any loss or damage during shipment to Quasonix's facility. Following repair or replacement of covered Products, Quasonix will assume responsibility for the costs associated with the return of the material to the customer to an address provided by the customer. Notwithstanding the foregoing, items returned to Quasonix's facility and found to be operational or otherwise not covered by this Limited Warranty shall be returned to the customer at the customer's expense.

This Limited Warranty does not apply to expendable parts, such as cables, lamps, fuses, connectors, etc. This Limited Warranty does not extend to any Products which have been damaged or rendered defective (a) as a result of accident, misuse, abuse, or external causes; (b) by operation outside the usage parameters stated in the user documentation that shipped with the Products; (c) as a result of a failure to follow the instructions in the Operations & Maintenance Manual (d) by the use of parts not manufactured or sold by Quasonix; or (e) by modification or service by anyone other than (i) Quasonix, (ii) an Quasonix authorized service provider, or (iii) your own installation of end-user replaceable Quasonix or Quasonix approved parts if available for the Products in the servicing country.

THE TERMS OF THE WARRANTIES CONTAINED HEREIN DO NOT IN ANY WAY EXTEND TO ANY PRODUCT OR PART THEREOF OR SOFTWARE MATERIALS WHICH WERE NOT MANUFACTURED BY SELLER OR PREPARED BY SELLER OR ANY OF ITS AFFILIATES.

These terms and conditions constitute the complete and exclusive warranty agreement between the customer and Quasonix regarding the Products purchased. This Limited Warranty is applicable in all countries and may be enforced in any country where Quasonix or its authorized affiliates offer warranty service subject to the terms and conditions set forth in this Limited Warranty.

These terms and conditions supersede any prior agreements or representations (including representations made in Quasonix sales literature or advice given to the customer by Quasonix or an agent or employee of Quasonix) that may have been made in connection with the purchase of the Products. No change to the conditions of this Limited Warranty is valid unless it is made in writing and signed by an authorized representative of Quasonix.

8.1.1   Extended Warranties

Extended warranties or extra coverage are available upon request. Please contact Quasonix for details and pricing.

THE REMEDIES SET FORTH IN THIS LIMITED WARRANTY STATEMENT SHALL BE THE BUYER'S SOLE AND EXCLUSIVE REMEDY AND SELLER'S ENTIRE LIABILITY FOR ANY BREACH OF THE LIMITED WARRANTY SET FORTH HEREIN.

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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.

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 4, 5, and 9 on the 15 pin Nano-D connector or pins 4, 5, 9, 16, 17, 18, and 19 on the 21 pin Nano-D connector. Of these pins, up to four may be used for presets depending on the device options. The 15 pin Nano-D (TTL) model can have 2, 4, 8 presets. The 21 pin Nano-D (RS-422) model can have 2, 4, 8, or 16 presets. 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.

12 Appendix B – Understanding Clock/Data, AC, and BR

It is important to understand clock and data priorities when using a Quasonix transmitter. Table 21 describes the possible settings for Internal Clock, Clock Free, Clock Free Bit Rate, External Clock, External Data, and Automatic Carrier Output, and the resulting RF output.

Clock and data logic (where they come from and how they are selected) is shown in Figure 41.

When set to internal clock source (CS 1), the data source must also be set to internal via the DS command (DS 1) in order to have synchronous, usable data.

For details about specific commands, refer to AC, BBCK, BR, CF, or IC.

Table 21: Transmitter Priority of CS, CF, BR, and AC When RF is On

CS	CF	BR auto/manual	Ext Clk In	Ext Dat In	AC	RF Out
1	x	x	x	x	x	RF out is based on IC and ID
0	0	Auto	x	present	x	RF out is based on auto CF rate derived from ext data input
0	0	Auto	x	not present	0	RF Off
0	0	Auto	x	not present	1	RF stick at Carrier frequency
0	0	Manual	x	x	x	RF out based on BR setting (may be trash if no data is present or rate is wrong on ext dat input)
0	1	x	present	x	x	RF out based on ext clock and data (may be trash if no data is present on ext dat input)
0	1	x	not present	x	0	RF Off
0	1	x	not present	x	1	RF stick at Carrier frequency

*Note that 'x' means 'don't care'
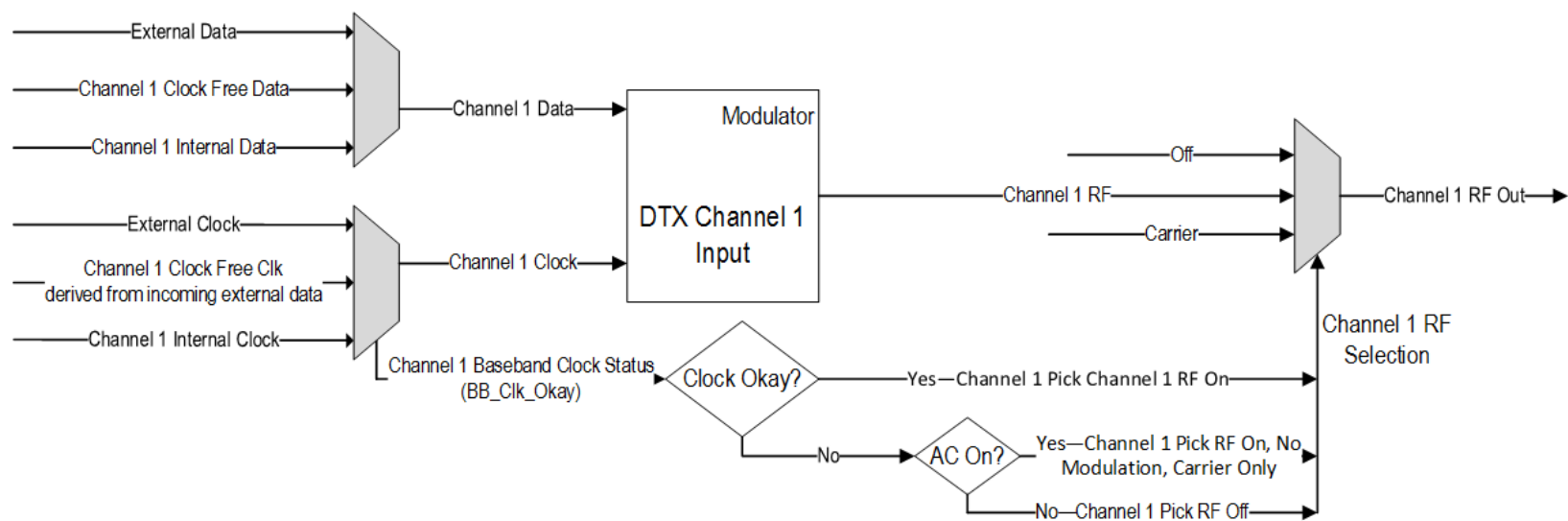
Figure 41: Transmitter Clock and Data Logic

13 Appendix C – Acronym List

Acronym	Description
AGC	Automatic Gain Control
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
CD	Compact Disk
CPM	Continuous Phase Modulation
DB-9	D-subminiature 9 pin Serial Connector
DC	Diversity Combiner
DHCP	Dynamic Host Configuration Protocol
FPGA	Field Programmable Gate Array
IF	Intermediate Frequency
IP	Internet Protocol
kbps	Kilobits per second
KHz	Kilohertz
LCD	Liquid Crystal Display
mbps	Megabits per second
MCX	Snap on subminiature connector
MHCPM	multi-h Continuous Phase Modulation
MHz	Megahertz
N	(connector type) Threaded RF connector
OQPSK	Offset Quadrature Phase Shift Keying
PCMFM	Pulse Code Modulation/Frequency Modulation
PM	Phase Modulation
PSK	Phase Shift Keying

Acronym	Description
QPSK	Quadrature Phase Shift Keying
RDMS	Receiver DeModulator Synchronizer
RF	Radio Frequency
RJ-45	Ethernet Connection Jack
RM	Rack Mount
RRC	Remote RDMS Client
RS-232	Recommended Standard 232 (Serial Communications)
SAW	Sawtooth Wave
SDI	System Degradation Indication
SOQPSK	Shaped Offset Quadrature Phase Shift Keying
SOQPSK-TG	Shaped Offset Quadrature Phase Shift Keying –Telemetry Group
TRL	Tracking Loop
TTL	Transistor Transistor Logic
UDP	User Datagram Protocol
UQPSK	Unbalanced Quadrature Phase Shift Keying
USB	Universal Serial Bus
VAC	Voltage Alternating Current
VSWR	Voltage Standing Wave Ratio
WAN	Wide Area Network