ISO 9001:2015
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Installation and Operation Manual

3rd Generation Dual Channel

Compact RDMS™ Telemetry Receiver-Combiner

Quasonix, Inc.
6025 Schumacher Park Dr.
West Chester, OH 45069
08 December 2023

Revision 1.0.4

Applies to RDMS™ System Version 19.3

Specifications subject to change without notice.

All Quasonix receiver products are under U.S. Department of Commerce jurisdiction categorized as 5A991; not covered by ITAR

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1 Introduction

1.1 Description

This document describes the installation and operation of the Quasonix 3rd Generation Compact RDMS™ Telemetry Receiver-Combiner and is updated to match RDMS™ System Version 19.3. The RDMS™ (Receiver / DeModulator / bit Synchronizer) is designed to downconvert, demodulate, and bit synch to a variety of RF telemetry signals from flight-test aircraft. With an extensible web-based browser interface, and antenna-tracking outputs, the Compact RDMS™ Telemetry Receiver-Combiner is capable of fulfilling a variety of flight test station requirements.

The following waveform formats are supported by RDMS™:

- PCM/FM (ARTM Tier 0)
- SOQPSK-TG (ARTM Tier I)
- ARTM CPM / Multi-h CPM (ARTM Tier II)
- Legacy (PSK) suite, which includes:
    - BPSK
    - QPSK
    - Offset QPSK (OQPSK)
    - Asymmetric QPSK (AQPSK)
    - Unbalanced QPSK (UQPSK)
    - Asymmetric Unbalanced QPSK (AUQPSK)
    - Digital PM
    - STC
    - SOQPSK/LDPC
    - STC/LDPC

Of the aforementioned, RDMS™ provides true multi-symbol trellis demodulation in all three ARTM modes, PCM/FM, SOQPSK-TG, and Multi-h PCM. It also provides a clock signal, obviating the need for any outboard bit synchronizer.

Modes that support LDPC use IRIG-standard low-density parity check coding to dramatically improve link margin by up to 9 dB.

The Compact RDMS™ Telemetry Receiver-Combiner is manufactured by:

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

1.2 Nomenclature

The Compact RDMS™ Telemetry Receiver-Combiner is available in a plethora of variations based on the number of frequency bands, demodulation methods, options, etc. The features and modes installed in each unit are identified in the model number, as depicted in Figure 1.

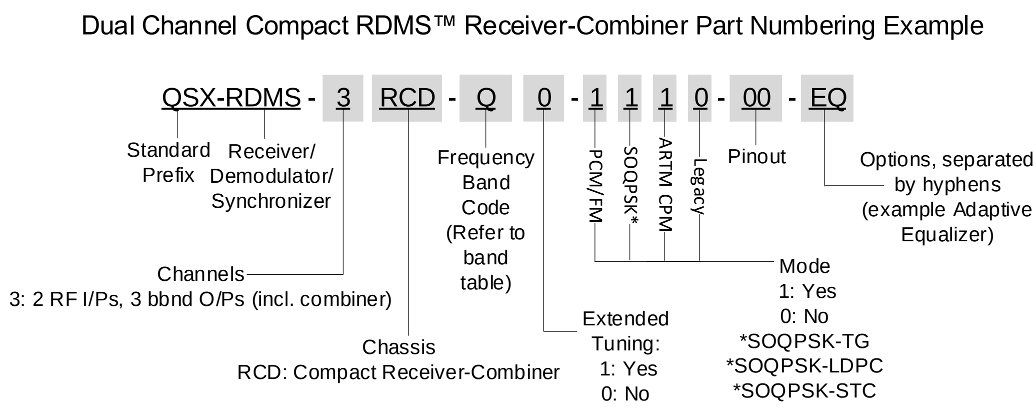


Figure 1: Compact RDMS™ Telemetry Receiver-Combiner Part Number Construction

Specifications are subject to change. Contact Quasonix for questions regarding your specific receiver.

1.2.1 Options

The available options are listed below. Refer to section 1.2.2 for detailed descriptions of each option. Please contact Quasonix for assistance ordering receiver options.

- 14 — 14 SAW filter option (adds 70 kHz, 1.4, 3, 6, 14, and 28 MHz filters)
- CS — Cybersecurity
- EN — Ethernet Payload
- EQ — Adaptive Equalizer
- K7 — K7 Viterbi Decoder (k=7, rate 1/2)
- VO — Analog outputs on J11, hardware option

For example, a model QSX-RDMS-3RCD-Q0-1110-00-EQ is configured as follows:

Table 1: Model Configuration Example

Identifiers	Description
QSX	Quasonix product
R	Receiver / Demodulator / Bit Synchronizer
DMS	Demodulator / Bit Synchronizer

Identifiers	Description
3	Channels
RCD	Compact Receiver-Combiner Chassis
Q	Frequency band code
0	No Extended Tuning
1110	Tier 0 present, Tier I present, Tier II present, Legacy (PSK) absent
00	Pinout code
EQ	Adaptive Equalizer option

1.2.2 Detailed Option Descriptions

1.2.2.1 SAW Filter Option – 14

This option adds additional SAW filters, for a total of 14. Additional filters are 70 kHz, and 1.4, 3, 6, 14, and 28 MHz.

1.2.2.2 Cybersecurity – CS, CS1, CS2

These options are used to address customer installation security requirements. The need for these options depends on the security requirements at the facility where the receivers will be deployed.

Contact Quasonix for additional details or for help with your particular security requirements.

1.2.2.3 Adaptive Equalizer - EQ

The Adaptive Equalizer option in the Quasonix receiver improves reception in multipath channels by using digital signal processing to compensate for the signal distortion due to multipath. This option is compatible with standard telemetry applications and installations and it works with any brand of transmitter.

Multipath fading can seriously degrade the quality of wireless telemetry data. Radio transmissions can reflect off of the airframe or other objects and arrive at the receiving antenna with different time delays, carrier phases, and relative strengths. The sum of these multiple transmission paths can produce serious distortion and signal fading resulting in poor data quality and long periods of data outage. Contrary to most situations, increasing the transmit power will not improve the link quality and may actually make the situation worse. Narrowing the beamwidth of the antenna may help eliminate some of the reflections and reduce the overall fading and distortion, but constraints on dish size and antenna tracking performance impose beamwidth limits.

Another solution is to mitigate the effects of the multipath channel by applying a filtering operation at the receiver that effectively undoes the distortion caused by the channel, thereby ‘equalizing’ the received signal. Since the transmitter is typically moving relative to the receiver, the RF propagation environment dynamically changes over time requiring the equalizer to ‘adapt’ to continually combat the perceived channel distortion. The ‘adaptive equalizer’ automatically calculates and applies a compensating filter to the received signal that restores its ability to be recovered by a traditional telemetry detector.

The EQ option is currently available for use with all modes *except* STC modes.

1.2.2.4 Viterbi Decoder (for Legacy PSK Only) - K7

The K7 option (k=7, rate 1/2) enables Viterbi decoding of a convolutionally encoded data stream, which converts it back to the original (uncoded) source data stream.

Convolutional encoding is a form of legacy forward error correction. Like LDPC, it adds redundant information at the transmitting end of a telemetry link and then uses that redundancy to detect and correct errors at the receiving end of the link. Use of convolutional encoding requires a matching Viterbi decoder in the receiver to extract the source data. The decoded data rate is half the encoded data rate. The receiver has two independent decoders, one for in-phase ("I") data and one for quadrature ("Q") data. For BPSK, only a single decoder is used. Each decoder is compatible with the convolutional encoding described in the "Consultative Committee for Space Data Systems, Recommendation for Space Data System Standards, TM Synchronization and Channel Coding, CCSDS 131.0-B-2, Section 3."

Viterbi decoding is used to decode constraint-length (K) 7, rate I 1/2, G2-inverted convolutional-encoded data.

The purpose and benefits of convolutional encoding are similar to LDPC. However, convolutional encoding requires more bandwidth than all but the lowest-rate LDPC codes, and its error-correcting performance is inferior to LDPC. Therefore, LDPC is the preferred forward error correction if possible.

The Viterbi Decoder control requires the K7 option, and the RDMS must be set to one of the following PSK modes: BPSK, QPSK, AQPSK, AUQPSK, OQPSK, or UQPSK.

Viterbi decoding and Reed-Solomon decoding can be used together or separately.

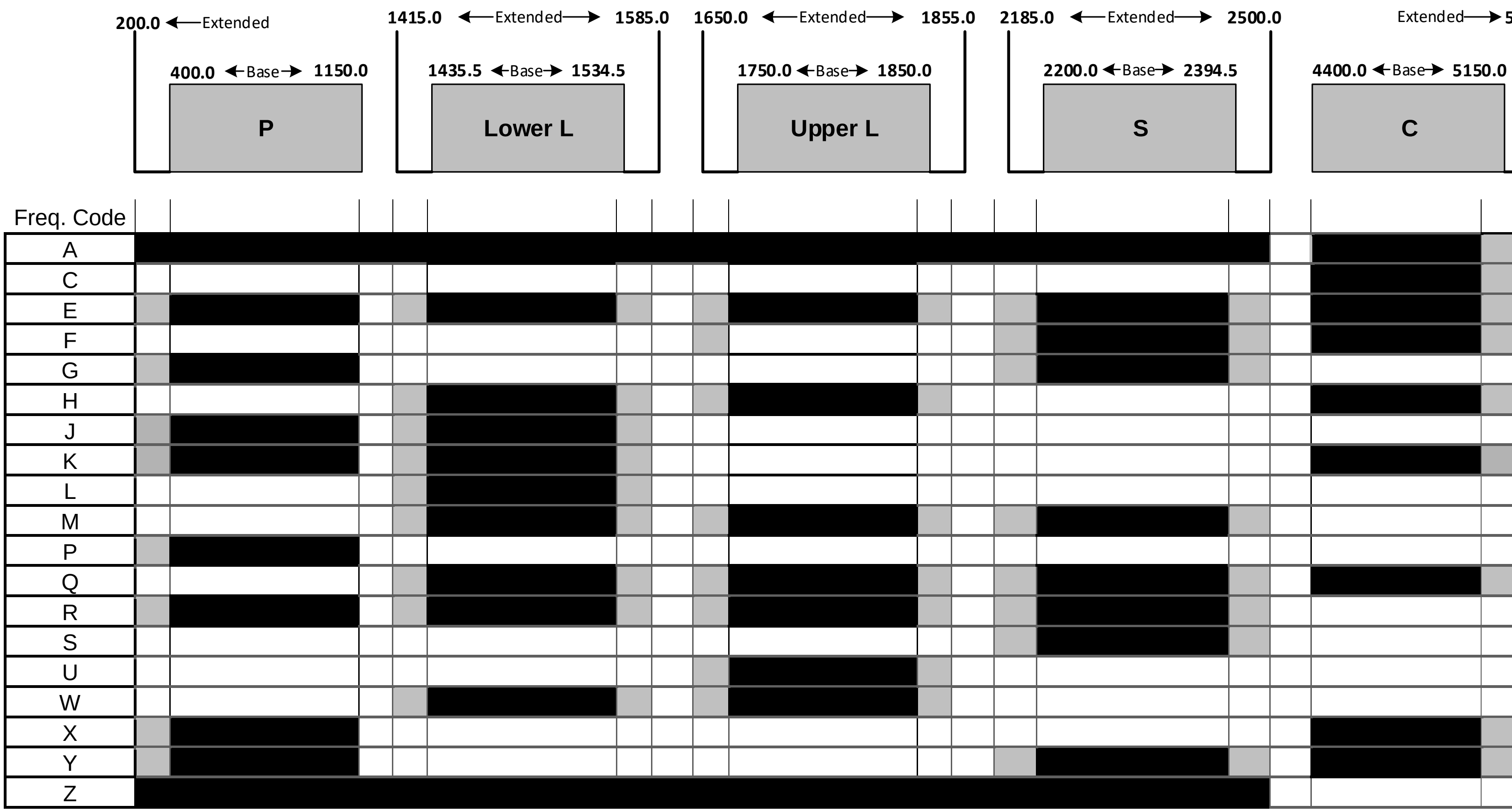
1.2.2.5 Analog Video Outputs (J11) Hardware Option – VO

Analog video outputs on J11 are available as a CRC option only. The default for J11 pins is unpopulated (no connection).

1.2.3 Band Configurations

Band configuration codes are listed in Table 2. Two additional band codes are described in section 1.2.3.1.

Table 2: Band Configuration Codes



Legend:
Frequency Gap
Standard (Base) Frequency Range
Extended Frequency Range (available by selecting Extended Tuning = 1 in part number)

1.2.3.1 Additional Band Codes

Two additional band codes are available:

- Band Code 7: 70 MHz standard range, 0.075 MHz-20 MHz, 70 MHz extended range
- Band Code T: 2025.0 MHz to 2110.0 MHz standard range

1.3 Package Contents

The contents of the box include the following:

- Compact RDMS™ Telemetry Receiver-Combiner
- 50 ohm terminators, preinstalled on IF output
- MDM-25, IP Reset Default connector

A copy of the Installation and Operation manual is included with the Browser Interface software (Help option).

2 Specifications

Characteristic	Specification
Receiver Section	
Type	Dual-conversion superheterodyne; two channels
Input RF Frequency	Refer to Table 2
Tuning resolution	Tunes in 62.5 kHz increments, to the 70 MHz IF output, after the 70 MHz IF output, receiver tunes in increments of less than 1 Hz
Frequency stability	1 ppm over temperature; 1 ppm per year aging
Reference oscillator	20 MHz
Noise figure	3.5 dB (typical), 5 dB (maximum)
LO phase noise, measured at 70 MHz IF output	-115 dBc/Hz @ 1 MHz offset
Maximum RF input	+20 dBm (+10 dBm for C-band)
Available gain (to 70 MHz IF output)	114 dB
Gain control	128 dB control range; User selectable: AGC or MGC (AGC freeze)
AGC load impedance	1 KOhm
AGC time constant	Adjustable to any value from 0.1 ms to 1000 ms
First IF bandwidth	60 MHz (nominal)
IF rejection	> 90 dB
Image rejection	70 dB
RF input impedance	50 ohms
VSWR	3:1 Max; 2:1 Typical
Second IF Section	
IF frequency	70 MHz
IF output level, nominal (AGC mode)	Channel 1 and 2: 70 and 250 kHz bandwidths: -15 dBm 0.5 – 4.5 MHz bandwidths: -10 dBm 6 and 10 MHz bandwidths: -5 dBm 14 – 40 MHz bandwidths: -15 dBm Combiner: -5 dBm
IF output impedance	50 ohms
IF bandwidths	250 kHz, 500 kHz, 1 MHz, 2 MHz, 4.5 MHz, 10 MHz, 20 MHz, 40 MHz. Automatic selection based on modulation type and data rate, with manual override Optional: 70 kHz, 1.4 MHz, 3 MHz, 6 MHz, 14 MHz, 28 MHz

Playback Demodulator IF In, Channel 1 and 2 Section	
Input Center Frequency	75 kHz – 20 MHz, 70 MHz through any selectable SAW filter
Input Level	-30 dBm ± 10 dB
Input Impedance	50 ohms, nominal
Demodulator Section	
Demodulator type	ARTM Tier 0 (PCM/FM), ARTM Tier I (SOQPSK-TG), ARTM Tier II (Multi-h CPM) Legacy suite: Analog FM, BPSK, QPSK, Offset QPSK (OQPSK), Asymmetric QPSK (AQPSK), Unbalanced QPSK (UQPSK), Asymmetric Unbalanced QPSK (AUQPSK), Digital PM, Space-Time Coding (STC)
Bit Rates (after LDPC, Viterbi, Reed-Solomon, and/or PCM encoding, if applicable)	Tier 0: 24 kbps to 23 Mbps in 1 bps steps Tier I: 100 kbps to 46 Mbps in 1 bps steps Tier II: 1 Mbps to 46 Mbps in 1 bps steps STC: 5 Mbps to 22 Mbps in 1 bps steps Legacy: 25 kbps to 23 Mbps in Analog FM, 25 kbps to 23 Mbps in BPSK, 50 kbps to 46 Mbps in QPSK in 1 bps steps
Synchronization time (Average, at BER = 1e-5)	Tier 0: 250 bits, Tier I: 385 bits, Tier II: 2,800 bits
Synchronization acquisition threshold	Tier 0: -8.0 dB Eb/N0; RF Input (dBm): -118.0 (1 Mbps), -108.0 (10 Mbps) Tier I: -6.0 dB Eb/N0; RF Input (dBm): -116.0 (1 Mbps), -106.0 (10 Mbps) Tier II: -7.0 dB Eb/N0; RF Input (dBm): -117.0 (1 Mbps), -107.0 (10 Mbps)
Synchronization dropout threshold	Tier 0: -10.0 dB Eb/N0; RF Input (dBm): -120.0 (1 Mbps), -110.0 (10 Mbps) Tier I: -6.0 dB Eb/N0; RF Input (dBm): -116.0 (1 Mbps), -106.0 (10 Mbps) Tier II: -15.0 dB Eb/N0; RF Input (dBm): -125.0 (1 Mbps), -115.0 (10 Mbps)
Sensitivity (BER = 1e-5)	Tier 0: 8.6 dB Eb/N0; RF Input (dBm): -101.4 (1 Mbps), -91.4 (10 Mbps) Tier I: 11.2 dB Eb/N0; RF Input (dBm): -98.8 (1 Mbps), -88.8 (10 Mbps) Tier II: 13.0 dB Eb/N0; RF Input (dBm): -97.0 (1 Mbps), -87.0 (10 Mbps)
Bit Synchronizer Section	
Input codes	NRZ-L/M/S, BIΦ-L/M/S
Output codes	NRZ-L; or input code unaltered
Data and clock out	TTL or RS-422
Lock detector out	TTL
Derandomizer	Standard IRIG 15-stage polynomial, selectable On/Off

Video Section	
Video out (DC to 35 MHz)	Quad wideband outputs: Ch1 and Ch2; Dual wideband outputs, Combiner
Video filter bandwidth	User programmable
Output level	1 Vp-p nominal, 4 Vp-p maximum
NTSC de-emphasis	Selectable Off/NTSC/PAL
Environmental Section	
Operating Temperature	-20°C to +70°C
Non-operating Temperature	-40°C to +85°C
Operating Humidity	0 to 95% (non-condensing)
Vibration	20 G, 5 Hz to 2 kHz (all axes)
Acceleration	100 G (all axes)
Shock	100 G pk, half-sine, 5 ms (all axes)
Altitude	Up to 100,000 ft.
Physical Section	
Size / Weight	10.31" x 4.00" x 1.92" / 80 oz.
Connectors	RF input: SMA female IF output: SMA female Power and Ethernet: MDM-9 Analog and Data: MDM-25
Power	28 VDC ± 4 VDC Current: 2.4 A typical, 3.5 A max at 25°C baseplate and 28 VDC
Inrush Current	12 VDC, 3.3 A max (as measured with a Fluke i30s AC/DC current clamp)

3 Installation Instructions

3.1 Mechanical

The CRC™ is designed to be mounted by eighteen (18) 6-32 screws through the holes along the front and back edges, as depicted in Figure 4 on the following page.

Pin assignments are listed in Table 4.

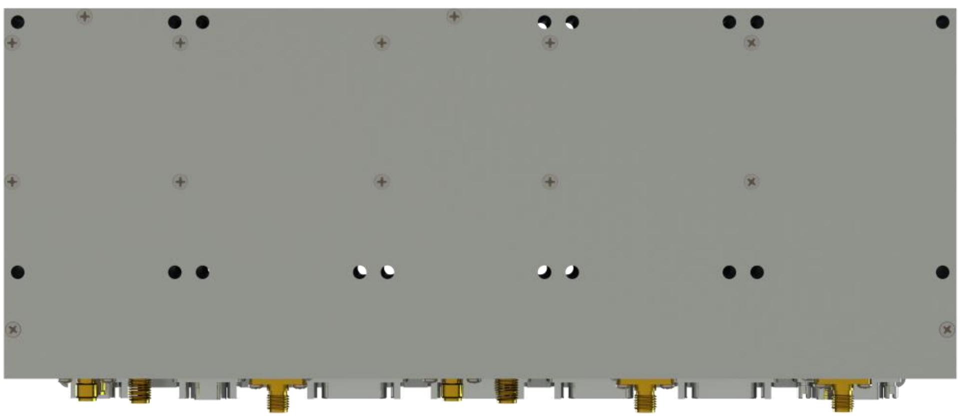


Figure 2: Mechanical Drawing – Top View (Dual-channel Connectors Shown)

Figure 3: Dual Channel Compact RDMS Receiver-Combiner (CRC)

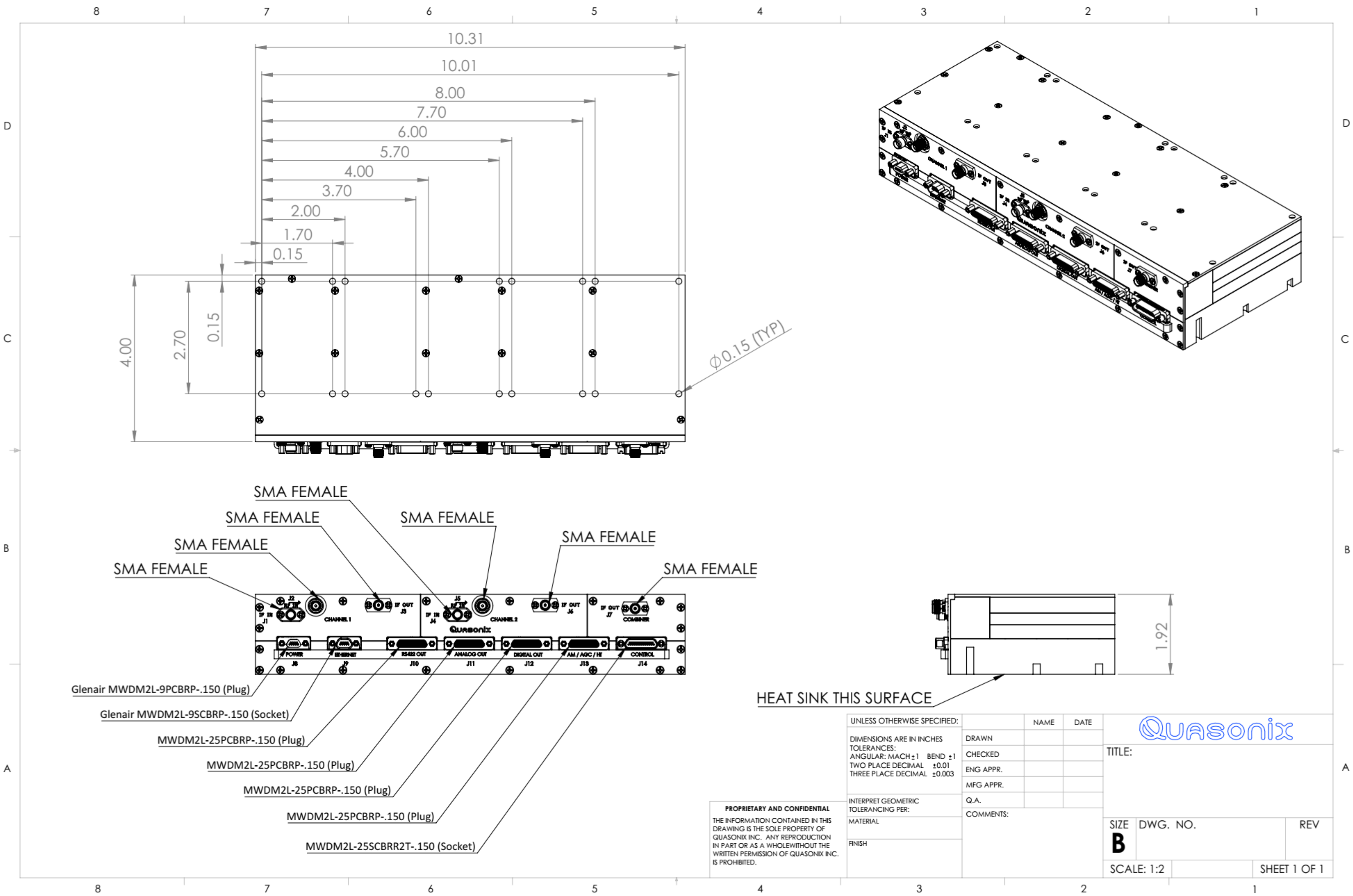


Figure 4: 3rd Generation Compact RDMS™ Receiver-Combiner

3.2 Thermal

The storage temperature of the Compact RDMS™ Telemetry Receiver-Combiner unit is rated for -40°C to +85°C, while the operating temperature is rated for -20°C to +70°C. At maximum bit rates, the unit dissipates approximately 100 watts. The majority of that heat is conducted to the bottom surface (with unit oriented so that the lettering on the front face is viewed right side up). It is essential that the unit be mounted to a heat sink capable of dissipating the 100 watts to minimize the risk of operating (or storing) outside the ranges specified.

3.3 Electrical

3.3.1 CRC Front Panel Connections

Front panel connectors are the same for all CRCs. The electrical interface connectors for all configurations are shown in Figure 5.

Figure 5: CRC Front Panel

Connector descriptions are described in Table 3.

Functional descriptions and electrical characteristics for each connector for channel 1, channel 2, and combiner located on the front panel are described in Table 4.

Table 3: Connector Descriptions

Function	Part Type/Manufacturer Number	Description
28 VDC Power	Glenair MWDM2L-9PCBRP-.150 (Plug)	MDM-9 Plug
Ethernet	Glenair MWDM2L-9SCBRP-.150 (Socket)	MDM-9 Socket
RS-422 Clock/Data Out	MWDM2L-25PCBRP-.150 (Plug)	MDM-25 Plug
Analog Out (Video)	MWDM2L-25PCBRP-.150 (Plug)	MDM-25 Plug
Digital Out (TTL Clock/Data)	MWDM2L-25PCBRP-.150 (Plug)	MDM-25 Plug
AM/AGC/HT	MWDM2L-25PCBRP-.150 (Plug)	MDM-25 Plug
Control (Factory)	MWDM2L-25SCBRR2T-.150 (Socket)	MDM-25 Socket

3.3.2 Front Panel Connections

Front panel connectors for all channels are described in Table 4.

Table 4: Front Panel Connector Specifications

Compact Receiver/Combiner			
	Channel 1	**Channel 2**	**Combiner**
Receiver Nomenclature	Connector Number/pin	Connector Number/pin	Connector Number/pin
IF IN	J1	J4	-
RF IN	J2	J5	-
IF Out	J3	J6	J7
28VDC Power	J8-4		
28VDC Power	J8-5		
28VDC Power	J8-8		
28VDC Power	J8-9		
28VDC Return (GND)	J8-1		
28VDC Return (GND)	J8-2		
28VDC Return (GND)	J8-6		
28VDC Return (GND)	J8-7		
Ethernet RX_p	J9-1		
Ethernet RX_n	J9-6		
Ethernet TX_p	J9-5		
Ethernet TX_n	J9-9		
RS422/Clock A_n	J10-1	J10-5	J10-9
RS422/Clock A_p	J10-14	J10-18	J10-22
RS422/Data A_n	J10-2	J10-6	J10-10
RS422/Data A_p	J10-15	J10-19	J10-23
RS422/Clock B_n	J10-3	J10-7	J10-11
RS422/Clock B_p	J10-16	J10-20	J10-24
RS422/Data B_n	J10-4	J10-8	J10-12
RS422/Data B_p	J10-17	J10-21	J10-25
Ground	J10-13		

MDM-25	50 Ω SMA

Note: Analog outputs on J11 are available only as an option on the CRC.

Contact Quasonix and request option VO.

Compact Receiver/Combiner			
	Channel 1	**Channel 2**	**Combiner**
Receiver Nomenclature	Connector Number/pin	Connector Number/pin	Connector Number/pin
I/VIDEO A	J11-9	J11-5	J11-1
I/VIDEO A GND	J11-22	J11-18	J11-14
Q/VIDEO B	J11-10	J11-6	J11-2
Q/VIDEO B GND	J11-23	J11-19	J11-15
VIDEO C	J11-11	J11-7	J11-3
VIDEO C GND	J11-24	J11-20	J11-16
VIDEO D	J11-12	J11-8	J11-4
VIDEO D GND	J11-25	J11-21	J11-17
Ground	J11-13		
TTL Clock A	J12-1	J12-5	J12-9
TTL Clock A GND	J12-14	J12-18	J12-22
TTL Data A	J12-2	J12-6	J12-10
TTL Data A GND	J12-15	J12-19	J12-23
TTL Clock B	J12-3	J12-7	J12-11
TTL Clock B GND	J12-16	J12-20	J12-24
TTL Data B	J12-4	J12-8	J12-12
TTL Data B GND	J12-17	J12-21	J12-25
Ground	J12-13		
TTL/HT_OUT/AM	J13-1	J13-3	J13-5
HT_OUT GND	J13-14	J13-16	J13-18
AGC	J13-2	J13-4	J13-6
AGC GND	J13-15	J13-17	J13-19
Lock Detect	J13-7	J13-9	J13-11
Sync Detect	J13-8	J13-10	J13-12
Aux Analog A	J13-20	J13-22	J13-24
Aux Analog B	J13-21	J13-23	J13-25
Ground	J13-13		
Power on	J14-20	J14-19	J14-18
TXD	J14-15	J14-17	J14-16
RXD	J14-24	J14-22	J14-23
TDI	J14-12	J14-6	J14-21
TCK	J14-8	J14-2	J14-5
TDO	J14-9	J14-3	J14-11
TMS	J14-10	J14-4	J14-14
3.3V	J14-13	J14-7	J14-25
Ground	J13-1		

3.3.3 Electrical Signals

By default, the output data is valid on the falling edge of the clock, as shown in Figure 9. The polarity of the output clock may be inverted by toggling the Clock Polarity setting in its web-based browser interface (RDMS™ Browser Interface).

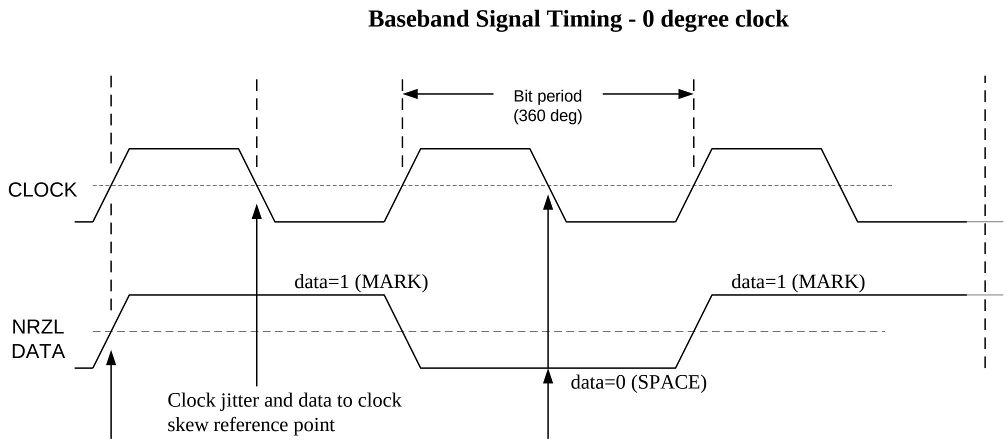


Figure 6: Baseband Signal Timing

The RF input to the receiver is a 50 ohm interface.

The CRC™ also provides a 70 MHz IF output for each channel for troubleshooting purposes. These IF outputs are capped with 50 ohm terminators, and these should be left in place unless another 50 ohm load (such as a spectrum analyzer) is connected instead.

IMPORTANT - Connector Notes

The 70 MHz IF output on the second SMA connector, labeled “IF OUT”, is provided for troubleshooting purposes.

The IF output must have a 50 Ohm load at all times. If it is not connected to external test equipment, then the 50 Ohm terminator *(metal cap) that comes installed on the port must remain attached*.

The IF input connector is only active if the correct part number is ordered. The metal cap on the connector upon delivery is a *dust cap only* and is NOT interchangeable with the 50 Ohm termination on the IF output.

Do not remove dust caps unless the connector is being used.

4 Operating Instructions

The Compact RDMS™ Telemetry Receiver-Combiner can be operated through the web-based browser interface. The browser interface is capable of configuring, maintaining, and monitoring multiple receivers within a network.

4.1 Power-on Operation

The 3rd Generation Compact RDMS™ Telemetry Receiver-Combiner contains a built-in web server. The receiver's browser-based graphical user interface enables configuration and monitoring of one, or multiple, RDMS™ units on the user's network. While the Browser Interface works with most modern browsers, the latest version of Firefox or Chrome is recommended. Quasonix recommends running Firefox in Private mode or disabling caching to improve performance. HTML5 compatibility is required. The Browser Interface (BI) provides easy-to-read, real-time status information to the user.

The Browser Interface is laid out intuitively with all primary control and monitoring functionality for Channel 1, Channel 2, and diversity combiner in one window.

To access the Browser Interface:

1. Plug a network cable into the CRC via the Ethernet connector. Plug the other end of the cable into either a network or PC on the same subnet as the CRC. Ensure that no other device on the network has the same IP address as the CRC.
2. Apply power to the CRC via the Power connector. Wait approximately 2-3 minutes before attempting to communicate with the CRC.
3. Open a browser on a PC on the same Ethernet network.

   The rack has an IP address assigned to it when the user sets it up. If it is static, the user must provide an IP address. If it is dynamic, the network assigns an IP address to the RDMS™. The operator needs to know this IP address.

   The CRC has a factory default IP address of 192.168.0.1 and a subnet mask of 255.255.0.0.
4. Type the IP address into the browser as:

   http://XXX.XXX.XXX.XXX

   where the X's represent the IP address of the receiver.

The main Browser Interface web page displays in the browser window and the user has control of the receiver.

For issues that occur during installation, call Quasonix Technical Support at 513-942-1287.

4.2 Reset IP Address to Default

The CRC has no user interface other than the Browser Interface. If the IP address of the CRC is lost or forgotten, there is no way to look up the IP address; instead, the only way to regain access to the device is by resetting the IP address to its default setting—192.168.0.1 with a subnet mask of 255.255.0.0.

A custom-made MDM-25 connector is provided with the CRC for resetting the IP address to its default. Figure 7shows a picture of this connector.

Figure 7: Custom MDM-25 IP Reset Connector

The steps to reset the IP address are as follows:

1. Power on the CRC, then wait three (3) minutes for power-up initialization to complete.
2. Plug the IP Reset Connector into the Control port on the front of the CRC.
3. Wait approximately one (1) minute for the IP address to reset.
4. Attempt to connect to the default IP address (192.168.0.1/255.255.0.0) by following the steps described in section 4.1.
5. IMPORTANT: After the IP address is reset to default and confirmed via Browser Interface connection, remove the IP Reset Connector from the Control port. If this is left in place, the IP address will once again be reset to default.
6. Browse to the About page, and modify the network settings as described in section 5.6.2.

5 Browser Interface

The Browser Interface provides the user with full configuration, control, and monitoring capabilities for one or multiple receivers. For configuration management purposes, only one browser interface can configure a receiver at a given time. However, multiple browser interfaces can monitor an individual receiver's status at once.

The browser interface's monitoring capabilities include:

- Receiver settings
- Signal strength
- Signal quality
- Signal lock detect
- Combiner link status (optional Diversity Combiner feature required)
- Constellation / eye pattern display
- Browser Interface status

The RDMS™ Browser Interface consists of a tool bar at the top of the screen, shown in Figure 8, and five selections that display a variety of parameters for each available channel. The Browser Interface defaults to the Network screen.

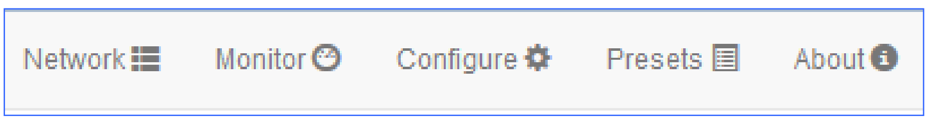


Figure 8: RDMS™ Browser Interface Header Tool Bar

5.1 Network Screen

The Network screen offers a quick snapshot of each rack-mount receiver, down to the channel level. The screen is comprised of a table with columns for RDMS address, Configuration Name, Channel, Frequency, Mode, Bit Rate, signal strength (S), signal quality (Q), and lock-detect status (as text and as a red or green color block). The user may access a specific unit by clicking on the Configure or Monitor button for any receiver listed.

The unit to which the user is currently connected is highlighted and defaults to the top of the list.

The Network screen uses a numerical representation for signal strength and signal quality. For a complete explanation, refer to section 5.4.2.5.

Figure 9 shows four RDMS™ receivers. The Lock field is highlighted in green to indicate there is a signal lock. The first receiver is highlighted in blue to indicate it belongs to the user. Note the RDMS Address matches the address on the top browser tab and in the URL box. The additional receivers are on the same network but are in use by other users.

Figure 10 shows a closeup of the right half of the Network screen with combiners only displayed. Figure 11 shows a closeup of the left side of the Network screen with the Configure and Monitor buttons.

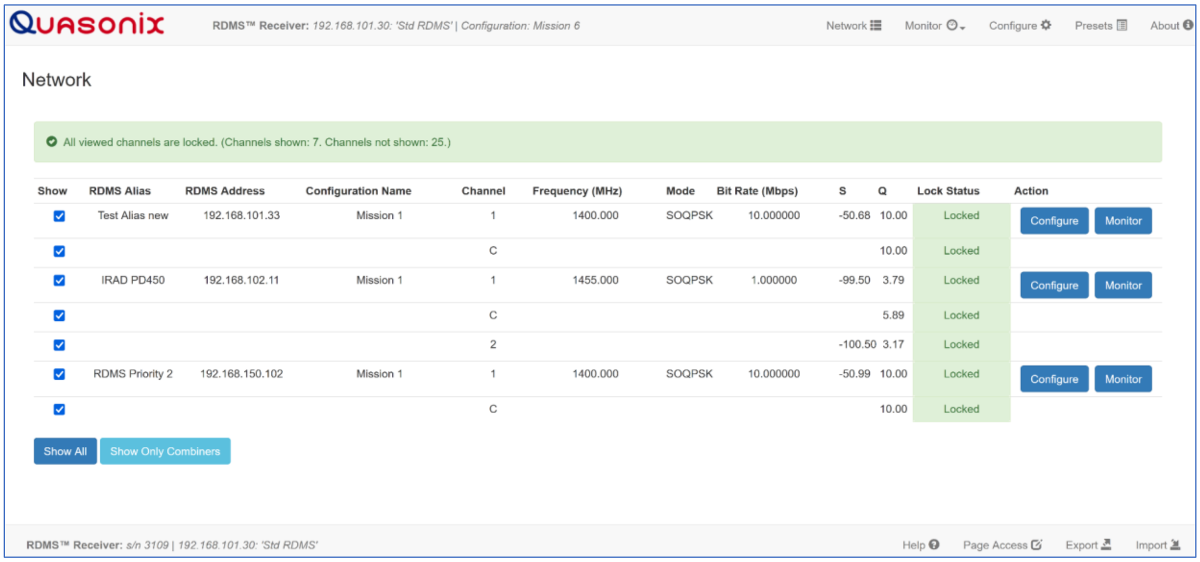


Figure 9: Network Screen with Multiple Receivers and Active Channels

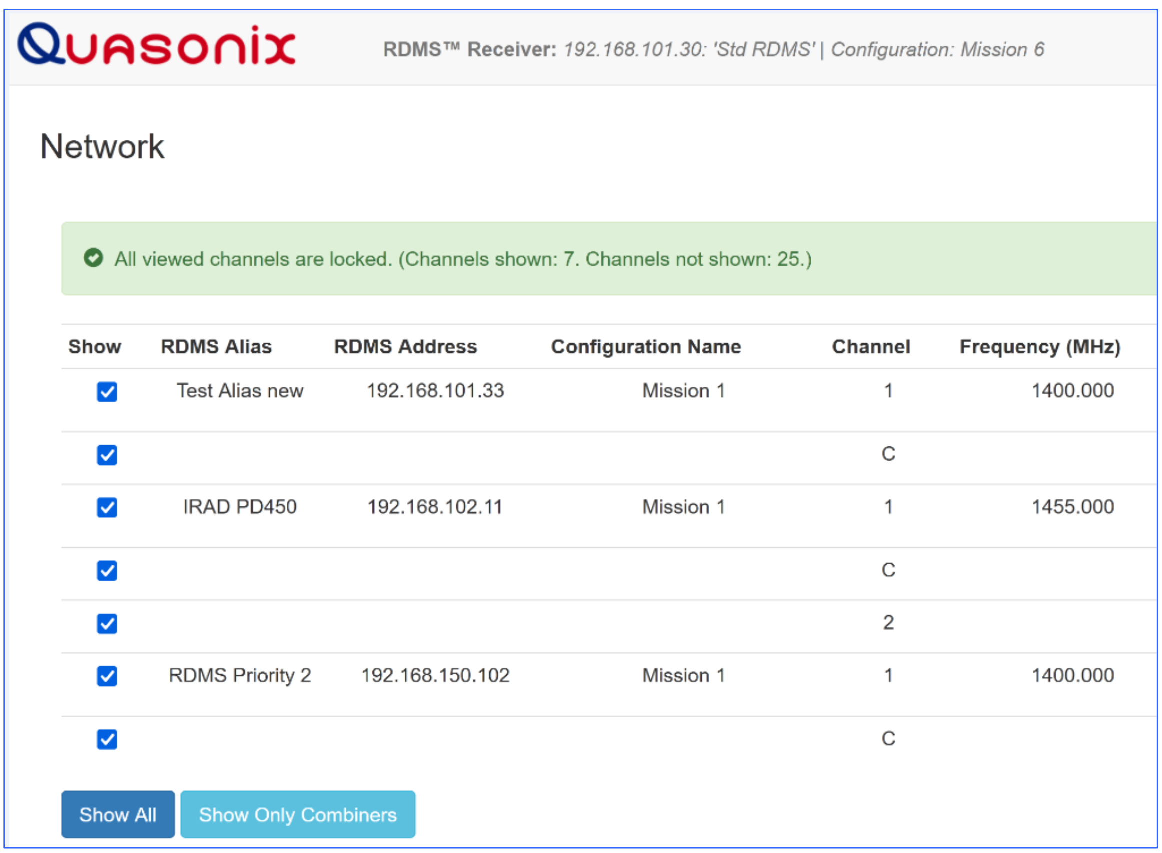


Figure 10: Network Screen, Closeup of Left Side, Combiners Only

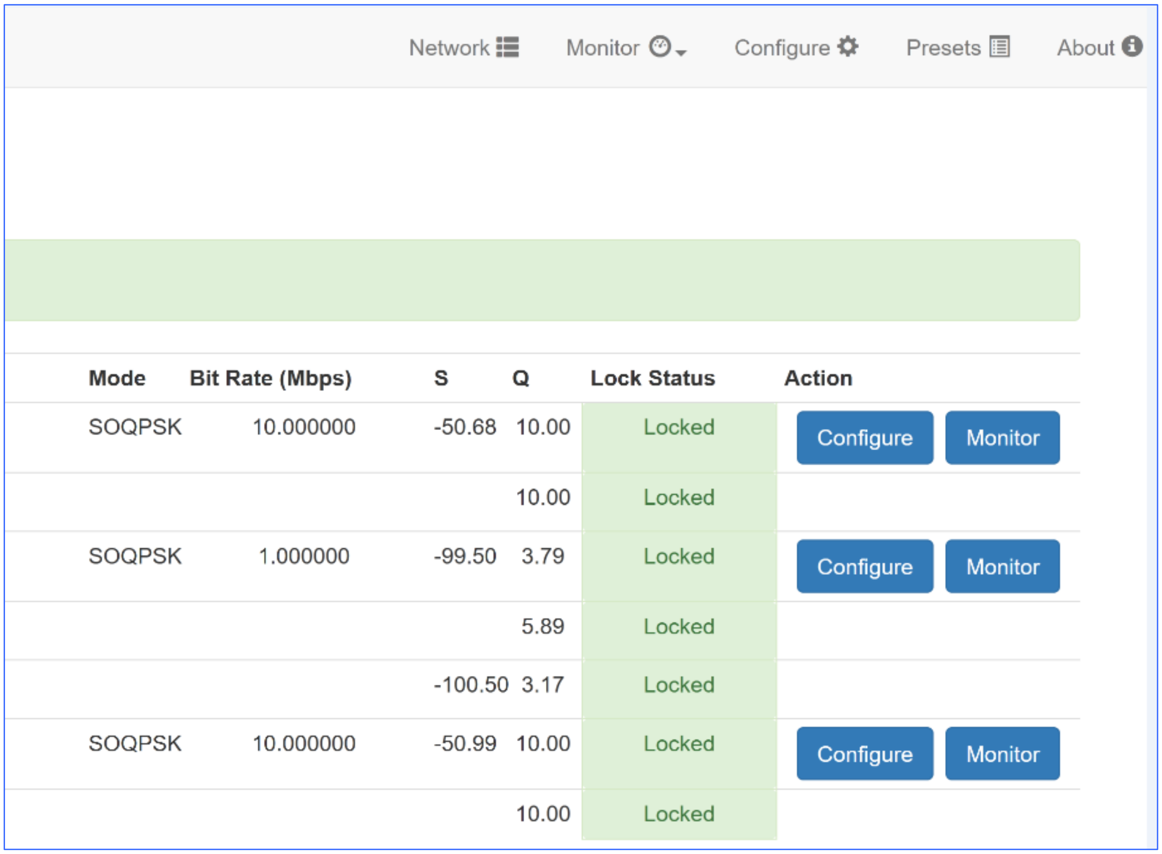


Figure 11: Network Screen, Closeup of Right Side

5.2 Monitor Screen

The Monitor screen may be accessed via the Monitor buttons on the Network screen, as described previously, or via the Monitor option on the Tool bar, as shown in Figure 12.

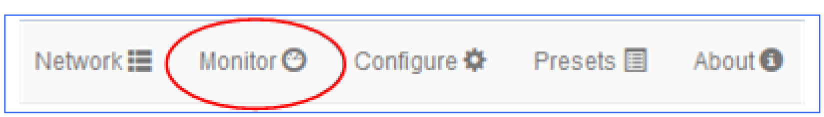


Figure 12: RDMS™ Browser Interface Tool Bar

The unit information displays in the Monitor view, as shown in Figure 13.

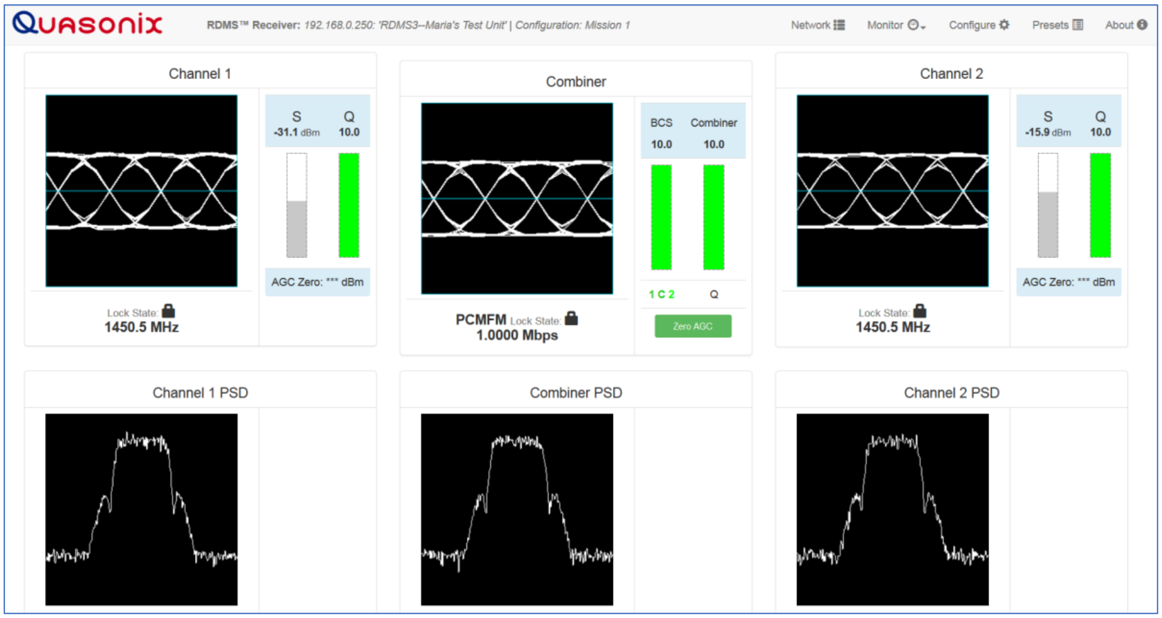


Figure 13: Browser Interface Monitor Screen

The Monitor screen provides the user with:

- Channel selection
- Basic receiver settings, such as frequency, mode, bit rate
- Signal indicators, including lock detect, signal strength, signal quality, best channel, combiner link status
- Graphical representations of the spectrum
- Zero AGC button – For user convenience, this button displays on the Monitor screen and the Configure screen

If the user is operating a single-channel receiver, only Channel 1 displays, as shown in Figure 14.

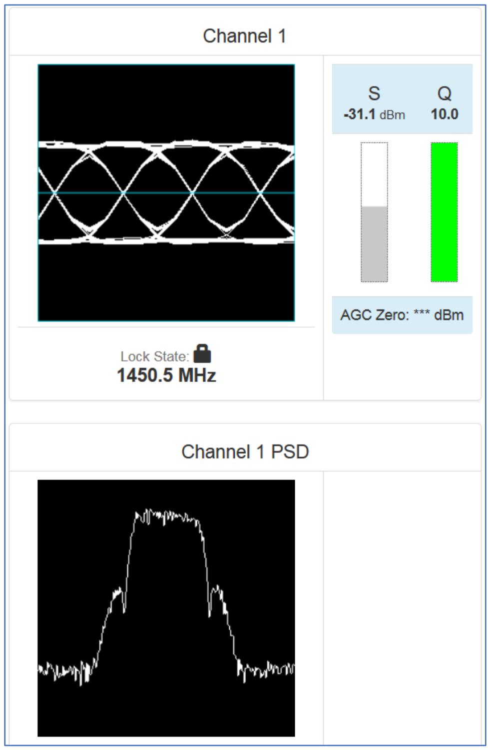


Figure 14: Monitor Screen for RDMS™ with Only One Channel Available

Additional status information, such as Frequency, Mode, and Bit Rate, is provided at the bottom of the display when the combiner is On, as shown in Figure 15, or displayed in the center of the screen between Channel 1 and Channel 2 when the combiner is Off, as shown in Figure 16.

Data Polarity:	Clock Polarity:	Equalizer:	DQ Encapsulation:	Derandomizer:	Mod Scaling:	Mod Persist:
Normal	Normal	Off	Disabled	Off	Track	Off

Figure 15: Monitor Screen Partial Status Information Block when Combiner On

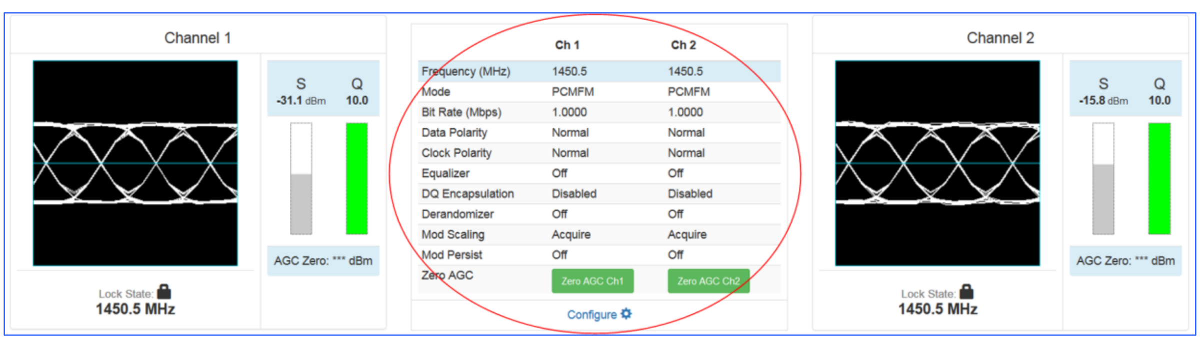


Figure 16: Monitor Screen Partial Status Information Block when Combiner Off

5.2.1 Signal Graph and Signal Indicators

The Signal Graph, shown in Figure 17, provides a separate window for real-time monitoring of the receiver's constellation or eye pattern. Depending on the modulation chosen, the monitor will either display an eye pattern for PCM/FM, or a signal constellation for the other modes.

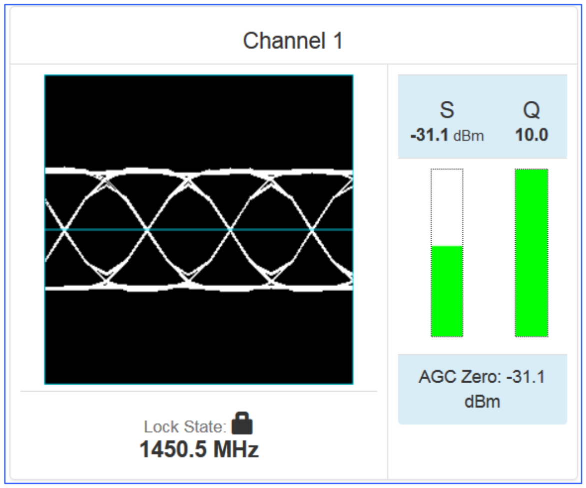


Figure 17: Signal Graph and Signal Indicators Windows

An example of a PCM/FM eye pattern is shown in Figure 18. An example of an SOQPSK constellation is shown in Figure 19.

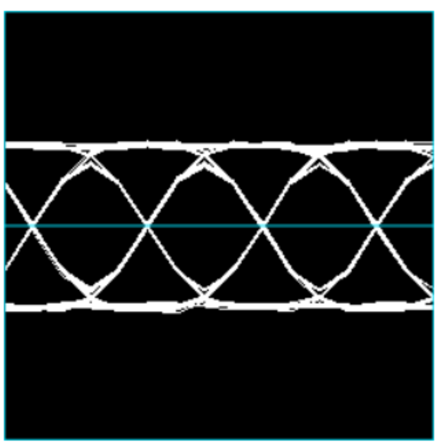


Figure 18: Example PCM/FM Eye Pattern

Figure 19: Example SOQPSK Constellation

To the right of the Signal Graph is the Signal Indicators window, shown in Figure 20.

The Signal Indicators window includes the following indicators for each receiver channel:

- Signal Strength

- Data Quality Metric (DQM)
- Signal Lock detection

The waveform graphics screen displays signal strength and signal quality in vertical bar graph form, an AGC Zero indicator below the signal and quality information, and signal lock detect through a padlock icon, as shown in Figure 20.

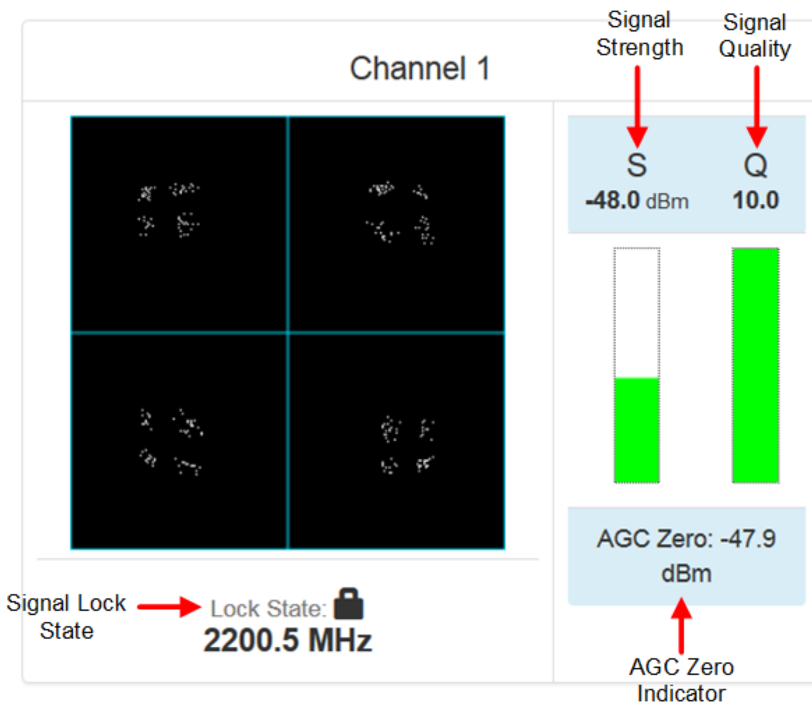


Figure 20: Waveform Graphics with Locked SOQPSK Signal

The demodulator measures signal strength in dBm and there is no limit to what the signal strength might be. Signal strength is displayed on a dynamic bar graph and spans from -127 dBm to +50 dBm on the Browser Interface. In addition to the visual representation of signal strength, the current measurement, in dBm, is numerically displayed directly above the bar graph. The signal strength bar transitions from red at 0 dB Eb/N0 to green at 10 dB Eb/N0 and greater.

The measurement of strength from an incoming telemetry signal by itself does not provide enough information about the integrity of the received data. Therefore, the Data Quality Metric (DQM) is displayed to the right of the signal strength bar, with “Q” above the graph. It transitions from red, being a zero (0) quality, to green, being a quality of 10, with 10 being the best possible quality. The DQM level is displayed at the top of the bar.

A signal lock indicator provides a visual representation of the demodulator’s current lock-detect state. If the demodulator has locked onto a downconverted signal, a locked (closed) padlock displays. Conversely, if the receiver has not locked onto a signal or has recently lost lock, the indicator turns red and displays as an unlocked padlock icon.

Note: The integrated Quasonix demodulator can detect and establish signal lock at very low signal levels. Therefore, it is not uncommon to see a red signal strength bar indicator accompanied with a signal lock indicator that is locked.

The standard signal strength (RSSI) information is set on the Configuration screen via the Advanced > RSSI Display drop down menu (next to the Zero AGC button). Refer to section 5.4.16.

If "Absolute" was the RSSI Display selection, the actual signal strength is displayed.

If "Relative" was selected, the RSSI displayed is relative to AGC Zero. The following bullets apply to RSSI Relative:

- A value of zero indicates no input signal
- A value above zero indicates how strong the signal is above no input
- "*** dBm" displayed (Figure 21) indicates AGC is not zeroed and the value is invalid
- Small "r" displayed next to the Signal Strength label indicates AGC Zero Relative was selected

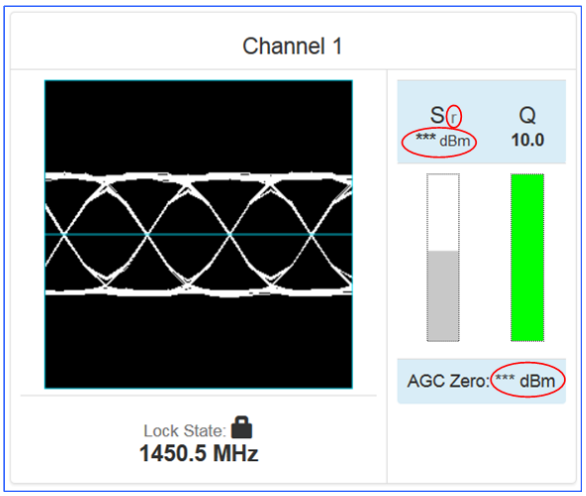


Figure 21: Signal Graph and Signal Indicators Windows, Zero AGC RSSI Display "Relative"

5.2.2 Spectrum Graph

Each channel display provides a real-time power spectral density (PSD) plot as it might display on a spectrum analyzer. An example is shown in Figure 22.

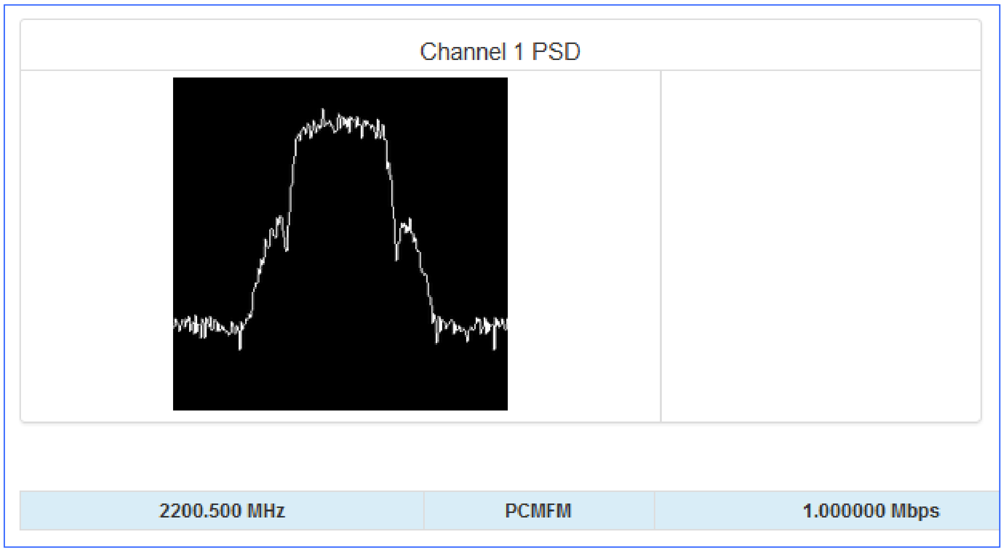


Figure 22: Power Spectral Density Plot Window

5.2.3 Diversity Combiner

If the optional diversity combiner is installed and enabled between two channels, then a Best Channel Source image and a DQM graph display in the area between the two channels on the Monitor. The Diversity Combiner with a signal lock is shown in Figure 23.

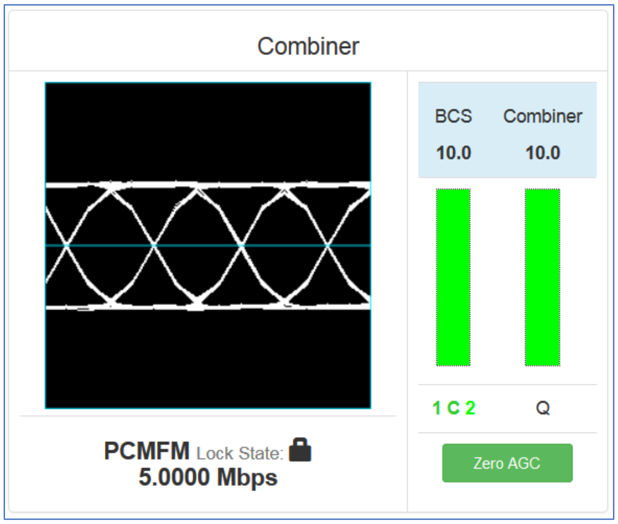


Figure 23: Diversity Combiner Link with Locked Signal

If diversity combiner is On, any changes made to one channel will be copied to the other channel so that both channels are synchronized. If diversity combiner is Off, each channel is separate and setting one channel does not copy settings to the other channel.

If the Combiner is On and Frequency Diversity On is selected, the frequency for Channel 2 may be set differently from Channel 1.

Best Channel Selector (BCS) status is only displayed with the Combiner option enabled and set to On. This status displays at the bottom of the combiner signal indicator window.

When the Combiner is On, the Zero AGC button displays under the DQM graph.

5.2.3.1 Best Channel Selector Status

Best Channel Selector status is only displayed with the Combiner option enabled and set to On. This status displays in the right-hand side of the combiner signal indicator window, to the left of the combiner Signal Quality (Q) status, as shown in Figure 24.

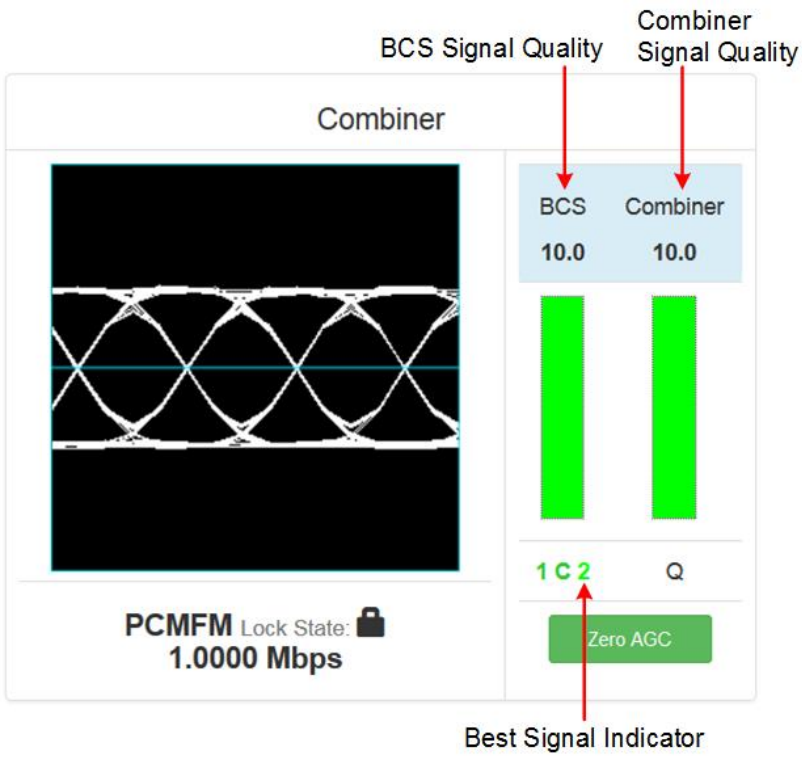


Figure 24: Best Channel Indicator Example

Two status items display for the BCS. First, BCS Signal Quality is indicated with a color-coded bar that indicates the data quality for the presently selected channel. Numerical data quality is shown above the bar. This indicator works just like the Combiner Signal Quality to the right of it. Second, BCS channel selection is shown below the BCS Signal Quality bar.

Each demodulated signal (Channel 1, Combiner, and Channel 2) is represented by a character in the BCS status display (‘1’, ‘C’, and ‘2’ respectively). The color of each character designates the current state of that channel in the best-channel selection process:

- Bright green – Best signal; this signal has the highest data quality of all correlating signals, and its quality is directly reflected in the BCS quality bar

- Green – Good signal; this signal correlates sufficiently to the best signal to participate in best-channel selection, but its data quality is not highest
- Red – Bad signal; this signal does not correlate sufficiently to the best signal to participate in best-channel selection
- Grey – Disabled signal; the BCS is set to Off

The preceding descriptions may seem to imply a static state for each channel. In reality, channel dynamics including noise, may cause fairly rapid changes in BCS state. The BCS indicator shows a snapshot of the current status multiple times per second, but may not reflect every state transition in a highly dynamic environment. In addition, Signal Quality updates are not necessarily synchronized. Thus, as channel conditions change, there may be brief times when Combiner data quality appears to exceed BCS data quality. On average, BCS data quality will always equal, or exceed, Combiner (and Channel 1 and Channel 2) data quality.

In general, the Combiner is expected to be the best channel. However, many conditions may lead to selection of Channel 1 or Channel 2 as the best channel. One common condition is multipath. Another common—and less intuitive—condition is absence of any signal impairment. In this case, all channels have essentially "perfect" signal quality, so the BCS cannot distinguish one that is "best" and will simply stick with its current selection until something changes. Similarly, if no signal is present, the BCS may pick any channel as "best" though none are good.

When the BCS status display indicates the Combiner is the best signal, the BCS and Combiner Signal Quality bars indicate equal quality for the BCS and for the Combiner. When the BCS status display indicates Channel 1 or Channel 2 is the best signal, the BCS Signal Quality bar indicates better data quality for the BCS than for the Combiner. This difference highlights the improvement provided by the BCS relative to Combiner data alone.

Figure 25 illustrates a good signal for Channel 1 and Channel 2, with the best signal being selected from the Combiner.

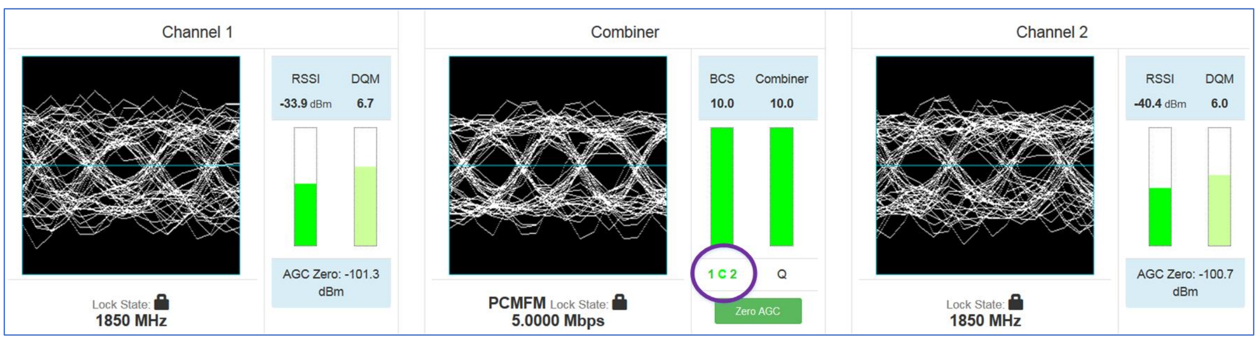


Figure 25: Best Channel Indicator-Combiner

Figure 26 illustrates a good signal for the Combiner and Channel 2, with the best signal being selected from Channel 1. This is an example of all channels being essentially "perfect."

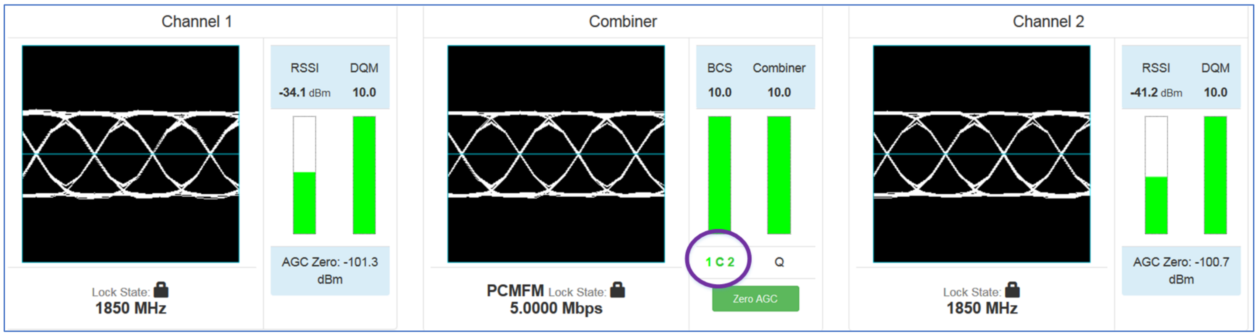


Figure 26: Best Channel Indicator-Ch 1

Figure 27 illustrates a bad signal for Channel 1, a good signal for the Combiner, with the best signal being selected from Channel 2. This can happen if one received signal is so much better than the other that the combined signal is composed of essentially 100% of the better signal and 0% of the worse signal.

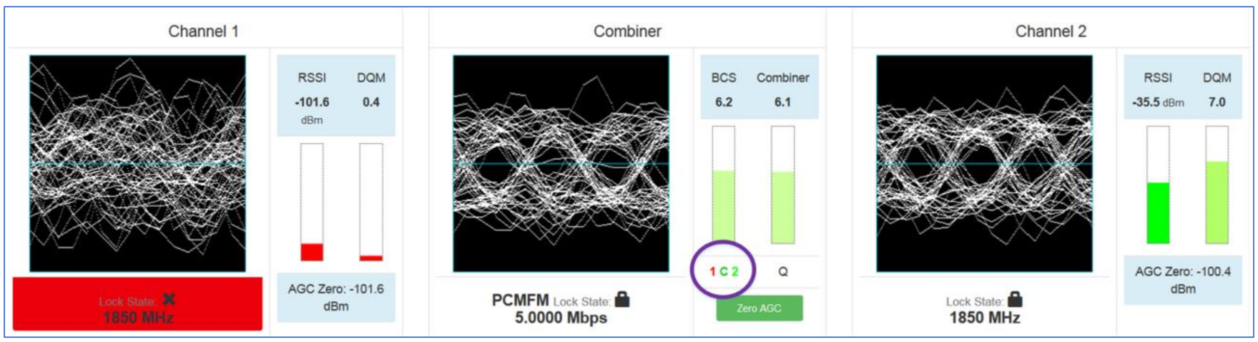


Figure 27: Best Channel Indicator-Ch 2

Figure 28 illustrates severe equalized multipath for Channel 1 and moderate equalized multipath for Channel 2. Note in this case the Combiner data quality is slightly better than Channel 1, but Channel 2 data quality is much better than the Combiner. In this case, the BCS selects Channel 2, as shown by the circled BCS selection indicator and BCS data quality of 10. Without the BCS, the Combiner output data quality would be less than 6.

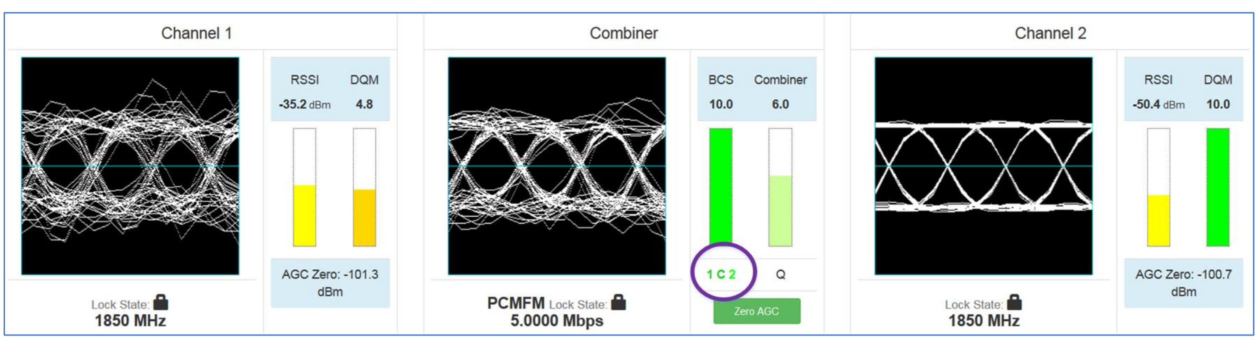


Figure 28: Best Channel Data Quality Better than Combiner Data Quality

Figure 29 illustrates BCS Off.

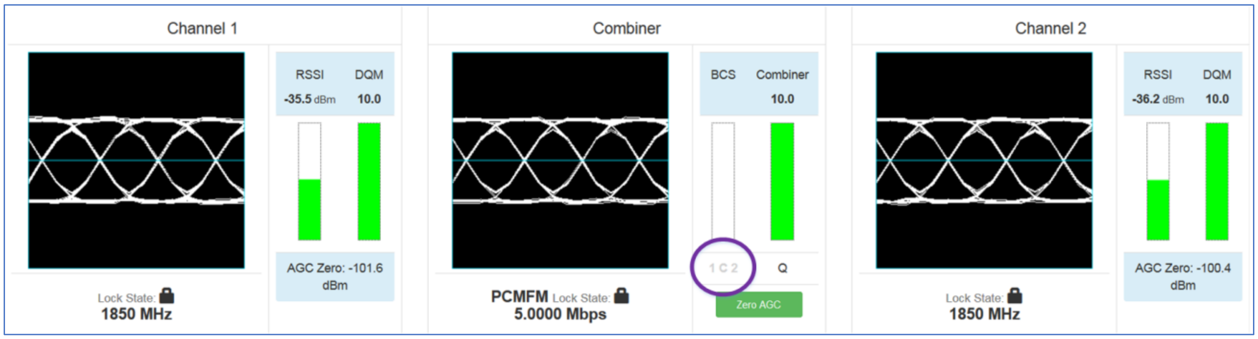


Figure 29: Best Channel Indicator Off (Grey)

5.2.4 Monitor Selective Display Options

The down arrow next to the Monitor option on the Menu Bar, shown in Figure 30, enables selection of specific items to monitor while reducing bandwidth requirements. The user may view:

- Full Monitor screen
- Eye pattern or Constellation only
- PSD (spectrum display) only
- Combiner display only

Examples of each display type are shown in the following figures.

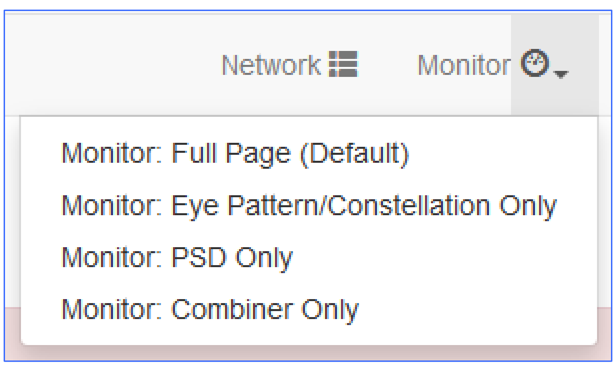


Figure 30: Monitor Display Menu

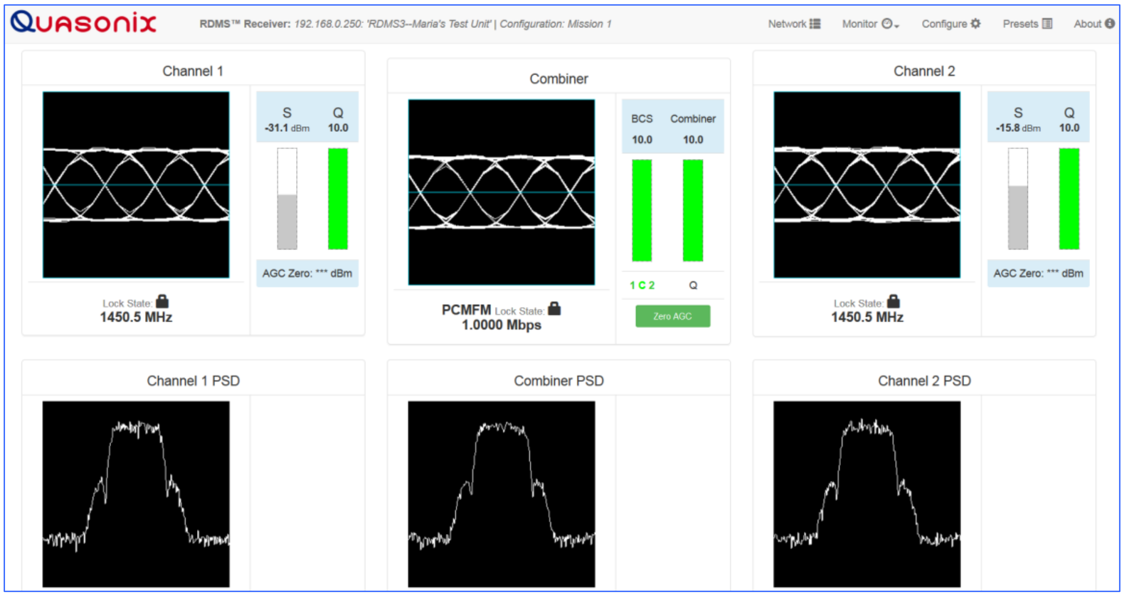


Figure 31: Monitor Full Display (Default)

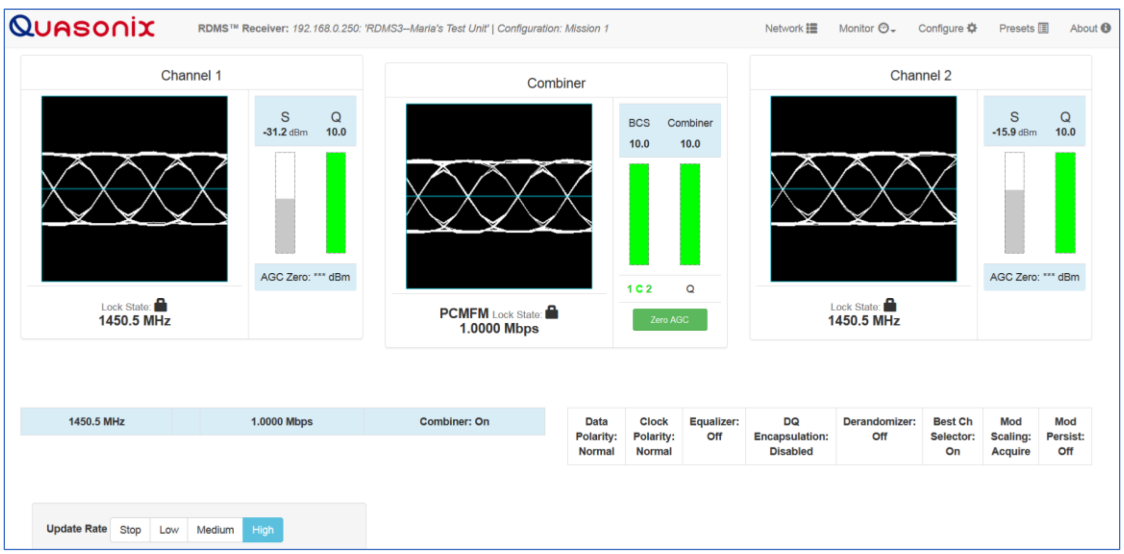


Figure 32: Monitor Eye Pattern/Constellation Display Only

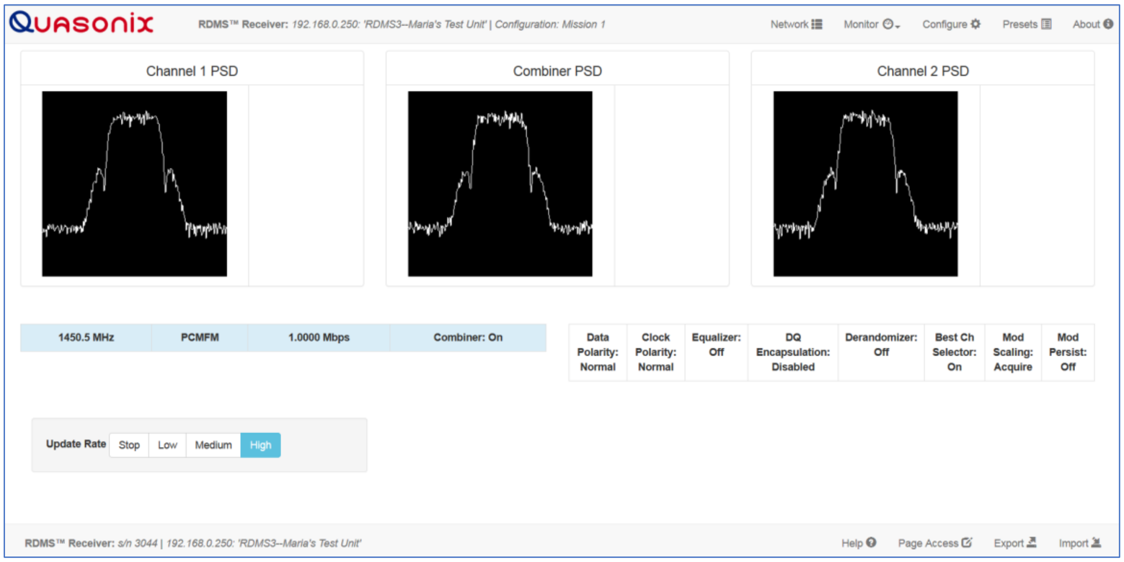


Figure 33: Monitor PSD (Spectrum) Only

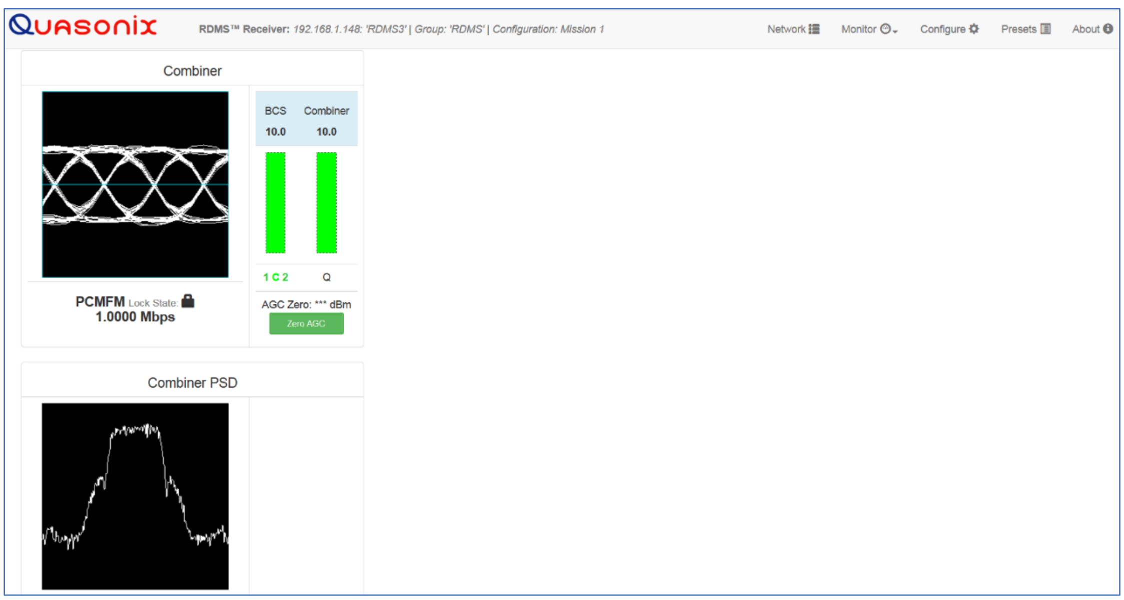


Figure 34: Monitor Combiner Display Only

5.2.5 Client Level Update Rate

Users may override the receiver level update rate temporarily. The Update Rate buttons at the bottom of the Monitor screen are used to change in increments between low, medium, and high. The user may press the Stop button to temporarily pause the screen transmission. This has the effect of taking a snapshot in time (freezing the page) and is useful to more closely evaluate details, such as a spectrum curve. Network bandwidth usage is roughly halved as you progress through each setting from High to Low. High is the as-shipped default setting. The receiver continues normal operation if the Monitor screen is temporarily stopped.

Navigation away from the screen and back does not change the setting, however, a refresh or reload of the screen automatically resets the frame rate to the default. For information about setting the default update rate, refer to Monitor Page Default Update Rate on the About screen, section 5.6.3.

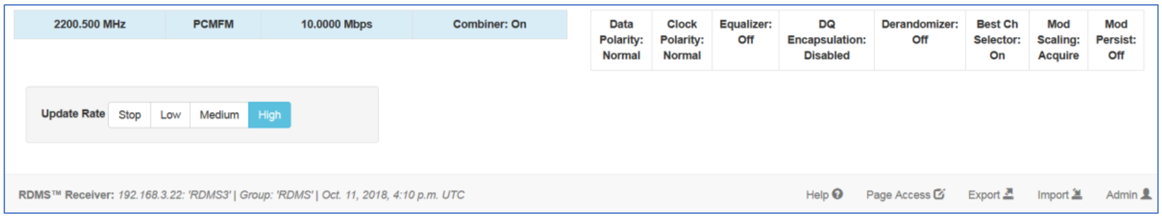


Figure 35: Monitor Combiner Display Only

5.3 Configure Screen

The Configure screen may be accessed via the Configure buttons on the Network screen, as described previously, or via the Configure option on the Header Tool bar, as shown in Figure 36.

Figure 36: RDMS™ Browser Interface Header Tool Bar

All changes to configuration parameters are highlighted in green until the Send Settings or Refresh buttons are activated. This is a visual reminder that something has changed.

5.4 Combiner

A pre-detection diversity combiner is a standard feature in all dual-channel compact receiver-combiners.

Diversity combining can be enabled by clicking on the check box in the Combiner field, as shown in Figure 37.

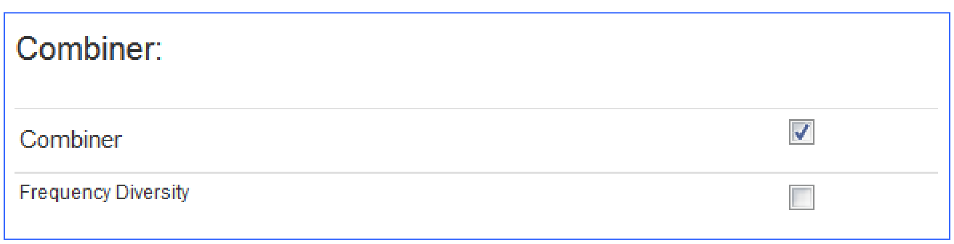


Figure 37: Configure Screen, Combiner Section

When the combiner is enabled on one channel, the second channel will automatically reflect this change.

Additionally, any parameter changes made by the user in one channel will automatically be made for the second channel, from which the combined signal is partially derived. The only setting that can still be changed individually when the diversity combiner is turned on is the channel frequency, which allows for frequency diversity to be implemented. To illustrate the synchronization of settings, the second channel's settings menu highlight bar will mimic the navigation path being taken by the user in the first channel.

Note: Whenever the Diversity Combiner is On, any changes made to the Frequency option (even with Frequency Diversity On enabled) causes Modulation Scaling for *both channels* to be set to the same value. However, if Mod Scaling was set to Locked when the Frequency was changed, Mod Scaling will change to Tracking.

5.4.1.1 Frequency Diversity

The Frequency Diversity option allows the user to independently change the frequency of each channel when the diversity combiner is On.

Click on the check box in the Frequency Diversity field to enable.

If there are two channels, the Combiner is set to On, and Frequency Diversity is Off, the channels are updated simultaneously.

5.4.2 Channel Selection and Basic Settings

The user may view channel displays and the Diversity Combiner display on the Configure screen in the Browser Interface. If the Combiner is On, only Channel 1 displays (Figure 38). Click on any field within the Configure screen to change and save settings for Channel 1, Channel 2, or both channels (Figure 39).

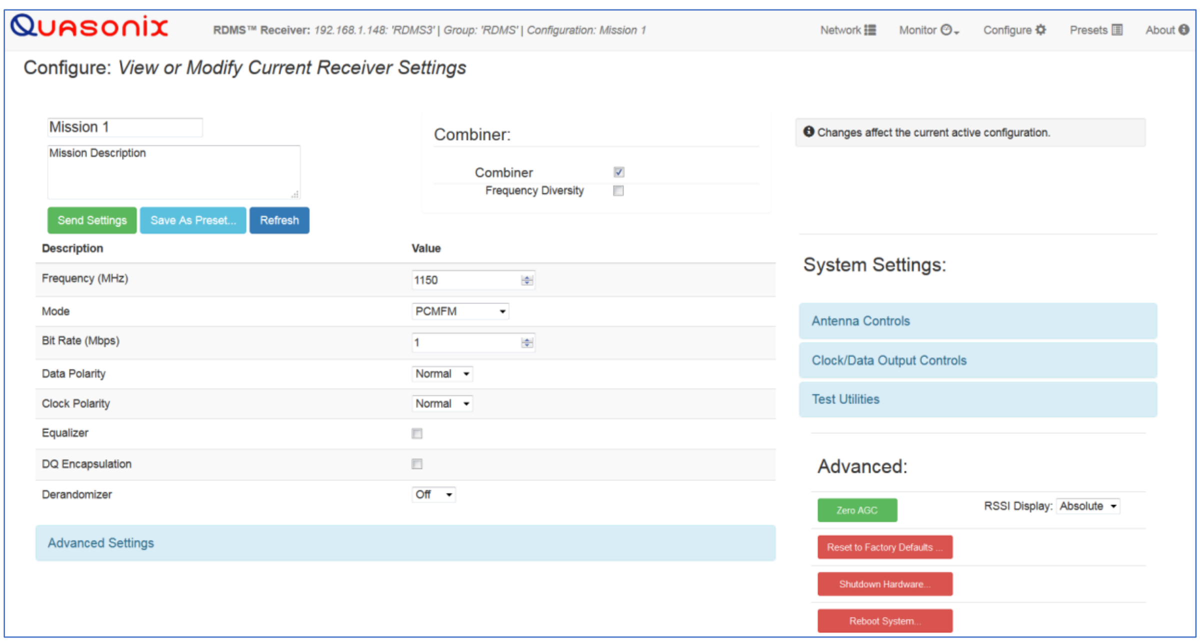


Figure 38: Configuration Screen with Combiner On, Channel 1 Displays

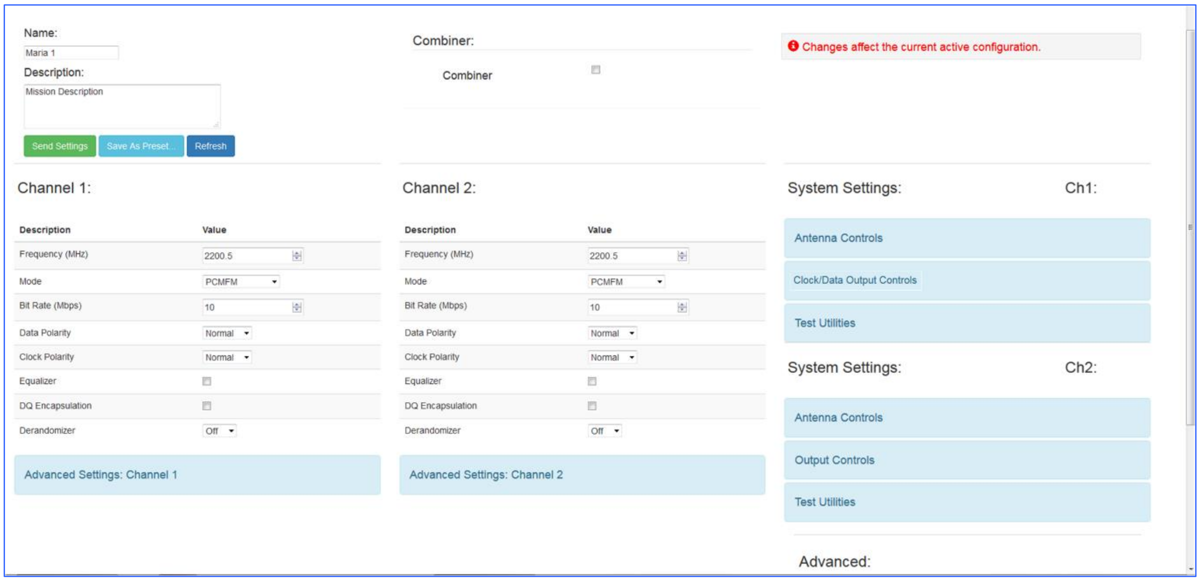


Figure 39: Configuration Screen with Combiner Off, Channel 1 and Channel 2 Display

The Configure screen includes all of the primary settings related to the receiver, including Frequency, Mode, Bit Rate, Data and Clock Polarity, Equalizer, DQ Encapsulation, and Derandomizer. The Power Ratio control is available for UQPSK mode only. A selection box displays below the Bit Rate option in UQPSK mode. Refer to section 5.4.2.1 for specific information about Power Ratio. Refer to section 5.4.2.2 for specific information about AQPSK mode.

Note: The Equalizer is currently available for use with all modes *except* STC mode.

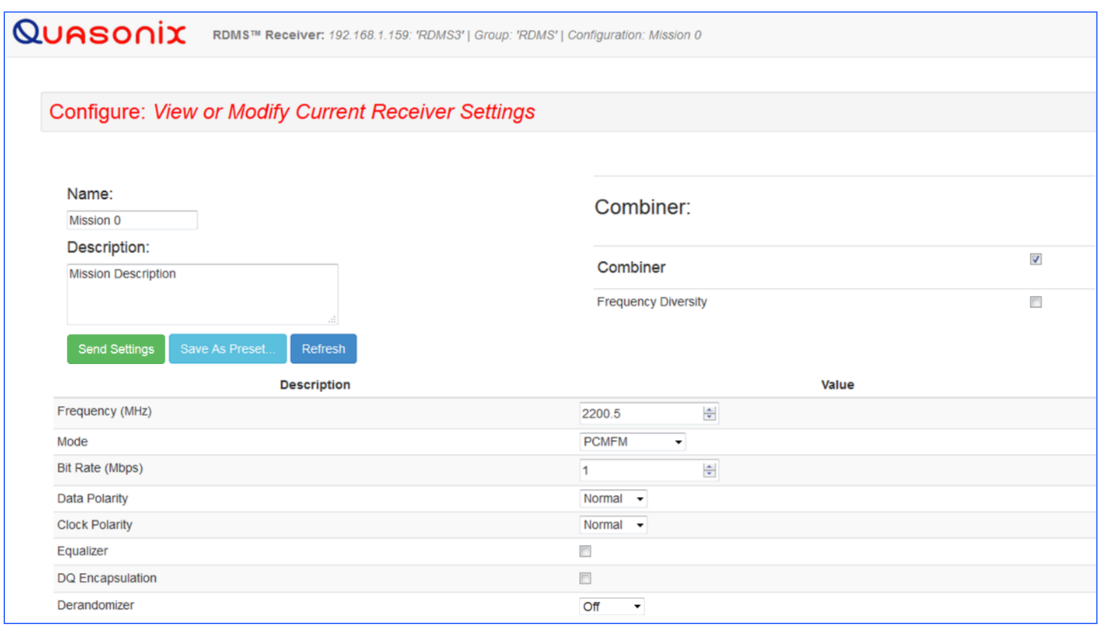


Figure 40: Configure Basic Settings Window-PCM/FM Mode

The settings can be adjusted by clicking on a check box (to enable or disable an option), clicking on a drop down menu and making a selection, or, in the case of Frequency and Bit Rate, typing the number directly or using up/down scroll arrows to select the desired value.

To save the current configuration as a preset, click on the Save as a Preset button, or click on the Refresh button to refresh the settings without saving. To create or modify other presets, use the Browser Interface Presets screen.

When selecting new settings on the Browser Interface Configure screen, these settings are not sent to the receiver and activated until the user clicks on the Save Presets button. *New options are provided to the user when certain options are selected*, for example, Frequency Diversity and Time Aligner are only available after Combiner is enabled *and saved*. Then other options may be changed *and saved*.

The Browser Interface alerts the user whenever a Save or Refresh is required. When a Save is necessary, the Send Settings button changes color (from green to gold), and a Save Changes message displays in the message area on the right side of the screen, as shown in Figure 41. Other notifications display in red text on the right side.

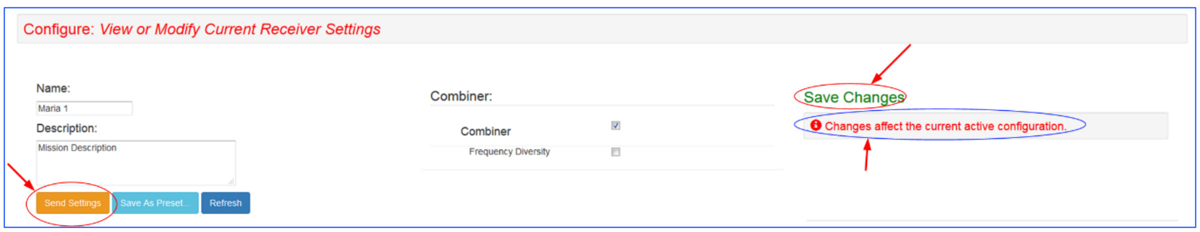


Figure 41: Configure Screen, Messages and Alerts

5.4.2.1 Power Ratio (UQPSK Mode Only)

To properly distinguish the in-phase (I) component from the quadrature-phase (Q) component in a modulated UQPSK signal, the demodulator requires knowledge of the ratio of power between the two components. This degree of unbalance is specified in dB.

For example, if the I component has four (4) times the power of the Q component, the power ratio will be 10*log10(4/1) = 6 dB. If the I component has lower power than the Q component, this setting will be negative. For example, if the I component has 1/5 the power of the Q component, the power ratio will be 10*log10(1/5) = -7 dB.

Note that small power ratios, between -3 dB and +3 dB, may be difficult for the demodulator to reliably distinguish.

5.4.2.2 AQPSK Mode

AQPSK mode results in two independent bit streams out of the RDMS. The I data is available on the normal clock and data outputs, but the Q data is only available on an MDM connector. Refer to Table 4 for connector/pin information for I data outputs (Clock A and Data A) and Q data outputs (Clock B and Data B). When AQPSK mode is selected, the Configure Basic Settings Window shows two bit rates (Bit Rate and Bit Rate B), as shown in Figure 42.

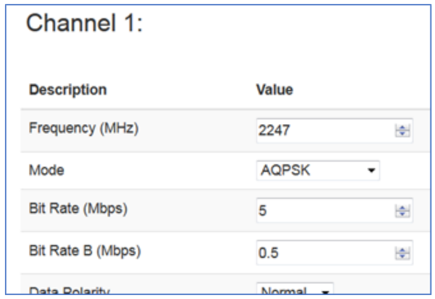


Figure 42: Configure Basic Settings Window AQPSK Mode, Two Bit Rates

5.4.2.3 Playback Demodulator

The Playback Demodulator function allows the RDMS™ to demodulate signals from a previous mission recorded by an Intermediate Frequency (IF) Recorder. This approach has several possible advantages, including superior trellis demodulation capability relative to other receivers that may have been utilized for the original mission, and the ability to replay the mission multiple times with different settings to obtain the best achievable results.

When the RDMS™ Frequency is set to 75 kHz to 20 MHz, or 70 MHz with a selectable SAW filter (which is well below the standard 200.0 MHz-5250.0 MHz range), the RF downconverter is bypassed and demodulator IF input comes from the IF Input BNC instead. From this input, it is SAW filtered according to the IF Filter setting and demodulated as if it had been received by the RF front end. Accordingly, all demodulator-related settings will affect the performance of the demodulation process.

Note, the combiner does not work for playback below 70 MHz.

The normal gain control provided by the RF front end AGC is unavailable when using the receiver as a playback demodulator. Some IF input gain compensation is available, but the input signal must be within the range -30 dBm ± 10 dB to obtain optimal performance.

Mod scaling Acquisition mode (the default) accurately determines the modulation index of a signal in the presence of additive white Gaussian noise (AWGN). While AWGN is always present to some extent when the RF front end is in use, it may not be present when the signal comes directly from the IF input, at least until the playback signal is applied to the demodulator input.

There are a few possible approaches to ensure proper demodulation of PCM/FM signals in playback demodulation:

- If the modulation index is known to be 0.7 (e.g., the recorded source was taken from a digital transmitter), set Mod Scale to Off.
- If there is time for a manual operation after the start of playback, set Mod Scale to Off prior to playback and switch Mod Scale to Acquire after starting playback.
- If the modulation index is not 0.7 and acquisition during playback is not feasible, set Mod Scale to Tracking.

5.4.2.4 Data and Clock Polarity Settings

The Data Polarity and Clock Polarity are set by clicking on drop down arrow to display the menu, then selecting the desired option, Normal or Inverted, as shown in the Data Polarity example in Figure 43.

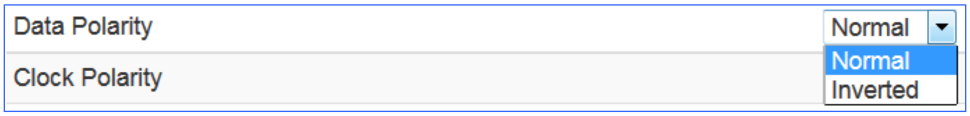


Figure 43: Settings Window, Data Polarity Selection

5.4.2.5 Data Quality Encapsulation (DQE)

Data Quality Encapsulation is the process of bundling data quality information along with payload data. This information is intended for use by a Best Source Selector (BSS) to optimally select correct payload data bits from amongst multiple streams of potentially errored payload data. Note that optimal performance can only be achieved if all sources of input to the BSS have independent errors; that is, related sources of data like Channel 1, Channel 2, and Combiner from a single receiver should not be presented to the BSS simultaneously.

Data quality is encoded as a Data Quality Metric (DQM). When calibrated per a standardized procedure, DQM based on bit error probability (BEP) allows DQE from multiple vendors to interoperate.

The Quasonix DQM is based on statistics developed deep inside the demodulator. Bit Error Probability (BEP) is the calculated likelihood that a bit is in error. A very low BEP can be determined from only a few bits. BEP does not require any known data and can be determined quickly and accurately from demodulator statistics. It is an unbiased quality metric, regardless of channel impairments. The DQM is calculated directly from BEP.

The basic DQM calibration fixture is described in the following steps and illustrated in Figure 44.

1. Input corrupted data (with clock)
2. Extract the frame sync word
3. Measure the BER of payload data
4. Compare DQM (converted to BEP) to measured BER and record/store on a packet by packet basis
5. Post process BEP and BER to develop score

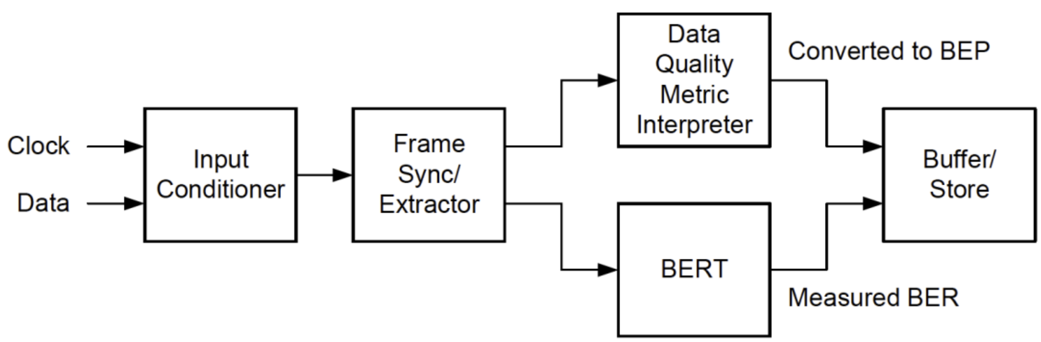


Figure 44: DQM Calibration Fixture Process

The DQE format includes a header consisting of the following:

- 16-bit sync pattern (0xFAC4)

  MSB first: 1111101011000100
- 16-bit ID word (format TBD)
- 16-bit DQM = min(round(-log10(LR) / 12 * (2^16)), 2^16 -1)

  16-bit unsigned integer, ranges from 0 to 65,535

  Likelihood Ratio (LR) = BEP / (1-BEP)

  Easily reversed:

  LR = 10^(-12 * DQM / 2^16)

  BEP = LR / (1 + LR)

  Q is defined as the "User's DQM":

  Q = 12 * DQM / 65536

  Represents the exponent of 10 in the LR, which approximates the BEP

  Examples:

  Q = 3 BEP = 1E-3

  Q = 7 BEP = 1E-7

BEP	LR	DQM	Q
0.5	1.00	0	0.00
1E-01	1.11111E-01	5211	0.95
1E-02	1.01010E-02	10899	2.00
1E-03	1.00100E-03	16382	3.00
1E-04	1.00010E-04	21845	4.00
1E-05	1.00001E-05	27307	5.00
1E-06	1.00000E-06	32768	6.00
1E-07	1.00000E-07	38229	7.00
1E-08	1.00000E-08	43691	8.00
1E-09	1.00000E-09	49152	9.00
1E-10	1.00000E-10	54613	10.00
1E-11	1.00000E-11	60075	11.00
1E-12	1.00000E-12	65535	12.00

Figure 45: DQE Format

Payload data is a user selectable length with a default of 4096 bits, with the exception of STC mode, where the default is 3200 bits, and SOQPSK/LDPC or STC/LDPC mode, where the default is the selected LDPC block size.

With a payload data length of 4096 bits, the network bandwidth expansion is ~1%.

DQM accuracy is verified under various channel impairments including AWGN-static level, AWGN-dynamic level (step response), dropouts, in-band and adjacent channel interference, phase noise, timing jitter, static multipath, and dynamic multipath (similar to break frequency).

To change the DQE, go to the Configure Basic Settings window, then click on the check box next to DQ Encapsulation. The parameter options are Enable (checked) or Disable (unchecked). The default is Disabled (unchecked).

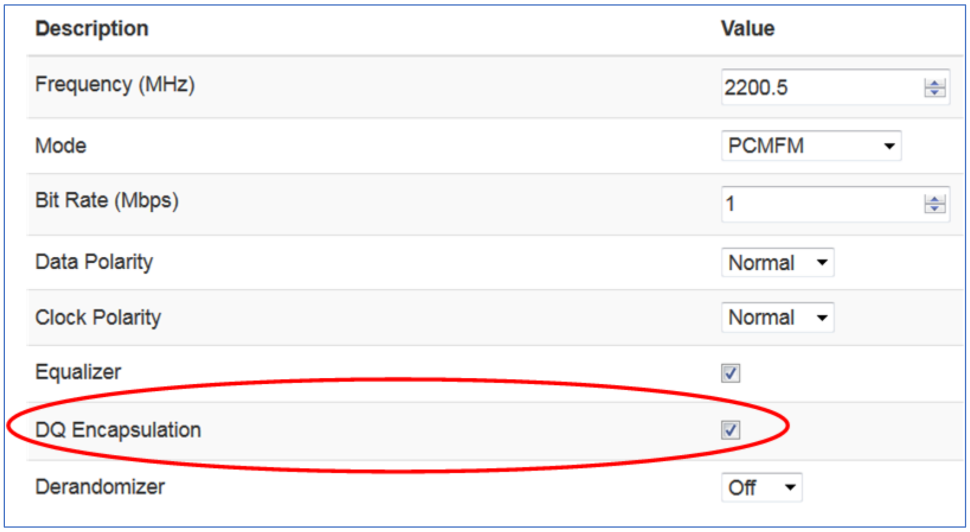


Figure 46: Configure Basic Settings Window, DQ Encapsulation Checked

Note: When DQE is enabled, normal bit error rate measurements cannot be made on the output data stream.

The DQM is displayed as Signal Quality on the Monitor screen, with a color-coded bar and a number above it (0-10).

5.4.2.6 Derandomizer Settings

The Derandomizer defaults to Off. Click on the drop down arrow to display the menu, then select the desired option (Figure 47). The standard running mode for non-LDPC operation is IRIG. The CCSDS option is only available when an LDPC Mode is enabled (SOQPSKLDPC or STCLDPC) or when Reed-Solomon decoding is enabled.

- IRIG – Derandomizes data randomized using the IRIG 15-stage randomizer
- CCSDS – Derandomizes data randomized using the CCSDS 8-stage block synchronous randomizer

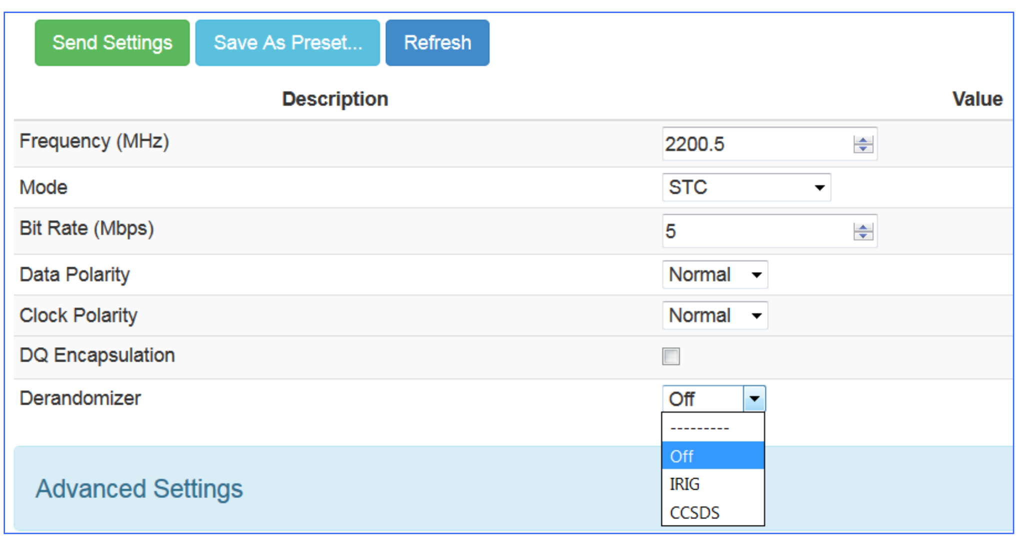


Figure 47: Settings Window, Derandomizer Drop Down Menu

5.4.2.7 Differential Decoding Settings (SOQPSK Only)

The Differential Decoding option is set to On or Off by clicking on the check box (Figure 48) to enable or disable the differential decoding. Differential Decoding defaults to enabled.

Differential decoding is available in all PSK modes (SOQPSK and legacy BPSK, QPSK, OQPSK, AQPSK, AUQPSK, and UQPSK). Legacy modes often use differential forms of PCM encoding (e.g., NRZ-M) instead, and only one or the other form of differential encoding should be used at a time.

In SOQPSK-TG mode, differential encoding and decoding eliminates the phase ambiguity inherent with the received data. The differential decoder can be enabled or disabled through the Main Menu by pressing Enter when the parameter is selected. The Enter key acts as a toggle switch. Normal SOQPSK operation requires the differential decoder to be On. The default value is On.

Differential encoding results in two differentially-decoded bit errors for each received bit error. This doubling negatively impacts subsequent error-correction capability for block forward error correction. Since the Attached Sync Marker used to identify block boundaries can also be used to resolve the phase ambiguity inherent in PSK modulation, differential encoding is unnecessary for block forward error correction. Therefore, differential decoding is automatically disabled when Reed-Solomon encoding is enabled.

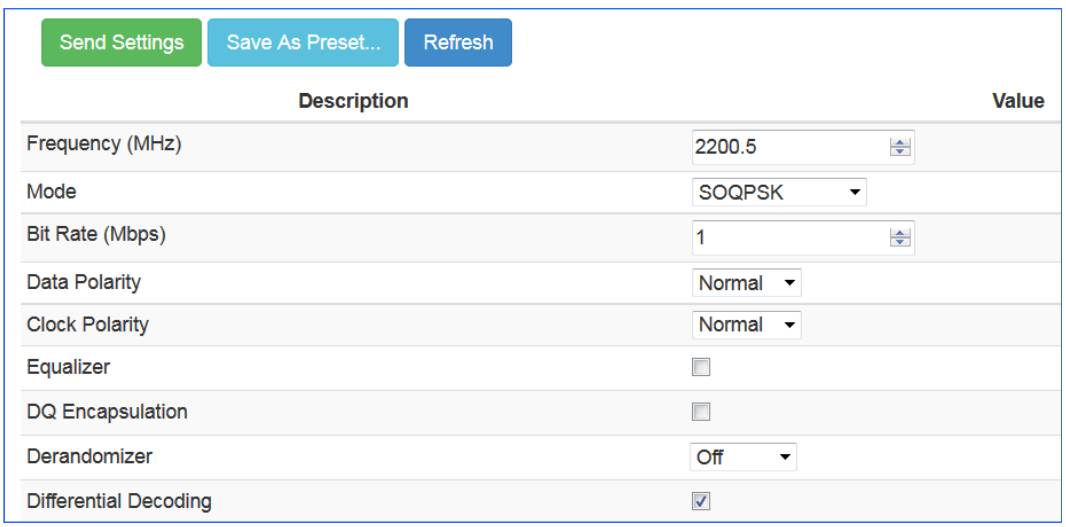


Figure 48: Configure Basic Settings Window-SOQPSK Mode

5.4.3 Configure Advanced Settings

The Configure screen also includes a secondary window for Advanced Settings. These include Measured Bit Rate, IF Filter, Output Muting, Muting Timeout, AFC Mode, Best Channel Selector, Time Aligner, and PCM Encoding, as shown in Figure 49. Additionally, the Advanced Settings window shows Video Output parameters, Channel A and Channel B Output, Channel A and Channel B Scale, Tape Output Frequency, and FM De-emphasis (when in PCM/FM mode).

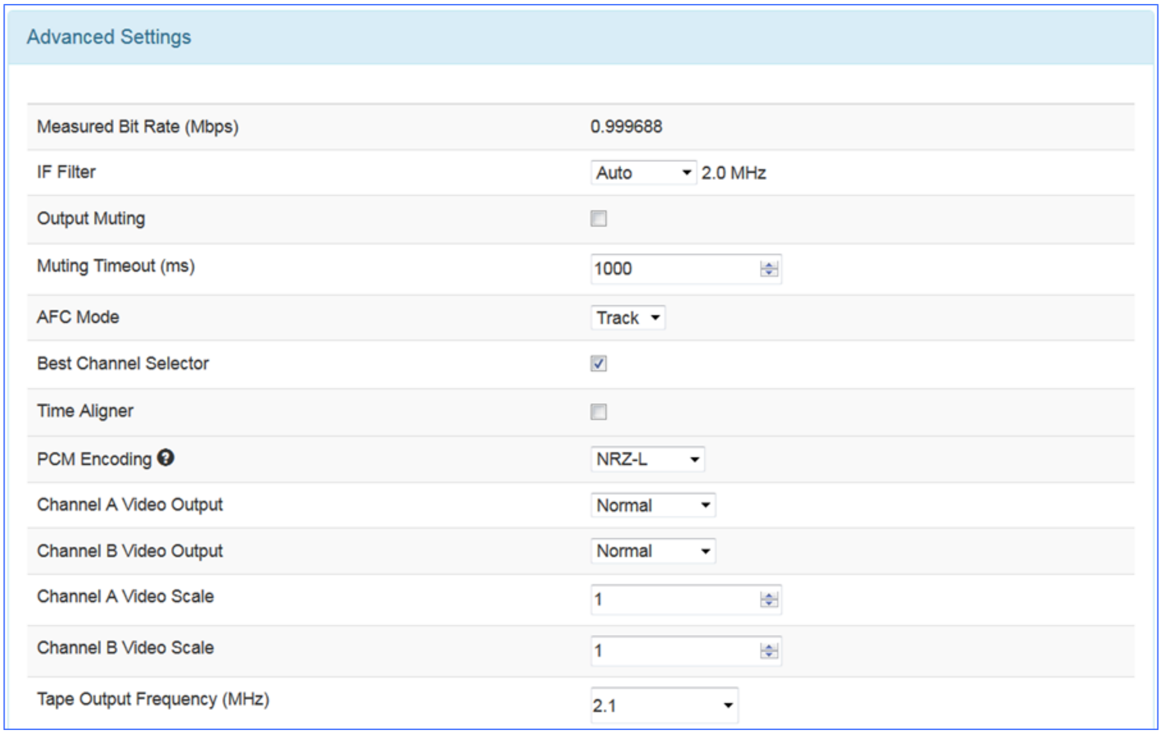


Figure 49: Advanced Settings Window

5.4.3.1 Measured Bit Rate Setting

Measured Bit Rate displays the receiver's bit rate on the input signal. This value may be copied and set as the specified bit rate. The purpose of this process is to eliminate unintended bit rate offset error so that the receiver can make full use of its bit synchronizer tracking range, or optionally reduce its tracking range. For the receiver to have an accurate measurement, however, the input signal must be close enough to the previously commanded bit rate to be within the current bit synchronizer lock range and actually be locked.

5.4.3.2 IF Filter

Based on the receiver's high level of integration, the proper IF filter is automatically selected based on the current mode and bit rate settings of the demodulator. Although manual filter selection is available through the IF Filter Menu, manual selection is not recommended. In the case of a receiver with diversity combining enabled, the two channels must have the same IF filter selected for proper operation.

The basic premise of trellis demodulation relies on the precise phase modulation of the transmitted signal. Some older analog transmitters have an inordinate amount of phase noise, reducing the effectiveness of the trellis demodulator. In Tier 0 (PCM/FM), enabling the Phase Noise Compensation option relaxes the requirements of the trellis demodulator, allowing better receive performance for transmitters with a high degree of phase noise.

When the modulation is set to PCM/FM, the Filter Settings window includes settings for IF and Phase Noise Compensation. In any other mode, only the IF Filter option is available.

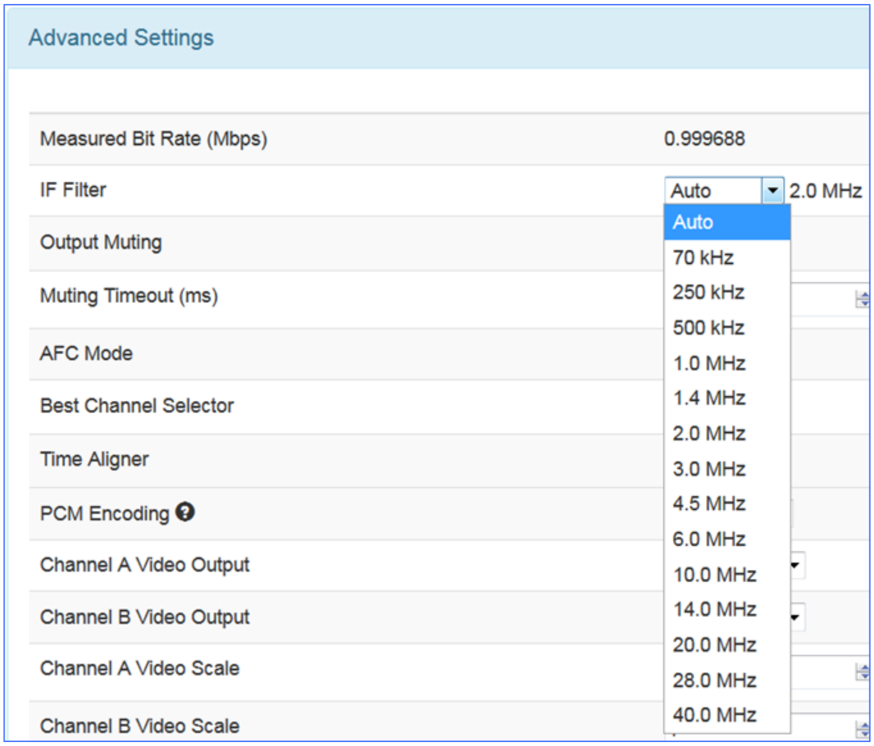


Figure 50: Advanced Settings Window, IF Filter Menu

5.4.3.3 Output Muting

The Output Muting option sets the muting value to On or Off. When Output Muting is set to On, the receiver stops sending clock and data information when the timeout value is reached. This option is beneficial to someone using a recorder with limited space. For example, if data is not locked to a valid signal or is outside the valid range, the information is muted (stopped) so the recorder is not filled with bad data.

5.4.3.4 Muting Timeout

The Muting Timeout option is used to set a timeout value (in milliseconds). This setting is used to determine when to mute (stop sending data) when the Output Muting option is set to On. The valid range is 0 to 46016 milliseconds. The default value is 1000.

5.4.3.5 AFC Mode

The AFC (Automatic Frequency Control) Mode option, shown in Figure 51, compensates for frequency offset in the received signal relative to the expected carrier frequency. Demodulators for all modes in the RDMS™ contain frequency-tracking loops that can accommodate some amount of frequency offset. The amount of offset that can be tolerated depends on the mode and is generally a small percentage of the bit rate. If the input frequency offset is greater than this amount, then AFC is needed to make up the difference.

The two main sources of offset are (1) reference oscillator frequency differences between the transmitter and the receiver, and (2) Doppler shift. Reference oscillator differences are constant or very slowly time-varying. Doppler shift, by its nature, tends to be dynamic. The optimal AFC mode depends on the source and magnitude of the frequency offset. Valid selections are Off, Hold, and Track. In general, Quasonix recommends setting the AFC Mode to Off, if possible.

Note that the AFC is automatically overridden (Off) if the demodulator can natively tolerate at least 50 kHz of frequency offset. This prevents the AFC from potentially interfering with frequency tracking if AFC is unlikely to be needed. Override may be disabled, and many other detailed AFC parameters may be controlled, via the command line interface. Refer to the RDMS™ Access via Telnet and Serial Control Protocol Technical Guide for AFC command details.

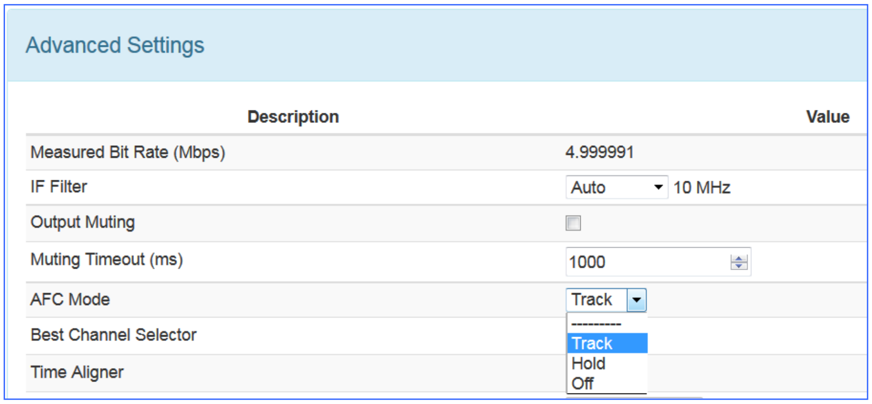


Figure 51: Advanced Settings Window, AFC Mode Menu

5.4.3.5.1 AFC Mode – Track

When AFC Mode is set to Track, the AFC continuously attempts to estimate and compensate for the input frequency offset unless the input Eb/N0 falls below a predefined threshold. This mode is best suited for dynamic frequency offsets.

5.4.3.5.2 AFC Mode – Hold

When AFC Mode is set to Hold, the AFC holds its current compensation. This mode is best suited for static frequency offsets. It may be advantageous relative to the Acquire mode if the channel is initially "known good" but may become impaired during a mission.

5.4.3.5.3 AFC Mode – Off

When AFC Mode is set to Off, the AFC continuously provides zero compensation. This mode is best suited for small frequency offsets that are within the amount of frequency offset that the demodulator can natively tolerate.

5.4.3.6 Best Channel Selector

The Best Channel Selector option sets the Best Channel Selector value to On or Off. When this option is checked (On), the combiner data output selects the best channel (1, 2, or Combiner) based on DQM.

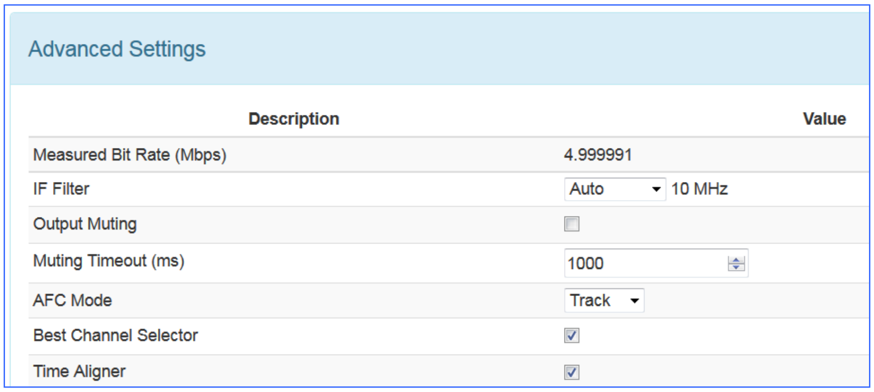


Figure 52: Advanced Settings Window, Best Channel Selector Checked

The Best-Channel Selector (BCS) is a revolutionary new feature, unique to the Quasonix RDMS™. Its purpose is to ensure that the back-panel data output from the Combiner is always optimal, even in rare cases where the Pre-Detection Diversity Combiner struggles relative to Channel 1 and Channel 2.

Normally, the Pre-Detection Diversity Combiner adds weighted copies of the Channel 1 and Channel 2 received signals to synthesize an improved combined signal. If the only impairment is noise (e.g., the test article is approaching maximum range), this combined signal is optimal, and provides 3 dB signal-to-noise improvement over Channel 1 and Channel 2 individually.

However, other impairments may cause the Channel 1 and Channel 2 signals to be uncombinable or to produce a suboptimal combined signal.

One simple example is frequency diversity with different multipath on Channel 1 and Channel 2. If the signal-to-noise ratio is equal on both received channels, the combined signal will be composed of half of each. This summed signal has half the amplitude of unintended reflections, but twice as many. The increased number of reflections can degrade demodulation performance, which may result in a higher bit error rate from the Combiner data output compared to the Channel 1 and Channel 2 data outputs.

The BCS solves this problem by selecting the best output data from Channel 1, Channel 2, and the Combiner on a bit-by-bit basis. The back-panel data output from the Combiner comes from the BCS whenever it is enabled, as shown in the system block diagram in Figure 53.

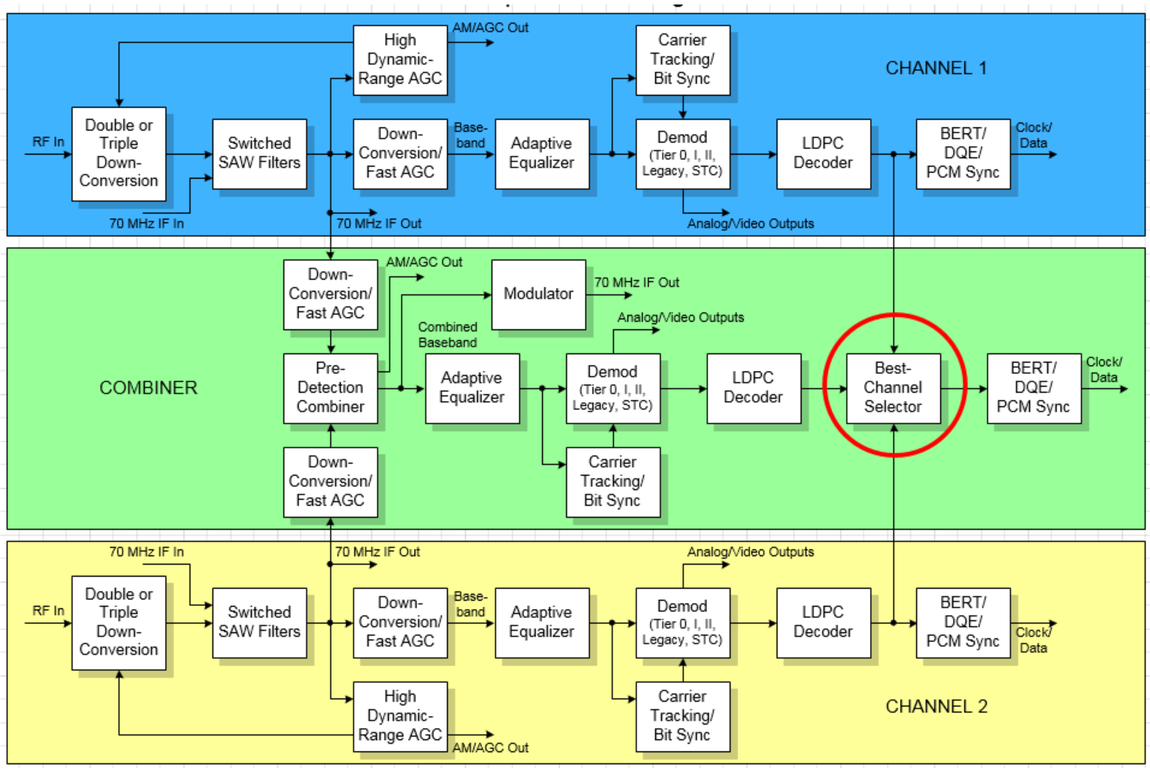


Figure 53: System Block Diagram with Best Channel Selector

This process yields optimal data output on a single connector under all conditions. The only penalty for this performance improvement is increased processing latency in the RDMS™, approximately equal to one DQE frame. Refer to section 5.4.2.5 for details about DQE.

When the BCS is disabled, the back-panel data output from the Combiner comes from the Diversity Combiner demodulator, as it traditionally has.

Another unique advantage of the BCS is that its output can be encapsulated using IRIG-standard Data Quality Encapsulation (DQE) for use by an external Best-Source Selector (BSS). This capability allows spatial diversity across a vast range with a minimal number of BSS channels and attendant bandwidth. Further, since the BCS need only accommodate relatively miniscule latency differences between its inputs, its local performance may exceed that of a BSS designed to handle several seconds of time delay between channels. Driving an external BSS with several RDMS™ BCS outputs leverages the strengths of both.

5.4.3.7 Time Aligner

The Time Aligner option is only available with the Combiner option enabled and set to On. The Time Aligner can be disabled or enabled. When disabled, it remains Off and does not affect the combiner.

Clicking on the check box to enable the (combiner) time aligner, as shown in Figure 54, lets it determine when to operate (with no user intervention).

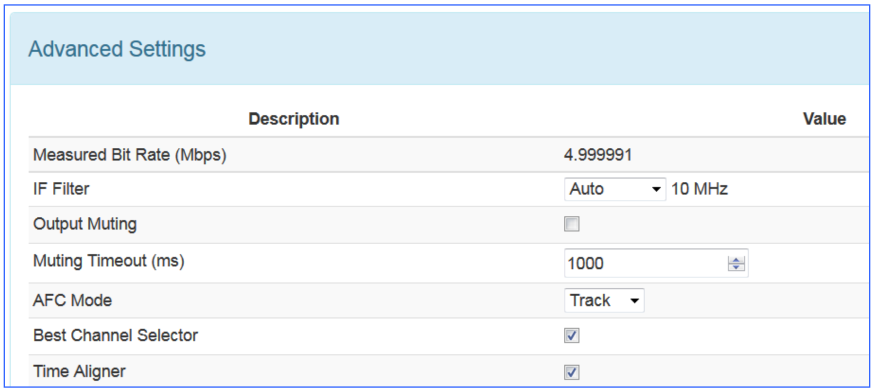


Figure 54: Advanced Settings Window, Time Aligner Selection Checked

Maximal ratio combining can only achieve optimal performance if the Channel 1 and Channel 2 input signals are accurately phase- and time-aligned. Traditionally, diversity combiners have performed phase alignment only, relying on the telemetry system design to provide adequate time alignment.

However, there are cases in which time alignment cannot be easily guaranteed. Such cases include frequency diversity and spatial diversity, where the propagation of transmit and receive paths for Channel 1 and Channel 2 may be quite different through cables, equipment, and the air. As bit rates continue to increase, fixed latency differences are magnified in relation to the bit period.

The Quasonix RDMS™ Combiner can perform both phase alignment and time alignment of the Channel 1 and Channel 2 signals. The Time Aligner is capable of correcting up to ±1300 nanoseconds of time skew between channels (about a quarter mile of free-space propagation). Similar to phase alignment, time alignment is dynamic, accommodating changes in relative target antenna positions over time.

When enabled, the Time Aligner continuously measures skew between channels but remains in a “monitor” state (with no timing correction) as long as the skew remains below a predefined threshold. When the skew exceeds the threshold, the Time Aligner switches to a “run” state (with full timing correction) as long as the signal quality is sufficient for it to continue to track timing skew.

If the propagation delay between channels is well-controlled and small, the Time Aligner may be disabled to guarantee minimal timing jitter.

5.4.4 PCM Encoding

The PCM Encoding setting controls the RDMS receiver output PCM data format. Two primary options are available: the receiver can convert encoded data to NRZ-L, or it can preserve transmit encoding.

The first option allows conversion of any of the following encoding formats to NRZ-L:

- NRZ-L: Non-return-to-zero, level
- NRZ-M: Non-return-to-zero, mark
- NRZ-S: Non-return-to-zero, space
- RZ: Return-to-zero
- Biphase-L: Biϕ, level
- Biphase-M: Biϕ, mark
- Biphase-S: Biϕ, space
- DM-M: Delay modulation (Miller code), mark
- DM-S: Delay modulation (Miller code), space
- M2-M: Modified delay modulation (Miller squared code), mark
- M2-S: Delay modified modulation (Miller squared code), space

The second option allows the transmit encoding to be preserved and output from the RDMS unaltered. To accomplish this, PCM Encoding must be set to NRZ-L – regardless of the actual transmit encoding. Also, for encoding formats that use di-bits to represent each user bit (i.e., RZ, Biϕ, DM, or M2), the RDMS bit rate must be set to twice the user bit rate. Note that the RDMS output clock will clock at twice the user bit rate in this configuration.

Select the desired encoding format from the drop down menu, as shown in Figure 55.

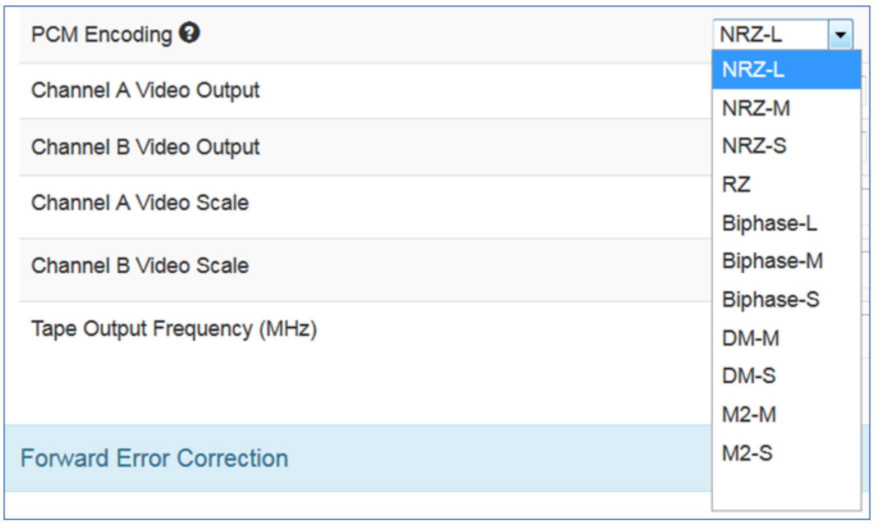


Figure 55: Advanced Settings Window, PCM Encoding Drop Down Menu

5.4.5 Channel A Video Output

The Channel A Video Output option, shown in Figure 56, selects what signal appears on the I/Video A output: Normal, Tape Out, or Carrier Only. The Normal output depends on the selected Mode, as shown in Table 5. Tape Out outputs the Pre-D signal, and Carrier Only outputs an unmodulated carrier; either of these will be output at the carrier frequency selected by Tape Out Freq (MHz).

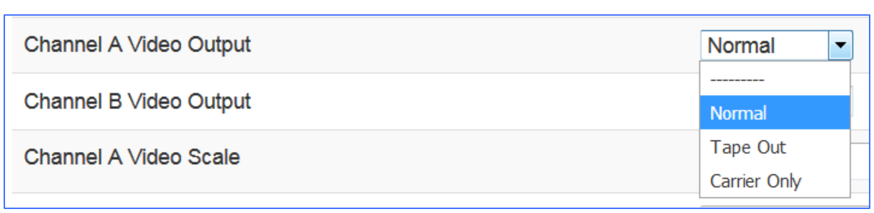


Figure 56: Advanced Settings Window, Channel A Video Output Drop Down Menu

Table 5: Normal (Default) Video Output Signals

Mode	I/Video A	Q/Video B
PCM/FM	Eye Pattern	Unused (0 Volts)
SOQPSK, SOQPSK/LDPC	Noncoherent I/Q Baseband	Noncoherent I/Q Baseband
MHCPM	Noncoherent I/Q Baseband	Noncoherent I/Q Baseband
BPSK	I Baseband	Unused
QPSK, OQPSK, AQPSK, UQPSK, AUQPSK	I Baseband	Q Baseband
DPM	I Baseband	Unused

5.4.6 Channel B Video Output

The Channel B Video Output option, shown in Figure 57, selects what signal appears on the Q/Video B output: Normal, Tape Out, or Carrier Only. The Normal output depends on the selected Mode, as shown in Table 5. Tape Out outputs the Pre-D signal, and Carrier Only outputs an unmodulated carrier; either of these will be output at the carrier frequency selected by Tape Out Freq (MHz).

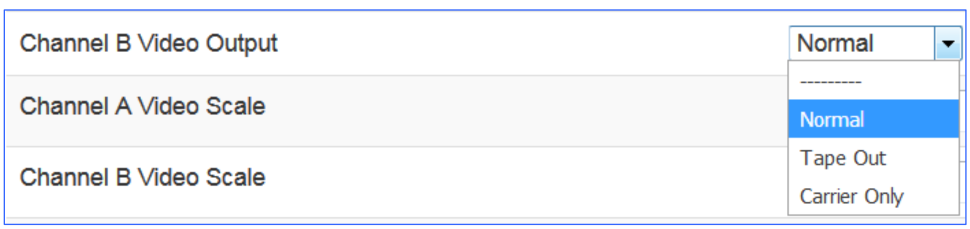


Figure 57: Advanced Settings Window, Channel B Video Output Drop Down Menu

5.4.7 Channel A Video Scale

The Channel A Video Scale option, shown in Figure 58, adjusts the peak-to-peak amplitude on the I/Video A output. By default the video output is 1.0000 V peak-to-peak using a standard deviated NTSC video signal. This setting allows the user to compensate for a system where this is not the case.

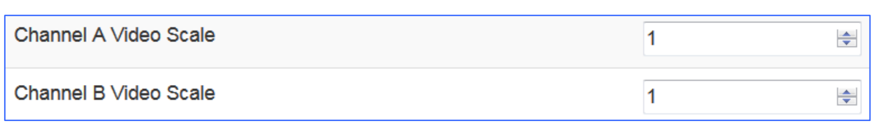


Figure 58: Advanced Settings Window, Channel A Video Scale

5.4.8 Channel B Video Scale

The Channel B Video Scale option, shown in Figure 59, adjusts the peak-to-peak amplitude on the Q/Video B output. By default the video output is 1.0000 V peak-to-peak using a standard deviated NTSC video signal. This setting allows the user to compensate for a system where this is not the case.

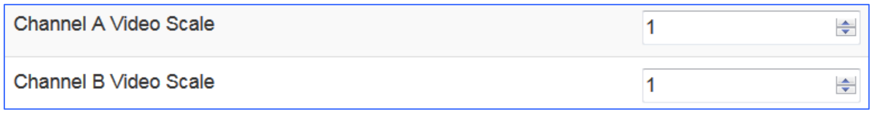


Figure 59: Advanced Settings Window, Channel B Video Scale

5.4.9 Tape Output Frequency

The Tape Out Frequency option, shown in Figure 60, sets the carrier frequency for any video output that is set to Tape Output or Carrier Only. The frequency may be selected from a standard set of values. Alternatively, any frequency up to 46.666 MHz may be entered as a custom frequency. Note, however, that frequencies above 30 MHz will experience filter roll-off and may not be useful.

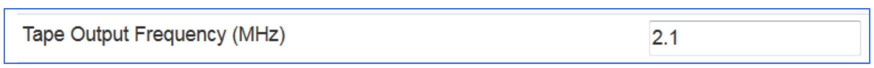


Figure 60: Advanced Settings Window, Tape Output Frequency

5.4.10 FM De-emphasis (PCM/FM Mode Only)

The FM De-emphasis option, shown in Figure 61, is used to set the FM De-emphasis value to NTSC, PAL, or Off. This option should be used when a corresponding video pre-emphasis filter is used on the video transmit side.

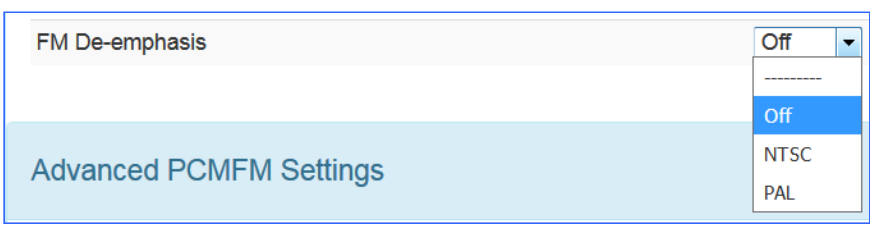


Figure 61: Advanced Settings Window, FM De-emphasis

5.4.11 Forward Error Correction

Forward Error Correction (FEC) may be accomplished by using Low-Density Parity Check (LDPC) encoding, in SOQPSK or STC modes, as shown in Figure 63 and in Figure 64, or by using Convolutional encoding/Viterbi decoding, and/or Reed Solomon encoding in legacy PSK modes (BPSK, QPSK, OQPSK, AQPSK, AUQPSK, or UQPSK), as shown in Figure 62.

All of these forms of FEC are discussed in detail in the associated sections: LDPC in section 5.4.11.1, Viterbi Decoder in section 5.4.11.2, Convolutional Symbol in section 5.4.11.3, Reed-Solomon Decoder in section 5.4.11.4, and Interleave Depth in section 5.4.11.5.

The Viterbi decoder and Reed-Solomon decoder can be disabled or enabled by clicking on the appropriate check box while a legacy PSK mode is selected (BPSK, QPSK, OQPSK, AQPSK, AUQPSK, or UQPSK). Likewise, the Convolutional Symbol setting for Viterbi decoding can be disabled or enabled by clicking on its check box.

Interleave depth for Reed-Solomon decoding may be changed by typing in the desired number, or by using the up/down arrows to scroll to the desired setting.

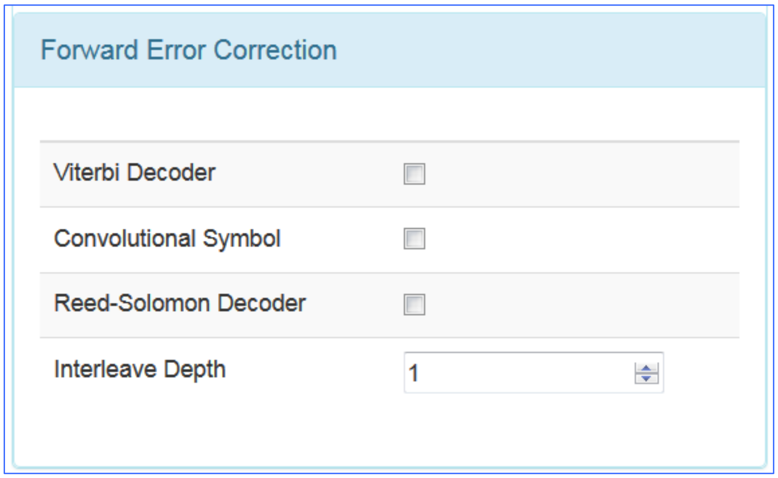


Figure 62: Forward Error Correction Window when in a PSK Mode

5.4.11.1 LDPC Mode (SOQPSKLDPC or STCLDPC Modes Only)

Low-Density Parity Check (LDPC) encoding is a form of forward error correction. It works by adding redundant information at the transmitting end of a telemetry link and then using that redundancy to detect and correct errors at the receiving end of the link. Details of LDPC coding are presented in IRIG 106-17 Appendix 2-D.

LDPC encoding can have many benefits. Its most common use is in range extension, where bit errors occur due to a weak received signal. LDPC can improve the point at which errors start to occur by over 9 dB. This increase in link margin is equivalent to almost tripling the operating distance of the telemetry link. Another application is error suppression—for links like compressed video that suffer major degradation due to small numbers of errored bits. LDPC has such a steep bit error rate curve that it converts the channel into essentially binary performance—perfection or highly errored. Since perfection is achieved deep into the area where occasional bit errors would normally occur, compressed video performance is greatly enhanced. Ultimately, any channel that can benefit from error reduction and has bandwidth available will likely benefit from LDPC encoding.

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), as shown in Figure 63. The larger block size offers better decoding performance in a static channel but may work less well in a dynamic channel with fast fading or other impairments. Lower code rates also provide better decoding performance at the cost of increased occupied bandwidth. The optimal code choice for any application may require empirical testing to determine.

LDPC decoding is only available for SOQPSK-TG and STC modulations. When in SOQPSK/LDPC or STC/LDPC mode, the appropriate code (k, r) must be selected for proper operation. Also, in these modes only, the user may select between no derandomization, standard IRIG derandomization as specified in IRIG 106-17 Annex A-2, or CCSDS derandomization as specified in IRIG 106-17 Appendix 2-D. Again, the derandomization selection must match the encoding selected at the transmitting end for proper operation.

SOQPSK/LDPC uses trellis demodulation. Trellis bit error rate performance in pure additive noise is slightly better than single-symbol bit error rate performance, as shown in IRIG 106-17, Figures D-10 and D-11. Trellis synchronization under adverse conditions may be significantly faster than single-symbol synchronization.

LDPC encoding is intended to improve performance specifically under harsh conditions, which might have a negative effect on AFC tracking. In general, Quasonix recommends setting the AFC Mode to Off if possible. This recommendation is especially important for the best LDPC performance. Refer to section 5.4.3.5 for more information about AFC Mode.

Available LDPC Mode options are:

k = 4096, r = 1/2	k = 1024, r = 2/3
k = 1024, r = 1/2	k = 4096, r = 4/5
k = 4096, r 2/3	k = 1024, r = 4/5

LDPC Code always displays in the Forward Error Correction window (Figure 63) when the waveform Mode is SOQPSKLDPC or STCLDPC.

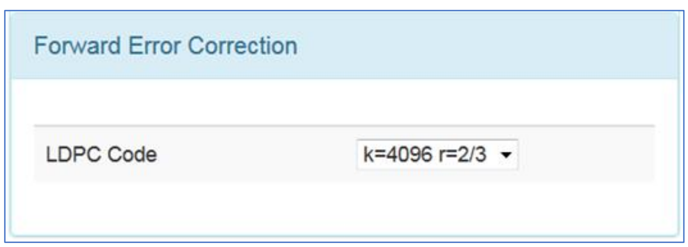


Figure 63: Forward Error Correction Window, when in SOQPSKLDPC or SOQPSKSTC Mode

Select the desired encoding format from the drop down menu, as shown in Figure 64.

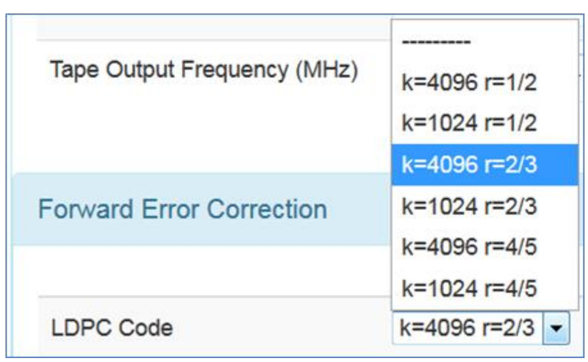


Figure 64: Forward Error Correction Window, LDPC Mode Drop Down Menu

5.4.11.2 Viterbi Decoder (K7 Option Required) (Legacy PSK modes only)

Convolutional encoding is a form of legacy forward error correction. Like LDPC, it adds redundant information at the transmitting end of a telemetry link and then uses that redundancy to detect and correct errors at the receiving end of the link. Details of K=7 rate=1/2 convolutional encoding are presented in CCSDS 131.0-B-2 Section 3. Viterbi decoding is used to decode convolutional-encoded data.

The purpose and benefits of convolutional encoding are similar to LDPC. However, convolutional encoding requires more bandwidth than all but the lowest-rate LDPC codes, and its error-correcting performance is inferior to LDPC. Therefore, LDPC is the preferred forward error correction if possible.

The Viterbi Decoder control requires the K7 option, and the RDMS must be set to one of the following PSK modes: BPSK, QPSK, AQPSK, AUQPSK, OQPSK, or UQPSK.

The Viterbi Decoder can be disabled or enabled by clicking on the check box in the Forward Error Correction window, shown in Figure 65.

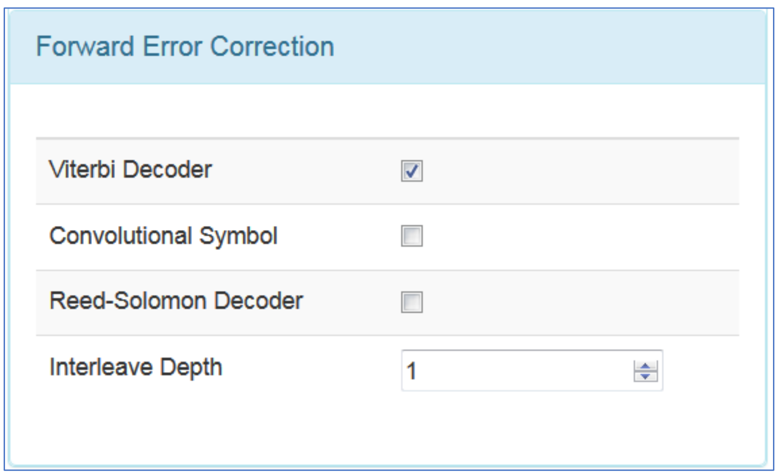


Figure 65: Forward Error Correction Window

5.4.11.3 Convolutional Symbol

The Space Network Users' Guide (NASA 450-SNUG) defines two different methods for generating quadrature symbols (variants of QPSK) when using convolutional encoding.

The first method is for I and Q data streams to be independently encoded. In this method, two convolutional encoders are used, one for I data and one for Q data, as shown in Figure 66.

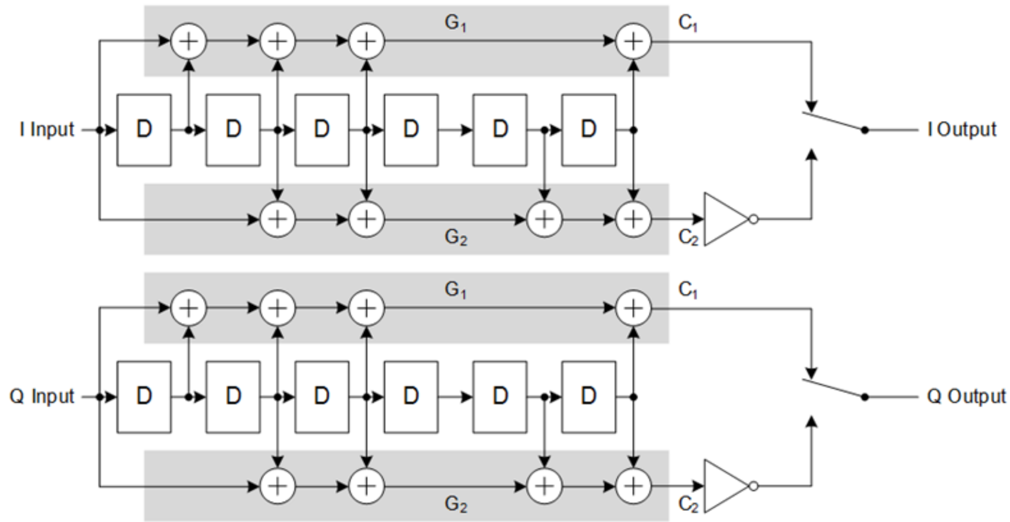


Figure 66: I and Q Data Streams Independently Encoded

The appropriate decoder for this method is selected by setting Convolutional Symbol to Disabled (unchecked), as shown in Figure 65. In older releases without the Convolutional Symbol control, this was the only method supported.

The second method is for I and Q data to be created from the G1 and G2 generators, respectively, of a single convolutional encoder. In this method, only one convolutional encoder is used for both the I and Q data.

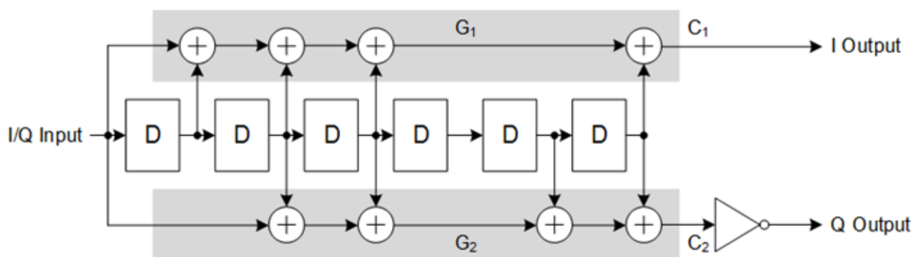


Figure 67: I and Q Data from Single Convolutional Encoder

The appropriate decoder for this method is selected by setting Convolutional Symbol to Enabled (checked), as shown in Figure 68.

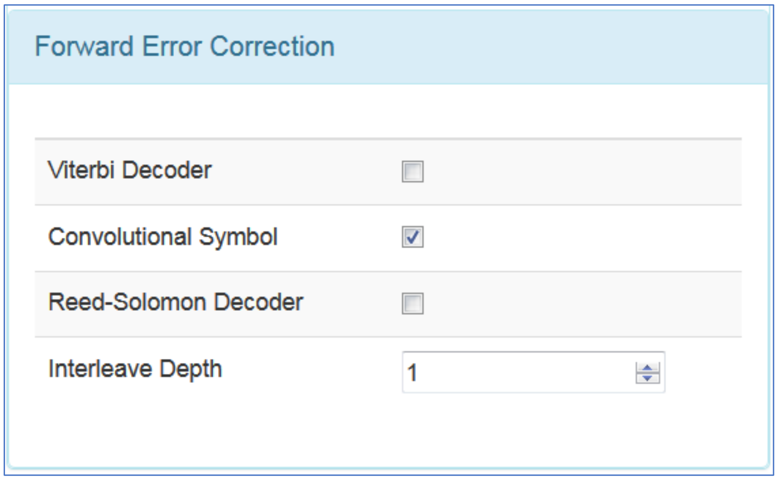


Figure 68: Forward Error Correction Window, Convolutional Symbol Enabled (Checked)

5.4.11.4 Reed-Solomon Decoder (K7 Option Required) (Legacy PSK modes only)

Reed-Solomon encoding is another form of legacy forward error correction. Like LDPC, it is a block code that adds redundant information at the transmitting end of a telemetry link and then uses that redundancy to detect and correct errors at the receiving end of the link. Unlike LDPC, however, encoding/decoding occurs on 8-bit symbols, and errors are detected and corrected on a symbol-by-symbol basis, regardless of the number of bits in error within a symbol. This characteristic makes Reed-Solomon encoding suitable for correcting burst errors. Details of Reed-Solomon encoding are presented in CCSDS 131.0-B-2 Section 4. The specific variant of Reed-Solomon decoder implemented is the (255, 223) code.

While Reed-Solomon encoding can be used by itself, it is a far less powerful code than LDPC. Its primary use is as a second code to correct burst errors that arise in the Viterbi decoder. The concatenation of Reed-Solomon encoding and convolutional encoding results in far better performance than either code by itself.

The Reed-Solomon control requires the K7 option, and the RDMS must be set to one of the following PSK modes: BPSK, QPSK, AQPSK, AUQPSK, OQPSK, or UQPSK. The RDMS has only one Reed-Solomon decoder. Therefore, in AQPSK and AUQPSK modes, only the ‘A’ data will be decoded when Reed-Solomon decoding is enabled; ‘B’ data will be output without decoding.

Reed-Solomon decoding and Viterbi decoding can be used together or separately.

The Reed-Solomon decoder is selected by setting R-S Decoder to Enabled (checked), as shown in Figure 69.

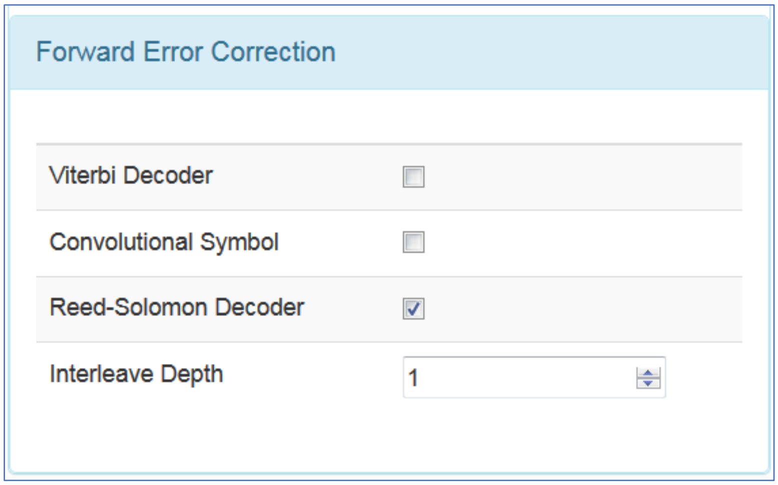


Figure 69: Forward Error Correction Window, Reed-Solomon Decoder Enabled (Checked)

5.4.11.5 Interleave Depth (K7 Option Required) (Legacy PSK modes only)

The burst error correction capability of the Reed-Solomon decoder can be extended by interleaving N code blocks, which spreads burst errors out in the decoder. Valid interleave depths range from N = 1 (no interleaving) to N = 8.

Type a valid Interleave Depth in the field in the Forward Error Correction window, or use the up/down arrows to scroll to the desired value. The valid range is 1 to 8.

5.4.12 Advanced PCM/FM Settings

The Advanced PCM/FM Settings window is shown in Figure 70. When the modulation is set to PCM/FM, the Scale Settings window includes settings for modulation scaling indexes. In any other mode, the Scale Settings are not available.

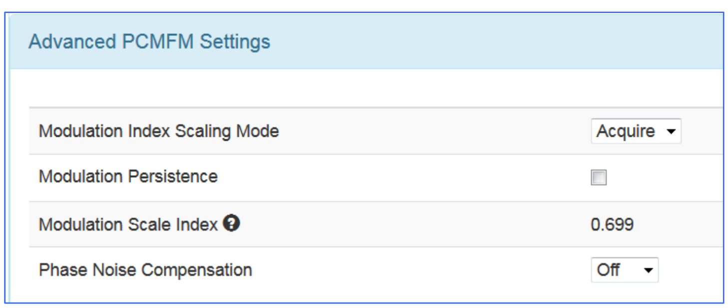


Figure 70: Advanced PCMFM Settings Window

5.4.12.1 Modulation Index Scaling Mode

Modulation Scaling is a method used to retain the maximum trellis-coding gain of a non-ideal FM signal. Modulation Index Scaling Mode contains four settings: Track, Hold, Off, and Acquire.

The RDMS™ automatically adjusts demodulator bandwidth based on the selected/estimated modulation index. However, IF filter bandwidth is not automatically adjusted, even when set to automatic. It is recommended that the user manually scale the IF filter bandwidth proportional to the modulation index for modulation indexes greater than 1.0.

The Modulation Index Scaling Mode option allows the operator to manually set the modulation scale index. This enables the receiver to operate at the optimum range of modulation desired by the user. The valid modulation scaling *index* range is 0.350 to 8.000.

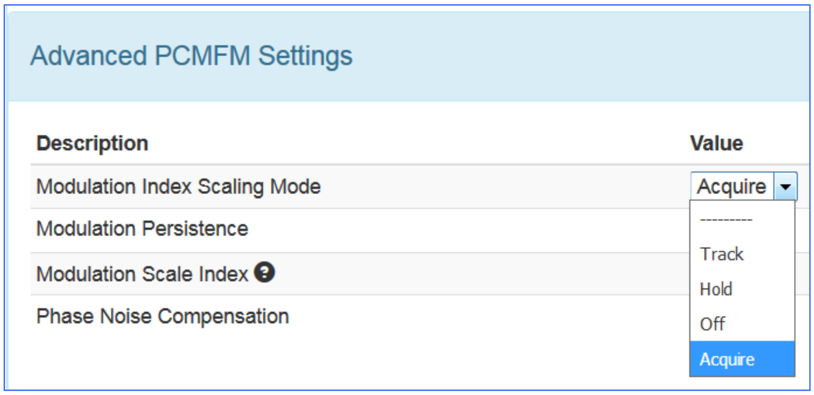


Figure 71: Advanced PCMFM Settings Window, Modulation Index Scaling Mode Menu

5.4.12.1.1 Modulation Scaling – Track

When the RDMS™ is powered on, the default setting is Acquire, unless the unit was powered off from a preset condition. If the unit was powered off from an unmodified preset setting, then the default condition of Modulation Scaling is as defined in the preset. When Track is set, the modulation scale index is actively being tracked.

Note: The active setting is not saved when the receiver is powered off, unless the Mod Persist option was set to On.

Frequency, mode, and bit rate changes, or any changes to a preset, cause the Modulation Scaling setting to revert back to Track. This is because the optimal signal monitoring is no longer valid.

Note: Whenever the Diversity Combiner is On, any changes made to the Frequency option (even with Frequency Diversity On enabled) causes Modulation Scaling for both channels to be set to Track.

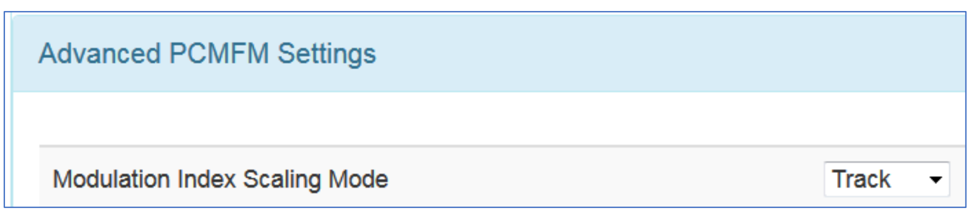


Figure 72: Advanced PCMFM Settings Menu, Modulation Scaling – Track

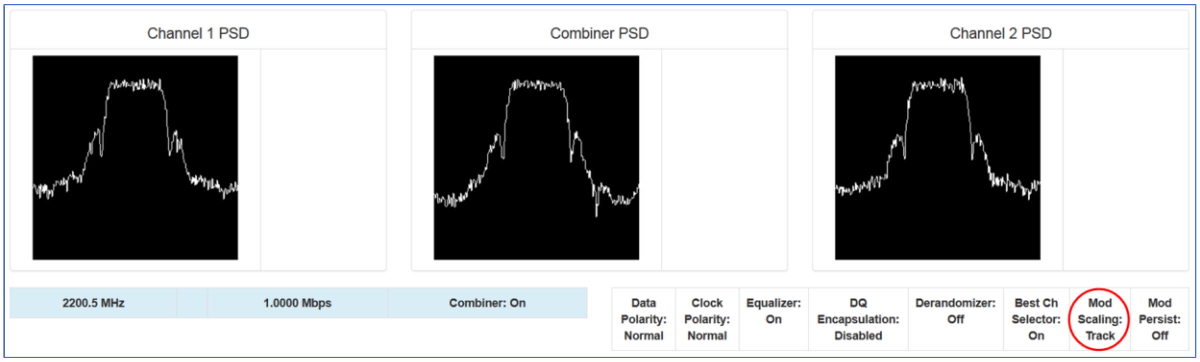


Figure 73: Monitor Screen, Mod Scaling Set to Track

The Mod Scaling indicator on the Monitor screen displays Track.

If there are two channels, and the Combiner is set to On, the Modulation Scaling controls for setting the modes are linked. In Acquire or Track mode, the actual scaling operation functions independently in each channel.

5.4.12.1.2 Modulation Scaling – Hold

When the RDMS™ has a good lock on the target transmitter, Modulation Scaling should be set to Hold by selecting the Hold option on the Advanced PCMFM Settings Window, Modulation Index Scaling Mode drop down menu, as shown in Figure 74.

When Modulation Scaling is set to Hold, the Mod Scaling indicator on the Monitor screen displays Hold, as shown in Figure 75, indicating the optimal modulation index is set.

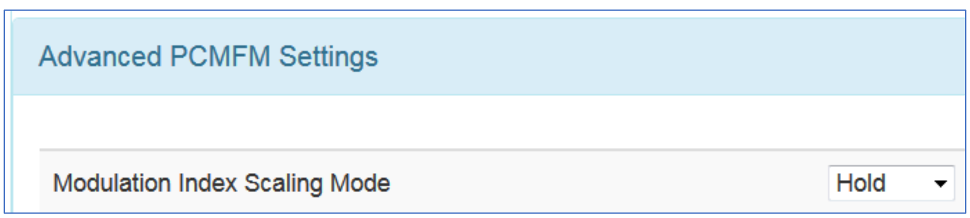


Figure 74: Advanced PCMFM Settings Menu, Modulation Scaling – Hold

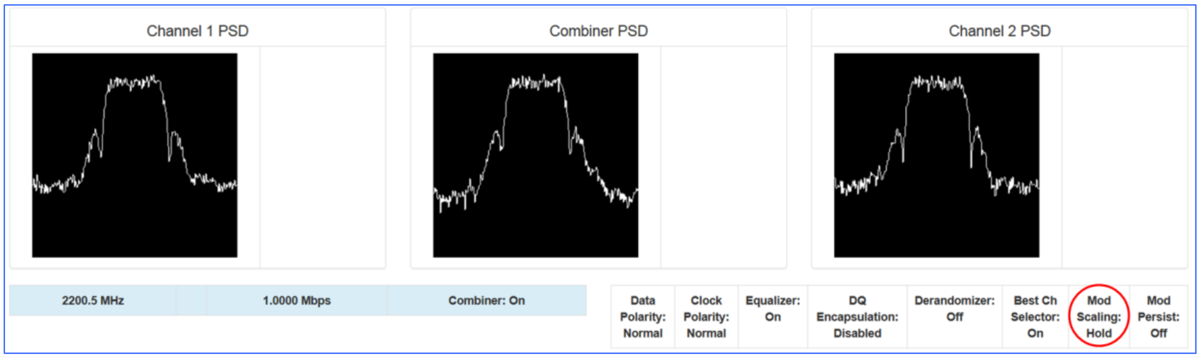


Figure 75: Monitor Screen, Mod Scaling Set to Hold

If Modulation Scaling is set to Hold, the active modulation scale index is also locked in on a particular setting. The modulation scale index is described in section 5.4.12.3.

Locked index numbers, manually or automatically selected, are lost when the Mod Scaling option is set to Tracking, Off, or Acquire. If the Locked index number is to be retained following a power-off cycle of the rack, then turn on the Mod Persist option in the Advanced PPCM/FM Settings screen. Refer to section 5.4.12.2, Modulation Persistence.

5.4.12.1.3 Modulation Scaling – Off

The Mod Scaling Off setting is shown in Figure 76. When Modulation Scaling is set to Locked, the Mod Scaling indicator on the Monitor screen displays Off, as shown in Figure 77, indicating the optimal modulation index is set.

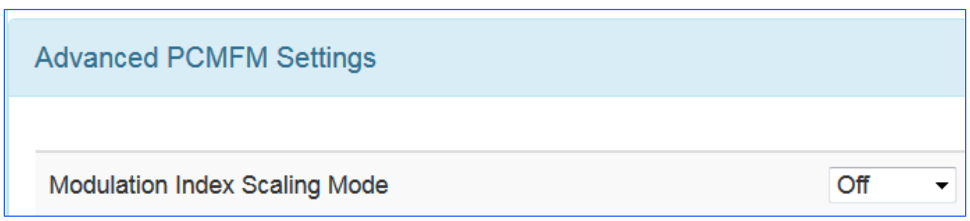


Figure 76: Advanced PCMFM Settings Menu, Modulation Scaling – Off

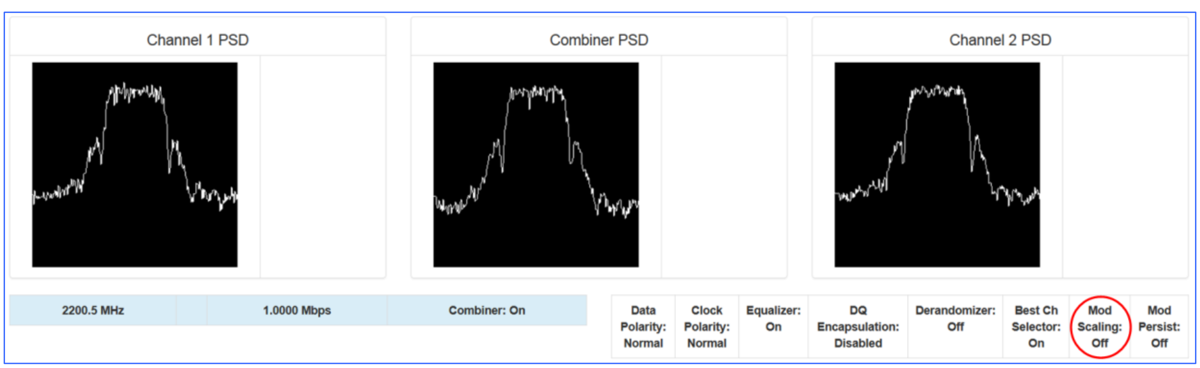


Figure 77: Monitor Screen, Mod Scaling Set to Off

With Mod Scaling turned Off, the Mod Index is set to the optimal 0.700. Mod Scaling should be turned off when a new generation, digitally synthesized transmitter is the source. Digitally synthesized transmitters do not have a variable deviation sensitivity adjustment, and as such are not subject to inaccurate modulation index settings

5.4.12.1.4 Modulation Scaling – Acquire

When the RDMS™ is powered on, the default setting is Acquire, unless the unit was powered off from a preset condition. Acquire mode has two states: Armed and Triggered. When Modulation Scaling is set to Acquire, in the absence of signal, the Mod Scaling indicator on the Monitor screen shows Acquire, as shown in Figure 79, the state is set to Armed. In Armed state, modulation scaling operates continuously.

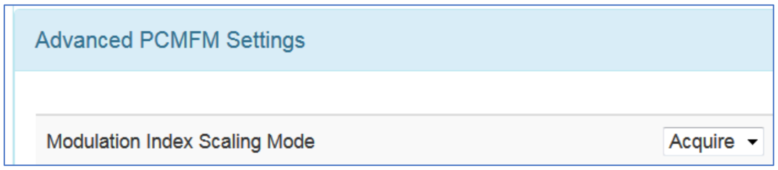


Figure 78: Advanced PCMFM Settings Menu, Modulation Scaling – Acquire

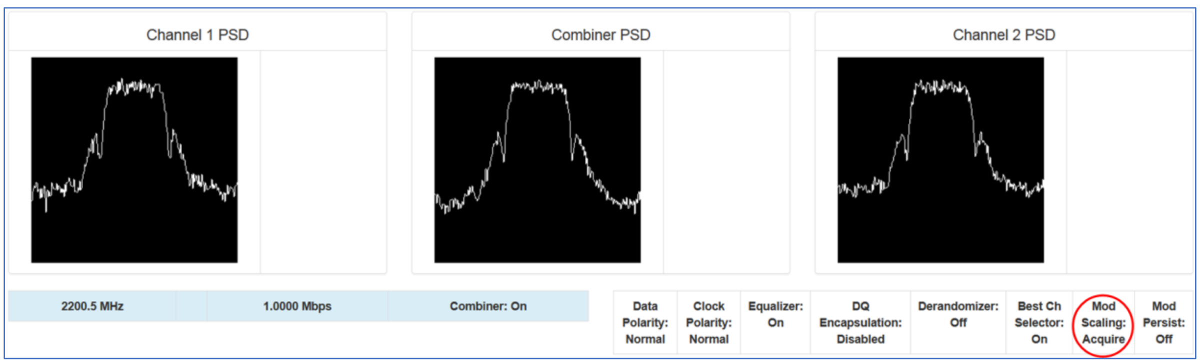


Figure 79: Monitor Screen, Mod Scaling Set to Acquire

If the receiver is locked and the delta h (the change in modulation index) has settled below the delta h threshold for the specified settling time, the state changes to Triggered, and in Triggered mode, the estimated h (modulation index) is monitored but the scale is not updated.

If delta h goes above the delta h threshold and settles again, the receiver is still locked, and the Eb/N0 at the settling point is higher than the last settling point, the current scaling is updated with the new estimate. There is no transition from Triggered back to Armed except for setting the mode to Acquire again.

5.4.12.2 Modulation Persistence

Modulation Persistence allows the current state of the Modulation Scaling setting to be retained following a power-off cycle. The default value is Off (not checked), as shown in Figure 80.

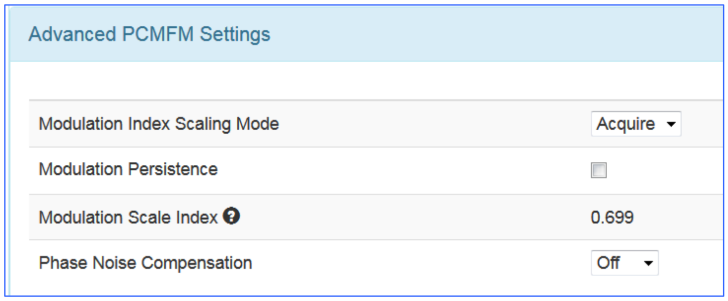


Figure 80: Advanced PCMFM Settings Window, Modulation Persistence Not Checked

When modulation scale index is set, the Modulation Scaling option on the Configure screen is simultaneously changed to Hold. The Hold notation includes the new index number that the operator has chosen.

If the held index number is to be retained following a power-off cycle of the rack, then turn on Modulation Persistence by checking the Modulation Persistence box on the Advanced PCMFM Settings screen. Save the current setup profile using the Save Presets option. Refer to section 5.5.1.

When the RDMS™ is powered on, the default setting is Acquire, unless the unit was powered off from a preset condition. If the unit was powered off from an unmodified preset setting, then the default condition of Modulation Scaling is as defined in the preset. When Tracking is set, the modulation scale index is actively being tracked.

Note: The active setting is not saved when the receiver is powered off, unless the Modulation Persistence option was set to On.

If there are two channels, and the Combiner is set to On, the Modulation Scaling is NOT linked. Modulation Scaling for channel one and channel two functions independently.

When the RDMS™ has a good lock on the target transmitter, Modulation Scaling should be set to Hold.

Mod Scaling should be turned off when a new generation, digitally synthesized transmitter is the source. Digitally synthesized transmitters do not have a variable deviation sensitivity adjustment, and as such are not subject to inaccurate modulation index settings

Acquire mode has two states: Armed and Triggered. When Modulation Scaling is set to Acquire, the state is set to Armed. In Armed state, modulation scaling operates continuously.

If the receiver is locked and the delta h (the change in modulation index) has settled below the delta h threshold for the specified settling time, the state changes to Triggered and the eye pattern turns green. In Triggered mode, the estimated h (modulation index) is monitored but the scale is not updated.

If delta h goes above the delta h threshold and settles again, the receiver is still locked, and the Eb/N0 at the settling point is higher than the last settling point, the current scaling is updated with the new estimate.

There is no transition from Triggered back to Armed except for setting the mode to Acquire again.

5.4.12.3 Mod Scale Index

The Mod Scale Index option allows the operator to manually set the modulation scale index. This enables the receiver to operate at the optimum range of modulation desired by the user.

To change the Modulation Scale Index, ensure that the Modulation Index Scaling Mode is set to Hold. If it isn't, the Modulation Scale Index field is set to *read only*, as shown in Figure 81. Use the steps in section 5.4.12.1 to set and save the scaling mode. When the scaling mode is saved as Hold, the Mod Scale Index field changes to an editable field, as shown in Figure 82. Type the desired scale index in the field or use the up/down scroll arrows to change the value. The valid modulation scale index range is 0.350 to 8.000.

If the held index number is to be retained following a power-off cycle of the rack, then turn on Mod Persist from the Advanced PCM/FM Settings screen. Refer to section 5.4.12.2, Modulation Persistence.

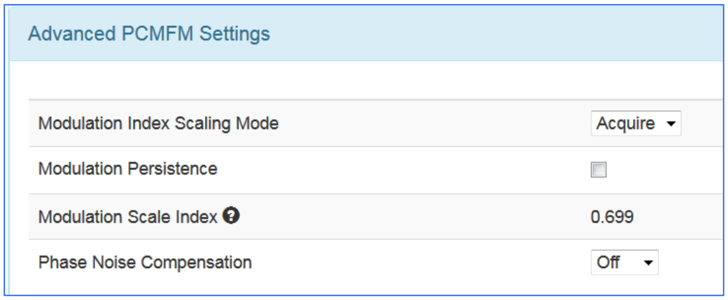


Figure 81: Advanced PCMFM Settings Window, Modulation Scale Index Current Value, Read Only

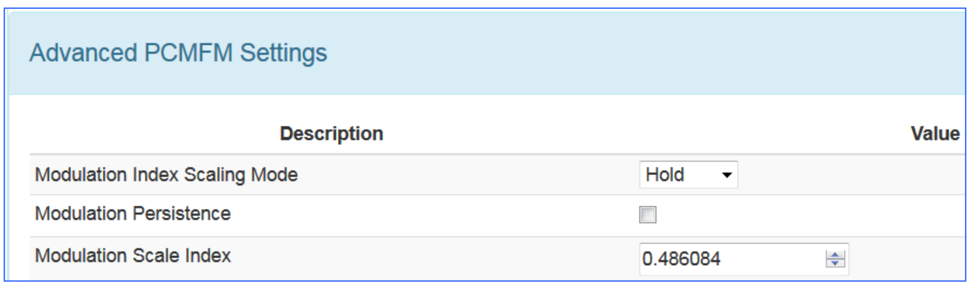


Figure 82: Mod Index Scaling Mode/Hold, Modulation Scale Index with Edit Field

To clear any held modulation scale index number, go to the Main Menu and toggle the Mod Scaling option back to Tracking. After Mod Scaling is set to Tracking, the modulation index follows the receiver's present estimate of the mod index.

5.4.12.4 Phase Noise Compensation

The Phase Noise Compensation (PNC) option is used to set the Phase Noise Compensation value to On, Off, or Auto. Refer to Appendix D in section 12 for detailed information about PNC.

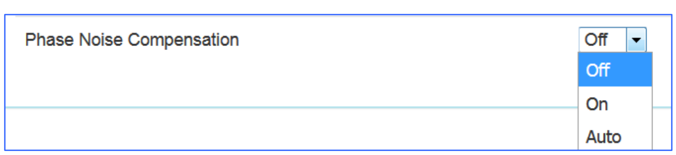


Figure 83: Advanced PCMFM Settings Window, Phase Noise Compensation Drop Down Menu

5.4.13 System Settings

The System Settings window, shown in Figure 84, includes the following settings:

- Antenna Controls
- Clock/Data Output Controls
- Test Utilities

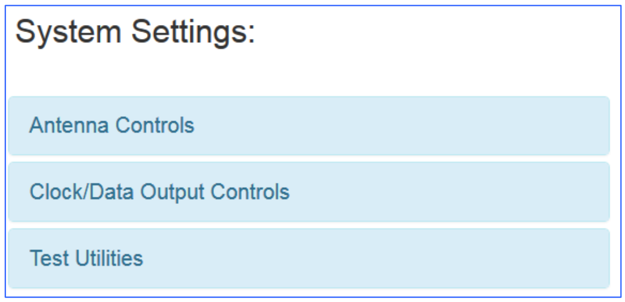


Figure 84: System Settings Window

5.4.13.1 Antenna Controls

The Antenna Controls section contains the following parameters for AGC (Automatic Gain Control) and AM, as shown in Figure 85.

- HyperTrack
- AGC Polarity (Positive/Negative)
- AGC Scale (in dB/V)
- AGC Time Constant (in ms)
- AGC Freeze
- AGC Zero Mode
- AGC Compensate
- AM Bandwidth (Hz)
- AM Polarity (Positive/Negative)
- AM Scale (0.05-2.5)
- D/C Antenna

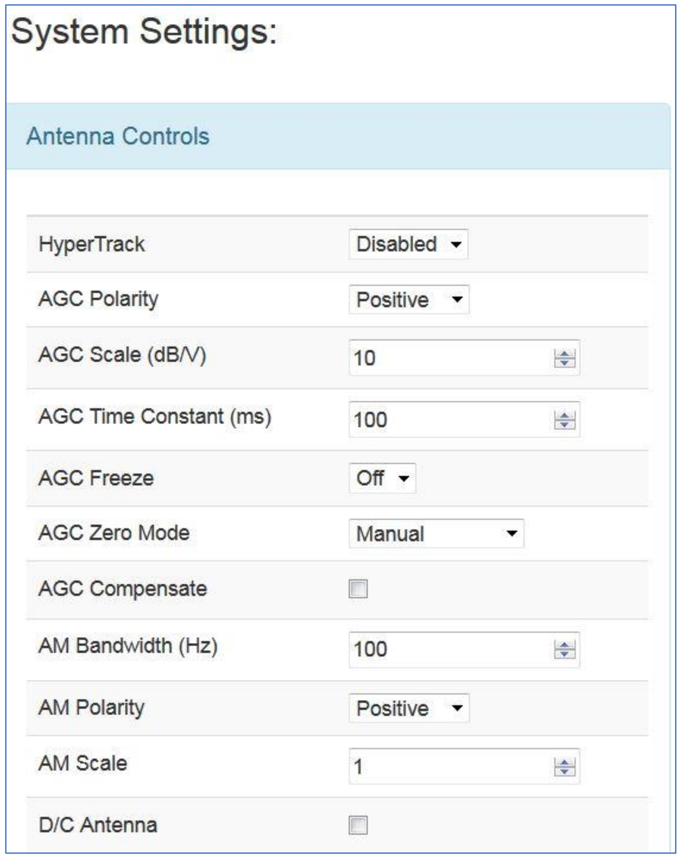


Figure 85: System Settings, Antenna Controls

5.4.13.2 HyperTrack

HyperTrack™ is an all-digital antenna control protocol that offers many benefits in antenna tracking performance and system operation. These benefits are too numerous and wide-ranging to describe fully here, but they include improved tracking stability, range-based tracking bandwidth, ability to track through strong interfering signals, rejection of incidental AM (e.g., from spinning test articles), and optimal multi-receiver tracking.

Enabling HyperTrack™ switches the AM/AGC front panel output to all-digital mode. This mode requires a HyperTrack™-compatible ACU for proper operation and to take advantage of the performance improvements. Disabling HyperTrack™ switches the AM/AGC front panel output to legacy analog AM mode.

Note, in a HyperTrack™-equipped receiver, the Sync Detect digital status output is unavailable. Also, when HyperTrack™ is enabled, the Lock Detect digital status output automatically becomes a copy of the HyperTrack™ digital output data.

Click on the drop down menu to select Enabled or Disabled, as shown in Figure 86.

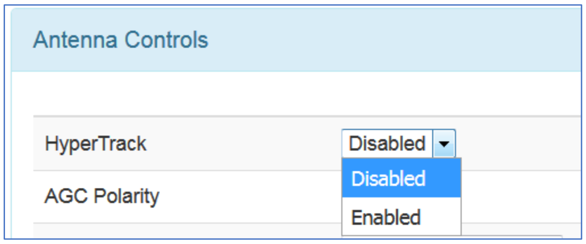


Figure 86: Antenna Controls Window, HyperTrack Selection

5.4.13.3 AGC Polarity

The AGC Polarity option is used to set the automatic gain control polarity. Click on the drop down menu to select Positive or Negative, as shown in Figure 87.

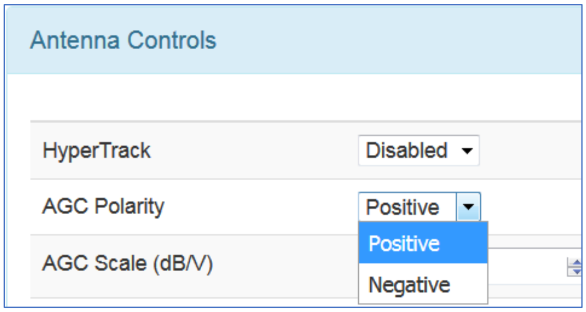


Figure 87: Antenna Controls Window, AGC Polarity Selection

5.4.13.4 AGC Scale

The AGC Scale option, shown in Figure 88, adjusts the voltage of the AM/AGC front panel MDM-25 output. The scale can be set in units of dB/V (decibels per volt). The higher the scale is set, the more dynamic range the AGC output can represent, but the lower its resolution will be. The AGC output is calibrated to a load of 1 KOhm. Operation into other load impedances will result in the effective AGC scale factor being higher or lower than expected.

For example, suppose the AGC zero point is -100 dBm. The AGC output will be 0.0 V when no input signal is applied. When a signal of -80 dBm is received (i.e., 20 dB above the zero point), then the AGC output will be 2.0 V if the scale is set to 10 dB/V and 1.0 V if the scale is set to 20 dB/V. The maximum AGC output voltage is ±5.0 V.

To change the AGC Scale value, type the new value, in dB/V, or use the up/down arrows to scroll to the desired value.

Figure 88: Antenna Controls Window, AGC Scale Selection

5.4.13.5 AGC Time Constant

The Time Constant option, shown in Figure 89, sets the time constant of the AM/AGC front panel MDM-25 output. The time constant can be set in units of ms (milliseconds). The higher the time constant, the slower the AGC output voltage will move in response to changes in input signal level.

Because the AM/AGC front panel MDM-25 output tracks any input signal level changes that are not tracked by the AGC, the AM output will include any signal amplitude frequency content from (approximately) the inverse of the AGC time constant up to the AM bandwidth limit. For example, if the AGC time constant is set to 100 ms and the AM bandwidth is set to 100 Hz, then the AM output will include any AM frequencies between roughly 10 Hz and 100 Hz.

To change the AGC Time Constant, type the new value, in ms, or use the up/down arrows to scroll to the desired value.

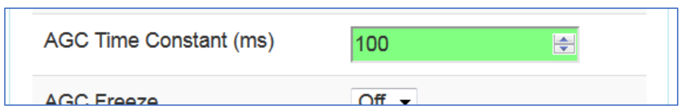


Figure 89: Antenna Controls Window, AGC Time Constant Selection

5.4.13.6 AGC Freeze

The AGC Freeze option disables the hardware gain compensation loop such that gain from the RF input to the IF output is fixed. The receiver front end becomes a constant gain block, which may be useful for making receiver noise figure measurements or antenna G/T measurements. Note, however, that RSSI measurement and AM/AGC outputs will continue to reflect changing input levels within a +/-16 dB window around the frozen level. Also, RSSI is calibrated to be precise enough—even varying front-end gain—that AGC Freeze is not absolutely necessary to obtain excellent noise figure or G/T readings via the RSSI measurement.

Click on the drop down menu to select On or Off, as shown in Figure 90.

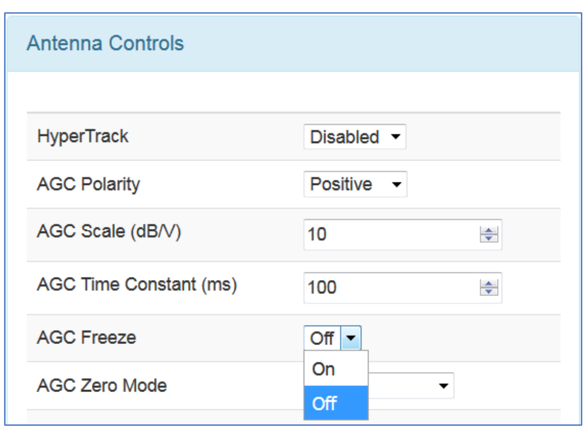


Figure 90: Antenna Controls Window, AGC Freeze Selection

5.4.13.7 AGC Zero Mode

The AGC Zero Mode option is shown in Figure 91. The AGC Zero Hold (On/Off) option from the 2nd Generation RDMS was replaced by AGC Zero Mode. There are three available settings, Manual, Hold, or Hold and Save.

- Manual – Means the AGC must be zeroed manually after any frequency or IF bandwidth change, or after a power cycle
- Hold – Means the AGC holds its zero level after any frequency or IF bandwidth change but must be zeroed manually after a power cycle
- Hold and Save – Means the AGC holds its zero level after any frequency or IF bandwidth change, or after a power cycle

The AGC Zero mode (manual, hold, or hold and save) remains set if a waveform mode changes.

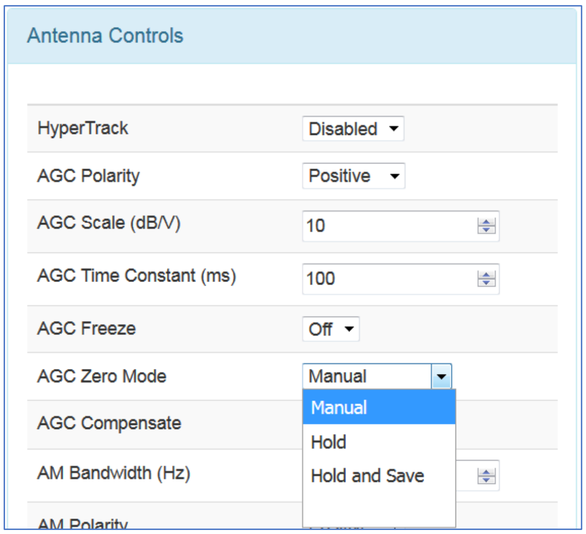


Figure 91: Antenna Controls Window, AGC Zero Hold Drop Down Menu

5.4.13.8 AGC Compensate

The user may enable AGC Compensation by clicking on the check box. Refer to section 11, Appendix B for more information about the AGC Compensation function.

5.4.13.9 AM Bandwidth

To change the AM Bandwidth value, type the desired value or use the up/down arrows to scroll to the appropriate value, as shown in Figure 92. The AM Bandwidth can be set from 5.00 to 50000.00 Hz.

5.4.13.10 AM Polarity

AM Polarity is set by clicking on the drop down menu to select the desired value, Positive or Negative, as shown in Figure 92.

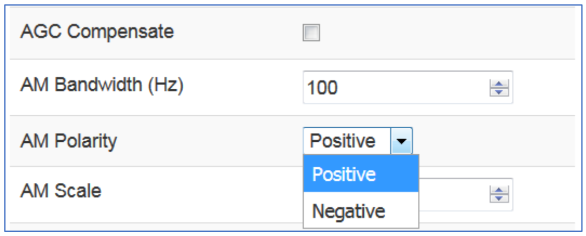


Figure 92: Antenna Controls Window, AM Polarity Drop Down Menu Selections

5.4.13.11 AM Scale

To change the AM Scale value, type the desired value or use the up/down arrows to scroll to the appropriate value. The AM Scale has a range from -128 to +128. At its default setting of 1, the response is 2V p-p, into a 75 ohm load with a 50% AM.

5.4.13.12 Downconvert Antenna

The DC Antenna option is only available when using the 5-band downconverter AND P and C band are enabled.

- When the downconverting antenna is not available, this command displays only an assumed value.
- The downconverting antenna setting only applies to C band frequencies.
- Click on the box in the DC Antenna field to check the box and enable the option, as shown in Figure 93.

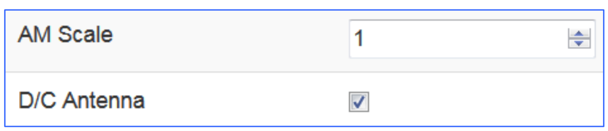


Figure 93: Antenna Controls Window, D/C Antenna Selection Checked

The downconverting antenna has an LO that is used to downconvert C band signals (4400 MHz – 5150 MHz) to a lower frequency range known as P band (400 MHz – 1150 MHz) using an LO frequency of 5550 MHz. This results in two issues that are addressed by the downconverting antenna control.

1. Spectral Inversion

   In a downconverting antenna, the LO is higher than the RF (high side injection) and the lower side band result is selected—the spectrum is inverted. All C to P band downconverting antennas are assumed to produce a spectrally inverted signal. The receiver automatically reinverts the signal before it is demodulated. (This is done in the downconversion to 70 MHz IF.) If an actual P band signal is received, it is NOT spectrally inverted and the automatic reinversion done by the receiver improperly causes the signal to appear inverted to the demodulator.

   The demodulator has a mechanism to invert the spectrum in the digital domain. The downconverting antenna setting determines how the spectral inversion is handled for P band signals.

2. C Band Frequency Specification Ambiguity

   It is common to tune to the C to P band downconverted signal by specifying the C band frequency. In a receiver that also has actual C band receiver capability, an ambiguity develops when a C band frequency is specified since it can be applied to either a C or P band signal. The downconverting antenna setting determines how a specified C band frequency is interpreted in a system where both C and P bands are enabled.

If a C band frequency is specified and the downconverting antenna is *enabled*, it is assumed the signal is a C to P downconverted signal. The receiver is tuned to the P band equivalent and the automatic inversion is used. If the downconverting antenna is *disabled*, the receiver is tuned to the specified C band frequency and spectral inversion is not an issue.

If a P band frequency is specified, it is assumed there is no downconverting antenna. The receiver is tuned to the actual P band frequency and the automatic spectral inversion is disabled.

5.4.14 Clock/Data Output Controls

The Clock/Data Output Controls section contains parameters for clock and data output for Channel A and Channel B, as shown in Figure 94.

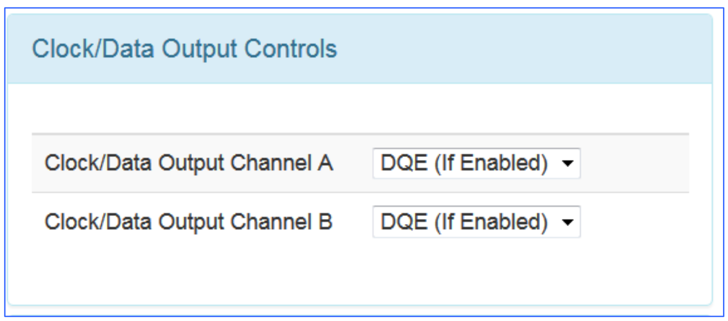


Figure 94: Output Controls Window

The Channel A Output options, shown in Figure 95, select what signals appear on the Channel A clock/data outputs: DQE, No DQE, or Test Data.

- DQE – Selecting DQE enables encapsulation of data on Channel A; if DQ Encapsulation is enabled (checked) on the Configuration Basic Settings window, the output is encapsulated, otherwise it is not
- No DQE – Selecting No DQE bypasses data quality encapsulation
- Test Data – Selecting Test Data causes the output of the Data Generator to display on Channel A clock and data

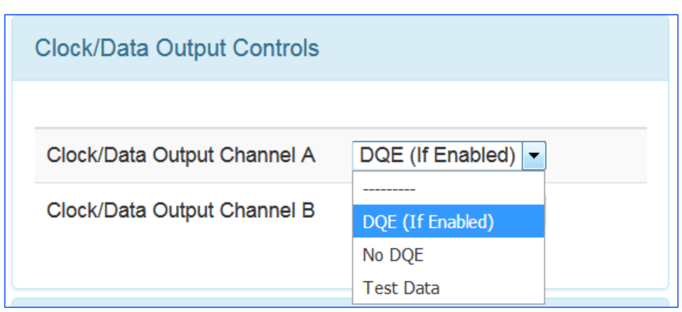


Figure 95: Output Controls, Clock/Data Output Channel A

The Channel B Output options, shown in Figure 96, select what signals appear on the Channel B clock/data outputs: DQE, No DQE, or Test Data.

- DQE – Selecting DQE enables encapsulation of data on Channel B; if DQ Encapsulation is enabled (checked) on the Configuration Basic Settings window, the output is encapsulated, otherwise it is not
- No DQE – Selecting No DQE bypasses data quality encapsulation
- Test Data – Selecting Test Data causes the output of the Data Generator to display on Channel B clock and data

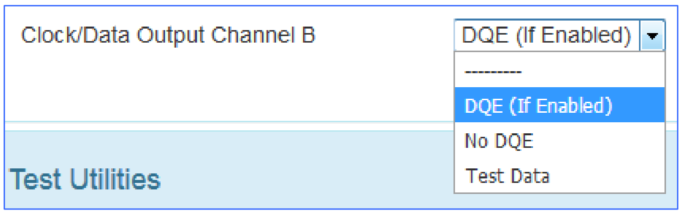


Figure 96: Output Controls, Clock/Data Output Channel B

5.4.15 Test Utilities

The Test Utilities selections, accessed via the Advanced Menu, as shown in Figure 97, provide access to the following options:

- Noise Generator
- Data Generator
- BERT

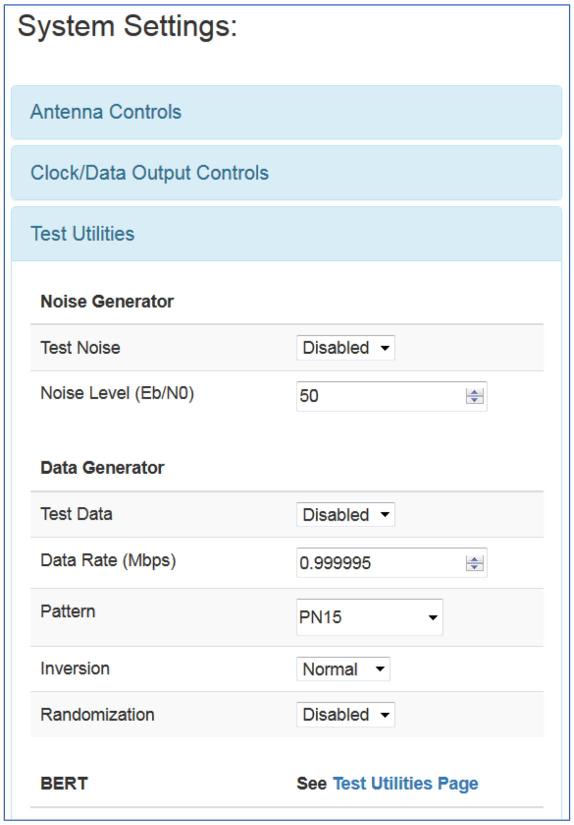


Figure 97: System Settings, Test Utilities

5.4.15.1 Noise Generator

The Noise Generator selection, shown in Figure 98, optionally sums AWGN (Additive White Gaussian Noise) with the received signal to achieve the desired E_b/N_0. Since the bit error rate of an ideally modulated signal at any given E_b/N_0 is known and should be readily reproducible, the Noise Generator may be used to verify transmitter or receiver RF integrity. Two parameters are available: Test Noise and Noise Level.

- Test Noise - Enables or disables the AWGN generator, as shown in Figure 98

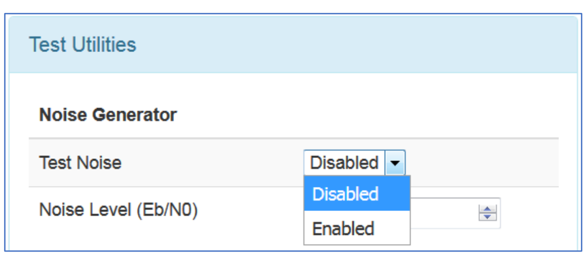


Figure 98: Test Utilities, Noise Generator-Test Noise Drop Down Menu

- Noise Level -Sets the noise level to use in the test in dB E_b/N_0, as shown in Figure 99

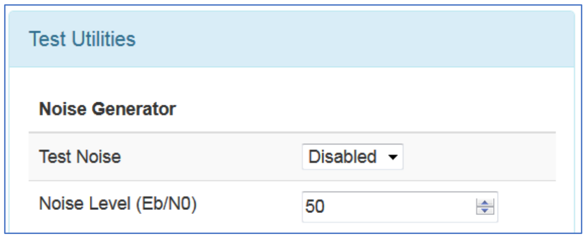


Figure 99: Test Utilities, Noise Generator-Noise Level Selection

5.4.15.2 Data Generator

The Data Generator option, shown in Figure 100, allows the user to generate data patterns at a settable data rate. This data may be used as known source data for system testing, including transmitter or receiver RF integrity verification. Optionally, the user may invert data, or add randomization. The available parameters are Test Data, Data Rate, Pattern, Inversion, and Randomization.

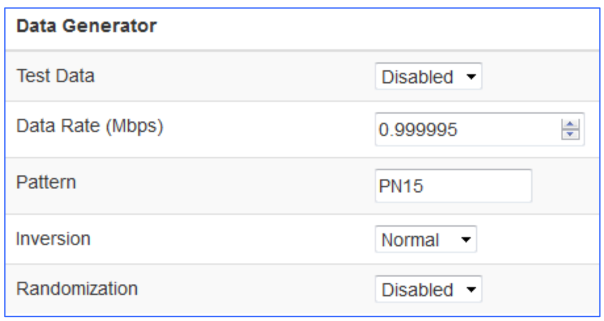


Figure 100: Test Utilities, Data Generator

- Test Data – Enable or disable test data generation, as shown in Figure 101

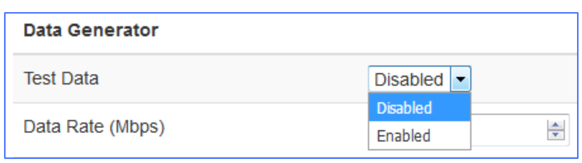


Figure 101: Data Generator, Test Data Drop Down Menu

- Data rate in Mbps – Typing a number in this field sets the data rate in Mbps, as shown in Figure 102

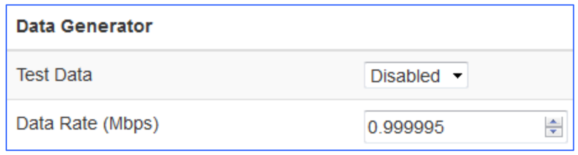


Figure 102: Data Generator, Data Rate Selection

- Pattern – Sets the data pattern produced by the data generator, as shown in Figure 103; This may be a fixed pattern or a pseudorandom pattern that repeats based on the chosen pattern/sequence (a shorter pattern looks more regular, a longer pattern looks more random)
    - PN6 - Pseudorandom pattern 2^6-1 bits in length
    - PN9 - Pseudorandom pattern 2^9-1 bits in length
    - PN11 - Pseudorandom pattern 2^{11}-1 bits in length
    - PN15 - Pseudorandom pattern 2^{15}-1 bits in length
    - PN17 - Pseudorandom pattern 2^{17}-1 bits in length
    - PN20 - Pseudorandom pattern 2^{20}-1 bits in length
    - PN23 - Pseudorandom pattern 2^{23}-1 bits in length
    - PN31 - Pseudorandom pattern 2^{31}-1 bits in length
    - User defined
        - User Defined – A unique binary pattern, between 2 and 32 bits, specified by the person running the test; only available when Pattern is "User Defined"

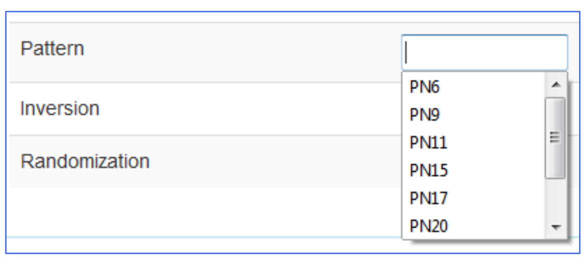


Figure 103: Data Generator, Pattern Selection

- Inversion – Set to Normal or Inverted, as shown in Figure 104; when Inverted the data stream is inverted; useful for patterns that are defined as inverted by certain standards, or to compensate for an inversion elsewhere in the system

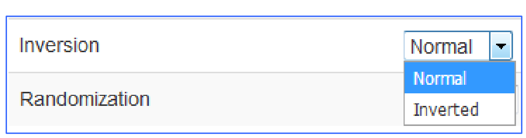


Figure 104: Data Generator, Inversion Drop Down Menu

- Randomization – Enable or disable IRIG 106 15-bit randomization, as shown in Figure 105; *not recommended for PN15 data*, due to potential conflict between the sequence generator and the randomizer, both of which are based on the same generator polynomial

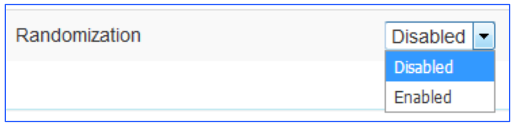


Figure 105: Data Generator, Randomization Drop Down Menu

5.4.15.3 BERT

The Bit Error Rate Tester (BERT) option, shown in Figure 106, allows the user to measure system performance. It does this by comparing received data to a specified data pattern and counting the ratio of errored bits to total received bits. This may be useful for various forms of system testing, including transmitter or receiver RF integrity verification. The Browser provides the ability to set BERT parameters and access BERT status information.

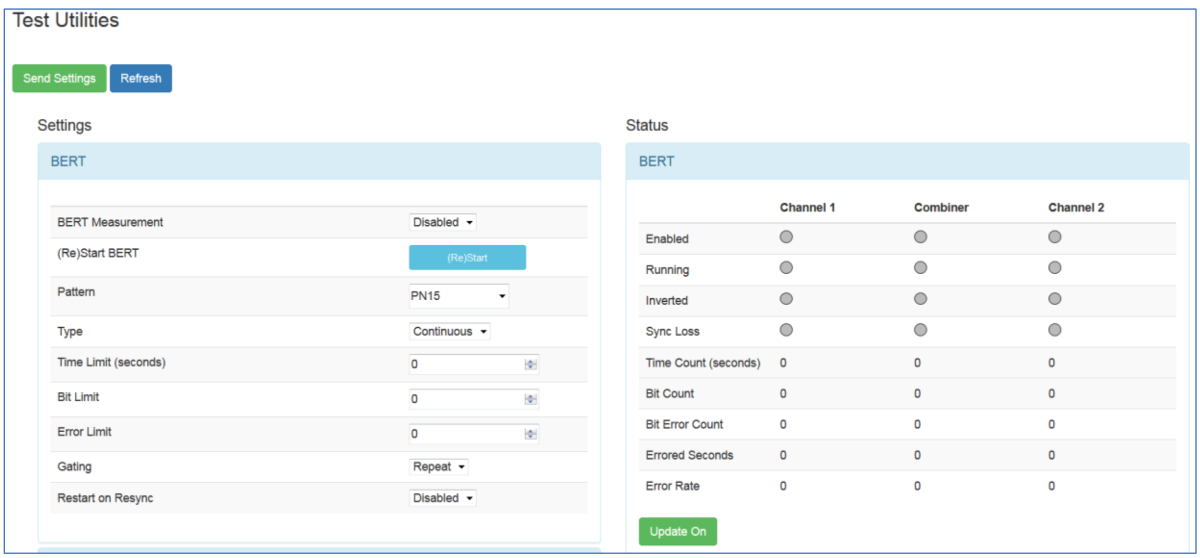


Figure 106: Test Utilities, BERT

5.4.15.3.1 BERT Settings

The available BERT settings are: Measurement, (Re)Start BERT, Pattern, Type, Time Limit (s), Bit Limit, Error Limit, Gating, and Restart on Resync. Each setting is described in this section.

- Measurement – Enables or disables Bit Error Rate (BER) measurement

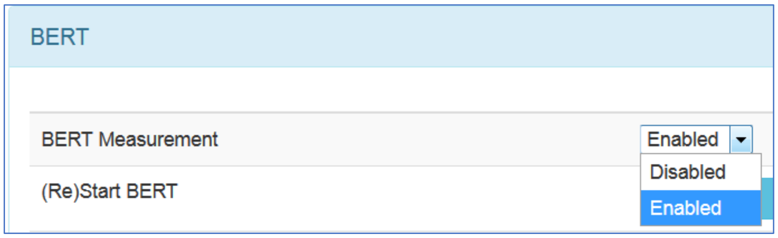


Figure 107: BERT, BERT Measurement Drop Down Menu

- (Re)Start BERT – Starts (or restarts) the (BER) test measurement with an error count and total bit count of zero; indicates whether a measurement is currently running or stopped

Figure 108: BERT, ReStart BERT Button

- Pattern – Sets the data pattern used by the bit error rate test; This may be a fixed pattern or a pseudorandom pattern that repeats based on the chosen pattern/sequence (a shorter pattern looks more regular, a longer pattern looks more random)
  - PN6 – Pseudorandom pattern 2^6-1 bits in length
  - PN9 – Pseudorandom pattern 2^9-1 bits in length
  - PN11 – Pseudorandom pattern 2^{11}-1 bits in length
  - PN15 – Pseudorandom pattern 2^{15}-1 bits in length
  - PN17 – Pseudorandom pattern 2^{17}-1 bits in length
  - PN20 – Pseudorandom pattern 2^{20}-1 bits in length
  - PN23 – Pseudorandom pattern 2^{23}-1 bits in length
  - PN31 – Pseudorandom pattern 2^{31}-1 bits in length
  - User Defined
    - User Defined – A unique binary pattern, between 2 and 32 bits, specified by the person running the test; only available when Pattern is “User Defined”

Figure 109: BERT, Pattern Drop Down Menu

- Type – Selects the BERT measurement type—Continuous or Limited; Limited tests automatically complete when the selected time limit, total bit limit, or errored bit limit is reached

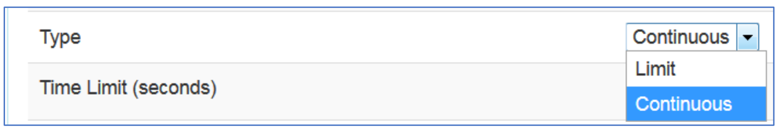


Figure 110: BERT, Type Drop Down Menu

- Time Limit (s) – (in seconds) – Sets a specific time limit for the BER measurement; the measurement completes when the time limit has elapsed

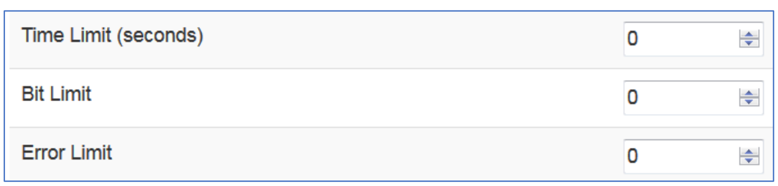


Figure 111: BERT-Time, Bit, and Error Limit Selections

- Bit Limit – Sets a specific number of total received bits, as shown in Figure 111; the measurement completes when the selected number of bits has been received
- Error Limit – (Bits) – Sets a specific number of bit errors, as shown in Figure 111; the test completes when the selected number of errored bits has been received
- Gating –Selects the action that occurs when the current measurement completes, as shown in Figure 112; this can be to stop, or to run a new measurement
    - Single – Runs the BER measurement one time based on programmed limits
    - Repeat – Runs the BER measurement until it reaches programmed limits, then repeats the measurement

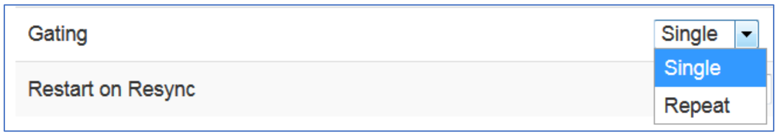


Figure 112: BERT, Gating Drop Down Menu

- Restart on Resync – When enabled, automatically clears the bit count and errored bit count to zero whenever the BERT loses pattern sync; this effectively restarts any measurement that may be inaccurate due to BERT synchronization loss

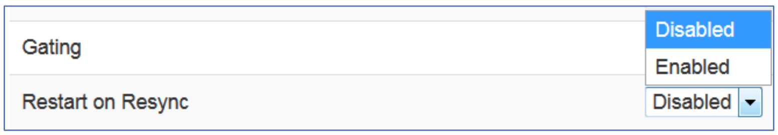


Figure 113: BERT, Restart on Resync Drop Down Menu

5.4.15.3.2 BERT Measurement Status

BERT Status is only available via the Test Utilities screen in the Browser. The Status information, shown in Figure 114, displays measurements for Channel 1, Channel 2, and the Combiner (if enabled) when a BER test is running.

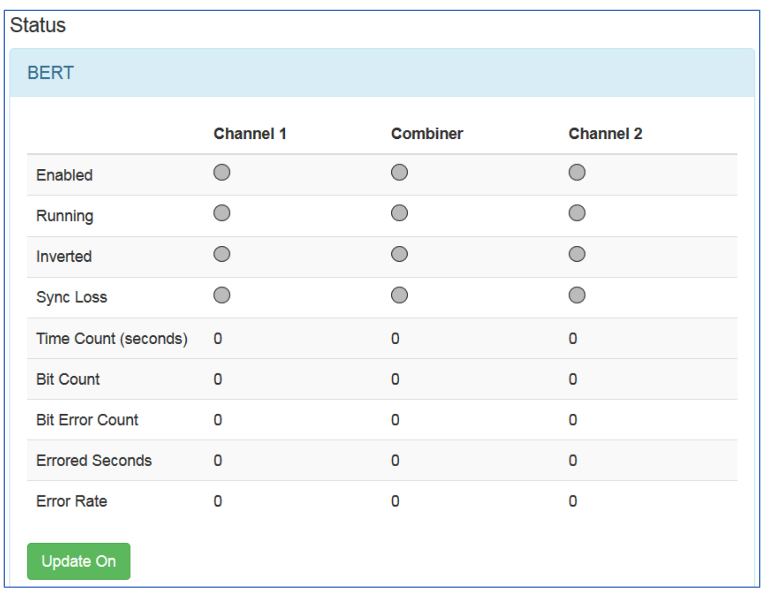


Figure 114: Test Utilities, BERT Status

Colored indicators are always grey when inactive, or an associated color during a test. The status display continually updates for the duration of a BER test.

- Enabled – Green when enabled

- Running – Green when running
- Inverted – Yellow if inverted
- Sync Loss – Red when sync loss occurs
- Time Count (seconds) – Time in seconds since starting or restarting the current BER test
- Bit Count – Number of bits passed during BER test
- Bit Error Count – Number of errored bits
- Errored Seconds – Number of seconds during the test in which errors occurred
- Error Rate – Bit error rate in scientific notation
- Update On/Off button – Freezes the state of the Status window for easy viewing, but the test continues to run as prescribed in the BERT Settings (limited or continuous)

An example of the Status screen when a BER test is running with bit errors is shown in Figure 115.

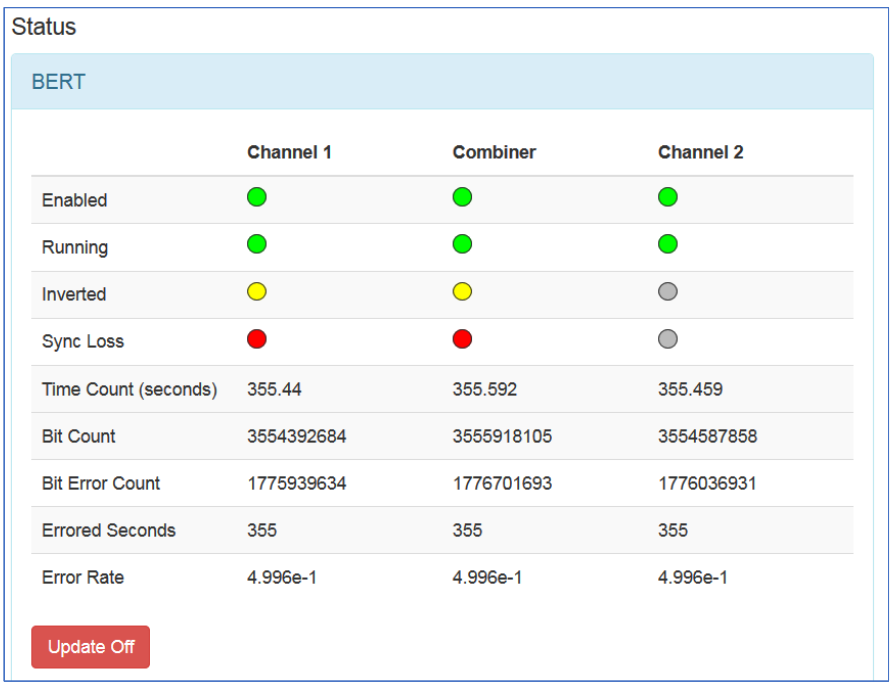


Figure 115: Test Utilities, Status During BER Test

5.4.16 Zero AGC Button

Automatic Gain Control (AGC) may be set to zero (0) by clicking on the green Zero AGC button in the Advanced section, shown in Figure 116. One or two buttons are available depending on the number of channels and the combiner mode.

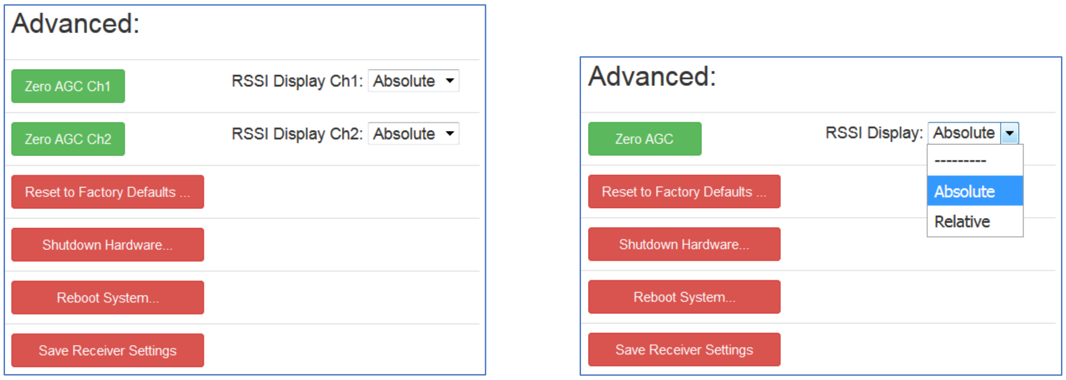


Figure 116: Advanced Buttons, Zero AGC Button, Separate Channels or Combiner Active

Zero AGC is used to set a baseline for background radio noise levels. A typical application of the AGC Zero function is explained in the following example.

a. Connect the receiver to its normal RF signal source, such as antenna, LNA, cabling, and splitters.

b. Orient the receiving antenna in a direction that is expected to yield the lowest signal level that the receiver is likely to encounter.

c. Activate AGC Zero under this condition by clicking on the Zero AGC button.

The AGC output voltage is set to zero volts DC at a time when the receiver input is at its minimum value. This process ensures that the AGC output voltage will not cross through zero volts DC under normal operation.

To confirm AGC Zero, view the Monitor screen Signal Strength bar graph. If AGC is not zero, the graph is grey and there is no AGC Zero value displayed, as shown in Figure 117. When AGC is zero, the bar graph is not grey and the AGC Zero value is displayed, as shown in Figure 118.

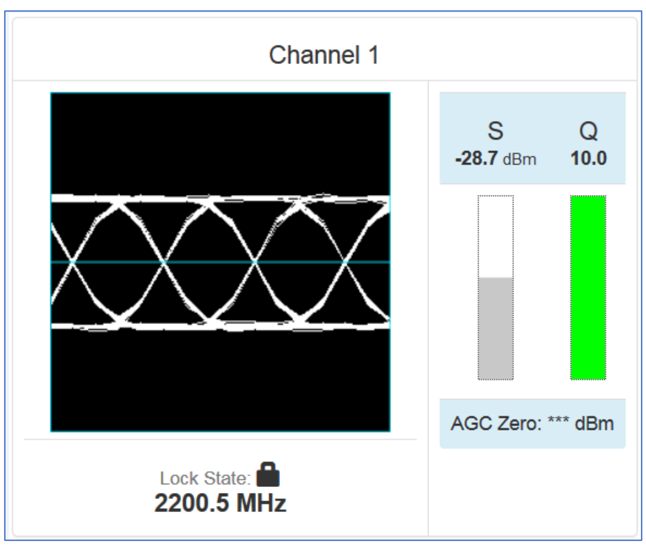


Figure 117: Monitor Screen, Signal Strength Grey – AGC Not Zero

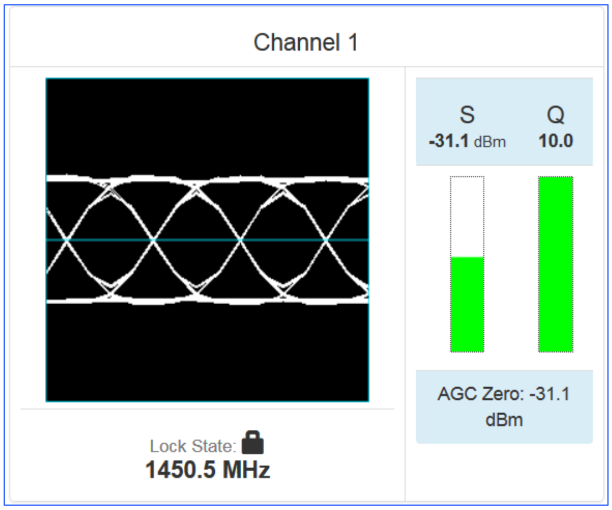


Figure 118: Monitor Screen, Signal Strength Not Grey – AGC Zero Value Displayed

5.4.16.1 RSSI Display

The RSSI display has two modes depending on the option selected in the RSSI Display drop down menu, shown in Figure 116.

If "Absolute" was the RSSI Display selection for the channel, the actual signal strength is displayed.

If "Relative" was selected, the RSSI displayed is relative to AGC Zero. The following bullets apply to RSSI Relative:

- A value of zero indicates no input signal
- A value above zero indicates how strong the signal is above no input
- "*** dBm" displayed (Figure 21) indicates AGC is not zeroed and the value is invalid
- A small "r" displayed next to the Signal Strength label indicates AGC Zero Relative was selected

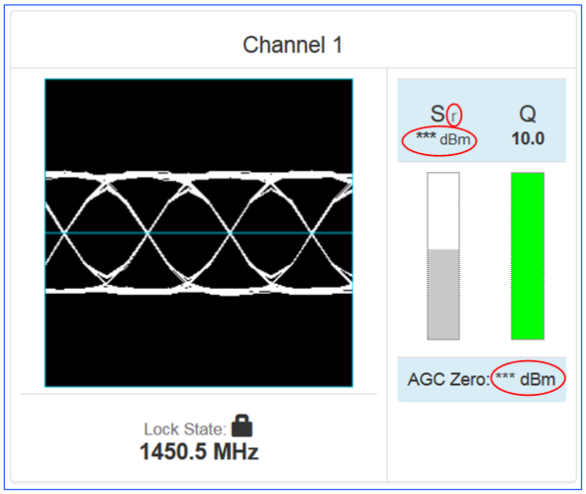


Figure 119: Signal Graph and Signal Indicators Windows, Zero AGC RSSI Display "Relative"

5.4.17 Reset to Factory Defaults Button

The Reset to Factory Defaults button, shown in Figure 120, sends a command to reset the RDMS hardware to factory default settings. During the process, the Browser Interface is temporarily unavailable. Note: This does not reset the RDMS IP address.

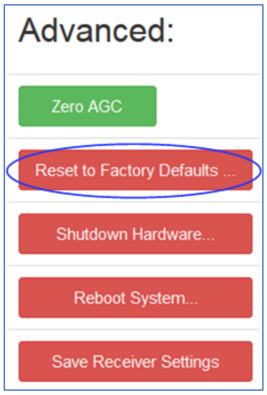


Figure 120: Advanced Buttons, Reset to Factory Defaults Button

5.4.18 Shutdown Hardware Button

The Shutdown Hardware button, shown in Figure 121, sends a command to prepare the RDMS hardware for the removal of power. All current receiver settings are saved to ensure the subsequent startup restores the receiver's state. *Remote access is disabled when this action is performed.* There is no remote command to restart the hardware. Power must be removed and reapplied.

If the user intends to immediately restart the RDMS, it is important to wait until the indication that the unit is offline is received. This takes about 30 seconds, and is typically indicated by an "Unable to connect" message in the browser.

To restart the RDMS, perform the following action, depending on your installation:

Remove power, then reapply using a remotely controllable power source, such as a network controlled power strip

Figure 121: Advanced Buttons, Shutdown Hardware Button

5.4.19 Reboot System Button

The Reboot System button, shown in Figure 122, enables a remote user to perform a shutdown/power up on a receiver.

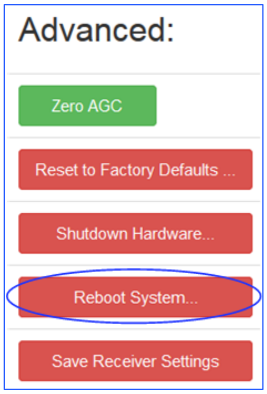


Figure 122: Advanced Buttons, Reboot System Button

5.4.20 Save Receiver Settings Button

The Save Receiver Settings button, shown in Figure 123, saves the current RDMS parameters. For example, the user may have changed a variety of parameters since the last shutdown/power up of the receiver and does not want to lose the settings in the event of a power outage. It is similar to saving a preset, but instead of saving the settings to a preset and recalling the preset, the current settings are just saved. If power is lost to the receiver, the saved settings are still set upon power up.

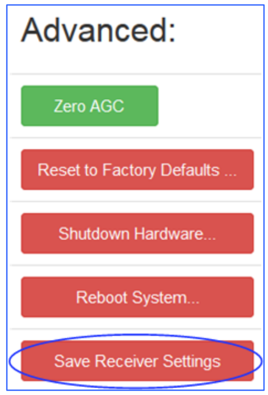


Figure 123: Advanced Buttons, Save Receiver Settings Button

5.5 Presets

The Presets functionality is accessed via the Presets option on the Tool bar, as shown in Figure 124.

Figure 124: Presets Option on Tool Bar

5.5.1 Save Presets

Accessed from the Presets option in the Tool Bar, Saved Presets screen, shown in Figure 125, allows the user to save and load settings stored on the RDMS™ receiver. Closeups of the right and left side of the Presets screen are shown in Figure 126 and Figure 127.

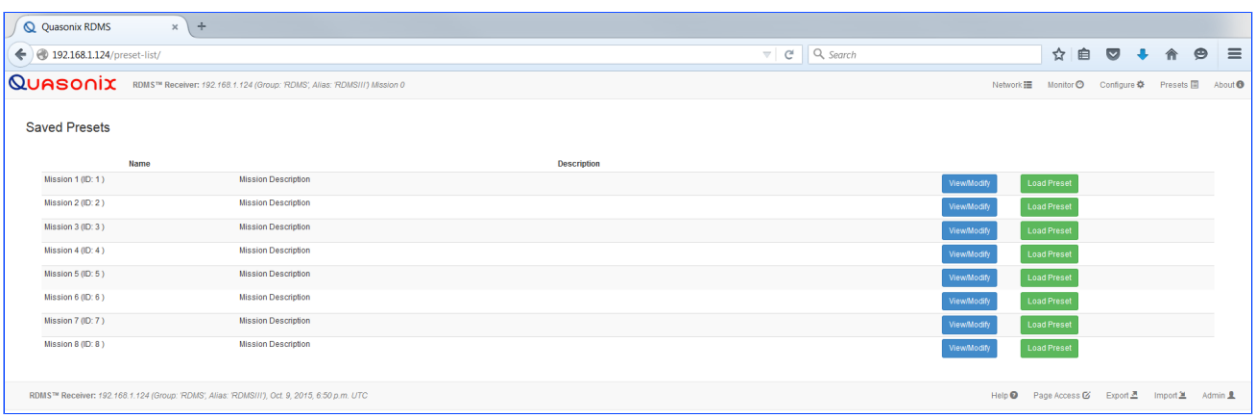


Figure 125: Presets Screen

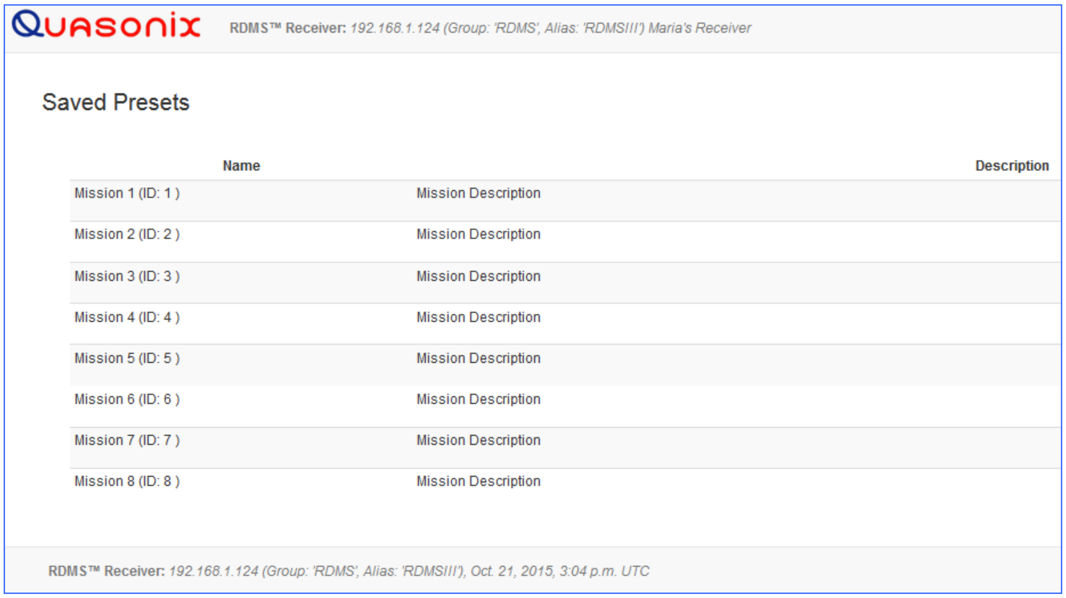


Figure 126: Presets Screen, Closeup of Left Side

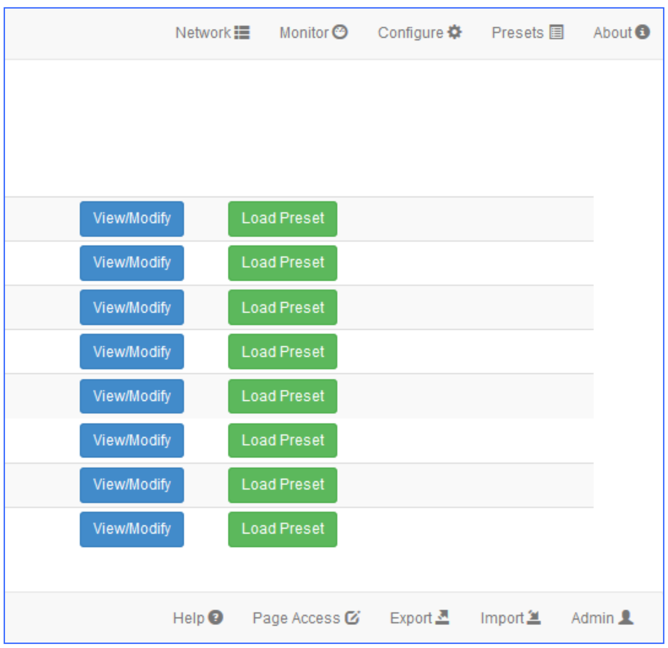


Figure 127: Presets Screen, Closeup of Right Side

The Saved Presets screen contains a list of eight (8) saved setup files. Files are accessed by clicking on the View/Modify button next to the desired preset.

When the user clicks on a View/Modify button, the Preset: View or Modify Preset screen opens, as shown in Figure 128. The contents and layout of this screen is similar to the Configure screen.

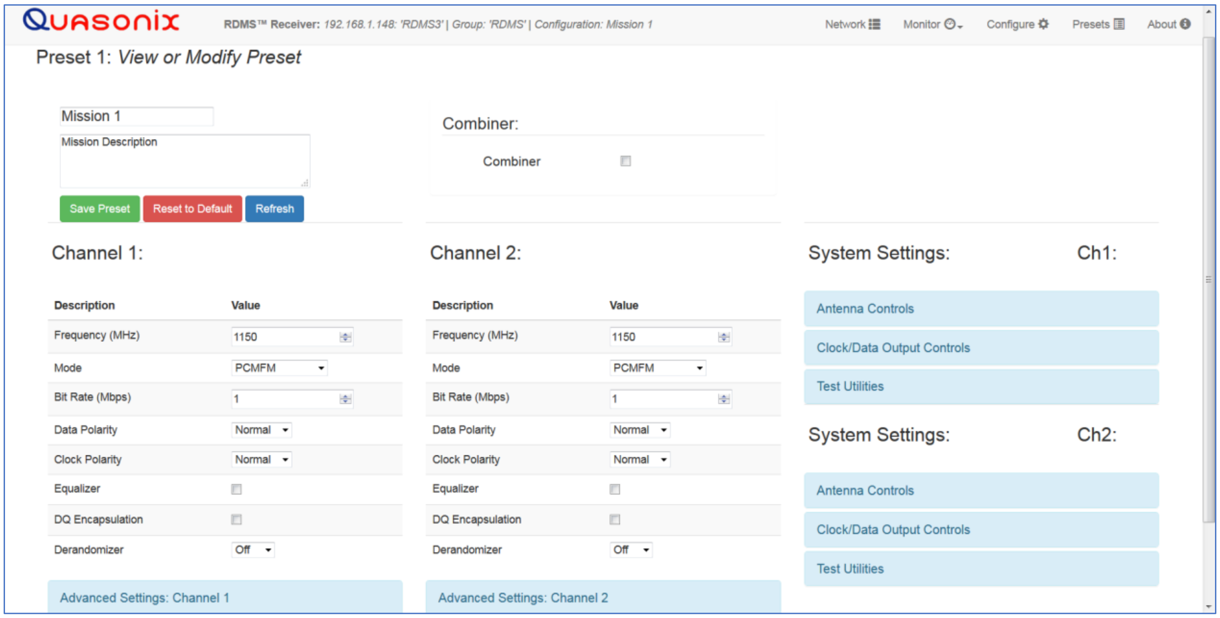


Figure 128: Preset: View or Modify Preset Screen

Type a name for the new preset file along with the desired description in the Preset Name and Preset Description fields as shown in Figure 129. Changing the name and description are not required but customizing them provides immediate recognition for the user. It also helps to eliminate confusion when changing an existing preset.

Preset names are limited to 20 alphanumeric characters, dots, dashes, and spaces.

Figure 129: Preset: View or Modify Preset Screen, Preset Name and Description Fields

The settings can be configured by clicking on a check box (to enable or disable an option), clicking on a drop down menu and making a selection, or, in the case of Frequency and Bit Rate, typing the number directly or using up/down scroll arrows to select the desired value. *New options are provided to the user when certain options are selected*, for example, Frequency Diversity and Time Aligner are only available after Combiner is enabled *and saved*.

If all of the settings are configured as desired, click on the green Save Settings button. If the configuration must be modified, select or deselect settings until the desired configuration is achieved, or click on the Refresh button to erase the changes and redisplay the original settings. Then click on the Save Settings button.

To save the current configuration as a preset, click on the Save as a Preset button in the Browser Interface *Configure screen*.

A "successfully saved" message displays in the Message bar, as shown in Figure 130.

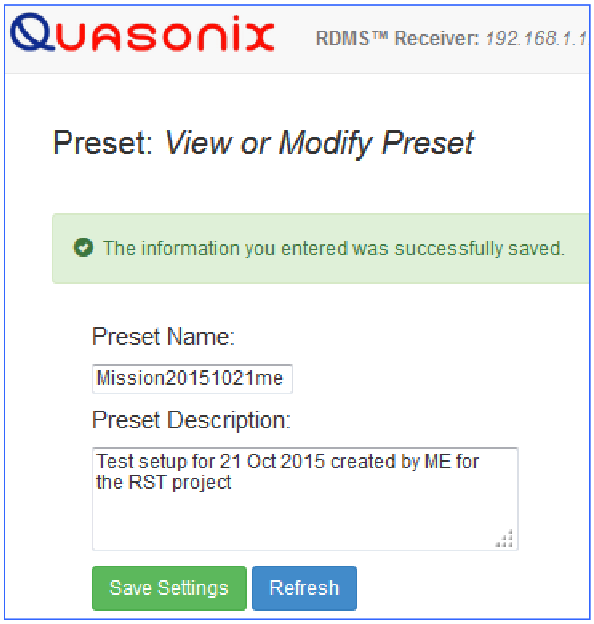


Figure 130: Preset: View or Modify Preset Screen, Information Successfully Saved Message

When the user clicks on the Presets option in the Menu bar, the Saved Presets screen displays clearly showing the new preset, as shown in Figure 131.

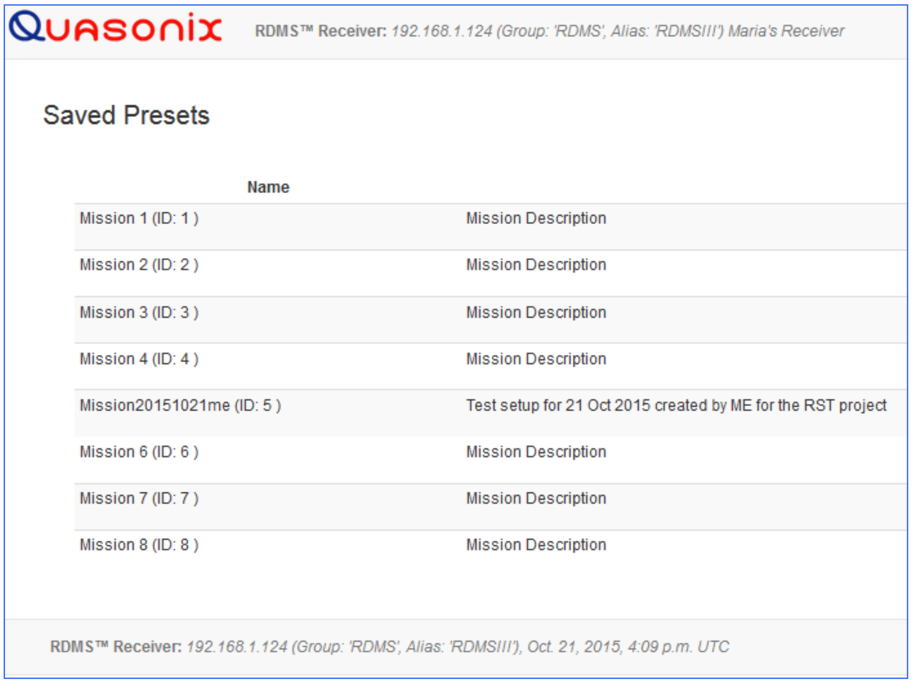


Figure 131: Saved Presets Screen with New Preset Added

To clear the preset and revert to the default settings for that preset, click on the Reset to Default button. The preset name field now displays "Default" to indicate the change took place. This is shown in Figure 132.

Figure 132: Preset: View or Modify Preset Screen, Preset Name Set to Default

5.5.2 Load Presets

Loading a preset configuration is a quick way to set up an RDMS™ with specific settings. The RDMS™ has eight (8) default configurations pre-loaded and ready to use on the receiver. As shown in the previous section, the user may set up and save other configurations for later reuse.

To load a preset, click on the Presets option on the Tool bar, as shown in Figure 133.

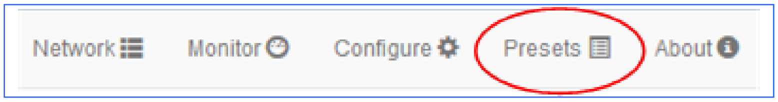


Figure 133: Presets Option on Tool Bar

When the Saved Presets screen displays (Figure 134), click on the green Load Preset button on the line containing the desired preset.

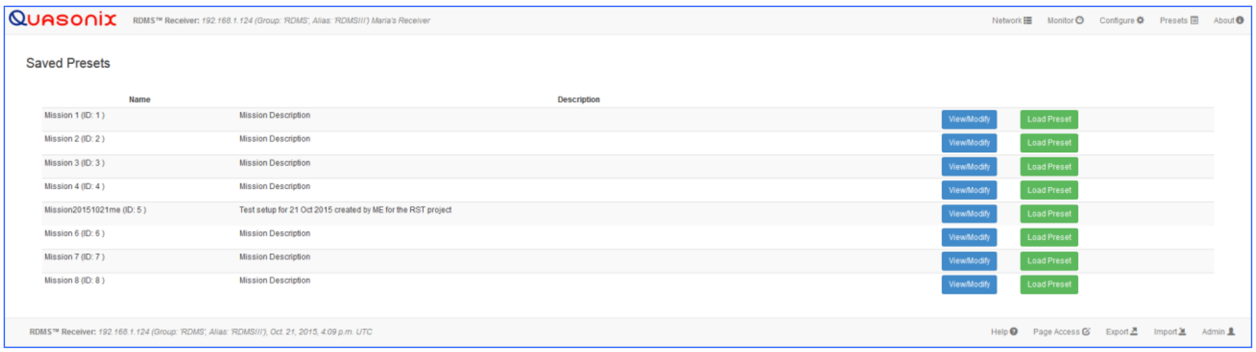


Figure 134: Presets Screen

5.6 About

To access the System Information screen, click on the About option on the Tool bar, as shown in Figure 135.

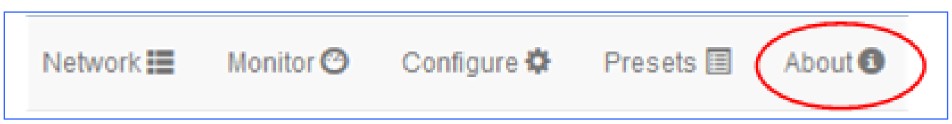


Figure 135: About Option on Tool Bar

In addition to displaying the system information, this screen is also used to add a Rack Alias, if desired. Type a new name into the Rack Alias field, as shown in Figure 137, then click on the Rename button.

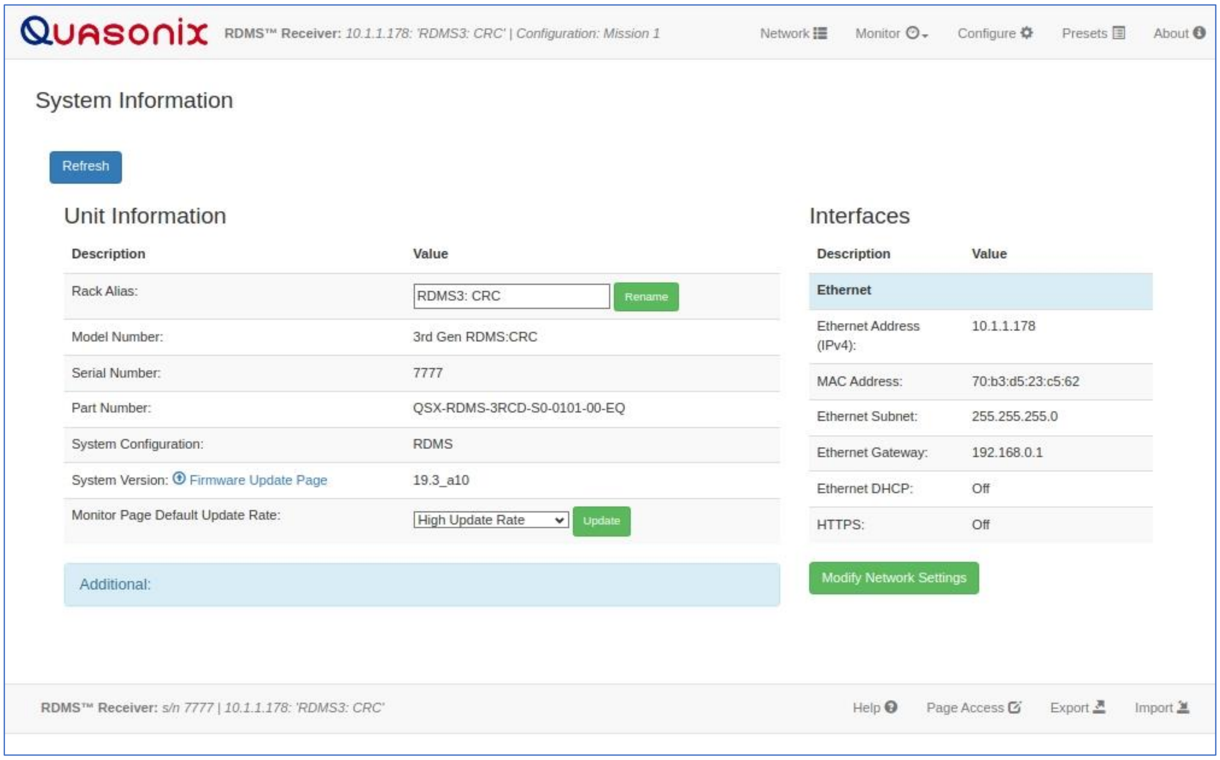


Figure 136: System Information Screen

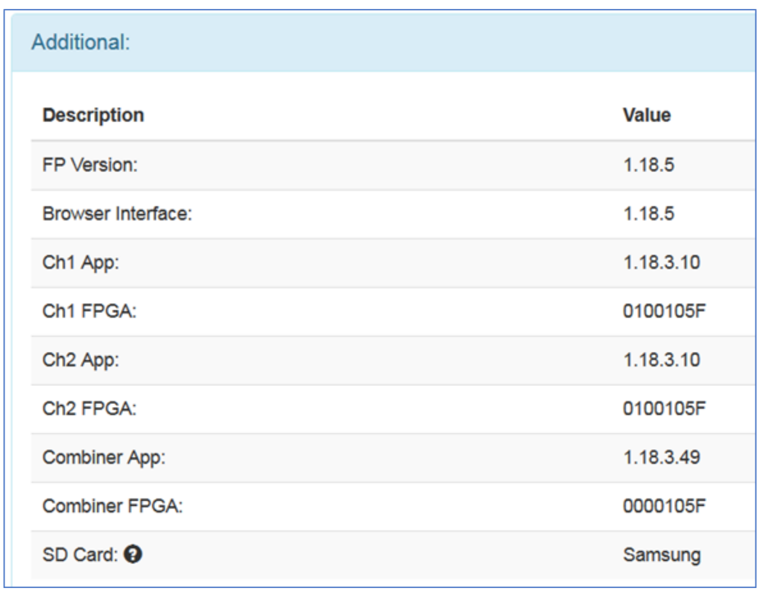


Figure 137: System Information Screen, Additional Information

5.6.1 Firmware Updates

The CRC supports a remote Firmware Update via the browser interface. This feature relies on an encrypted and signed firmware update file provided by Quasonix upon release.

To perform a network update:

1. Obtain a firmware update file from Quasonix.
2. Using a web browser, navigate to the About page of the RDMS Browser Interface, as shown in Figure 138.

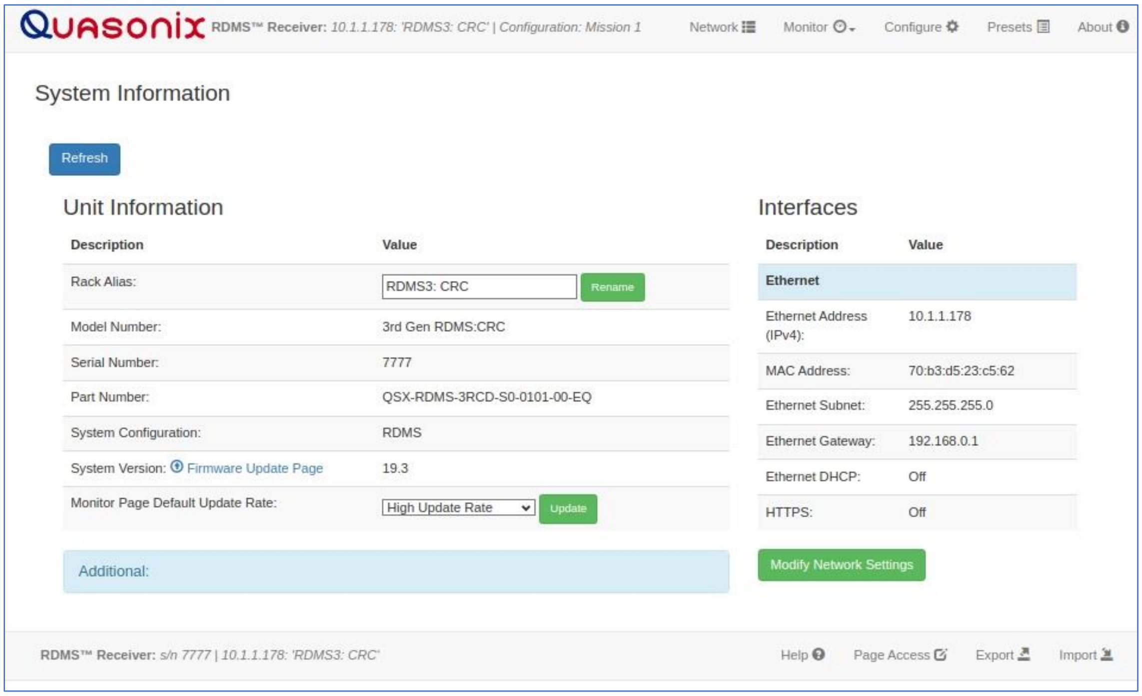


Figure 138: Browser Interface, About

3. Next to the System Version parameter, click on the Firmware Update Page link, as shown in Figure 139

Figure 139: About, System Version, Firmware Update Link

4. On the Firmware Update screen, review the Procedure and Notes, as shown in Figure 140.
5. Click on the Browse button to select the update file provided by Quasonix.

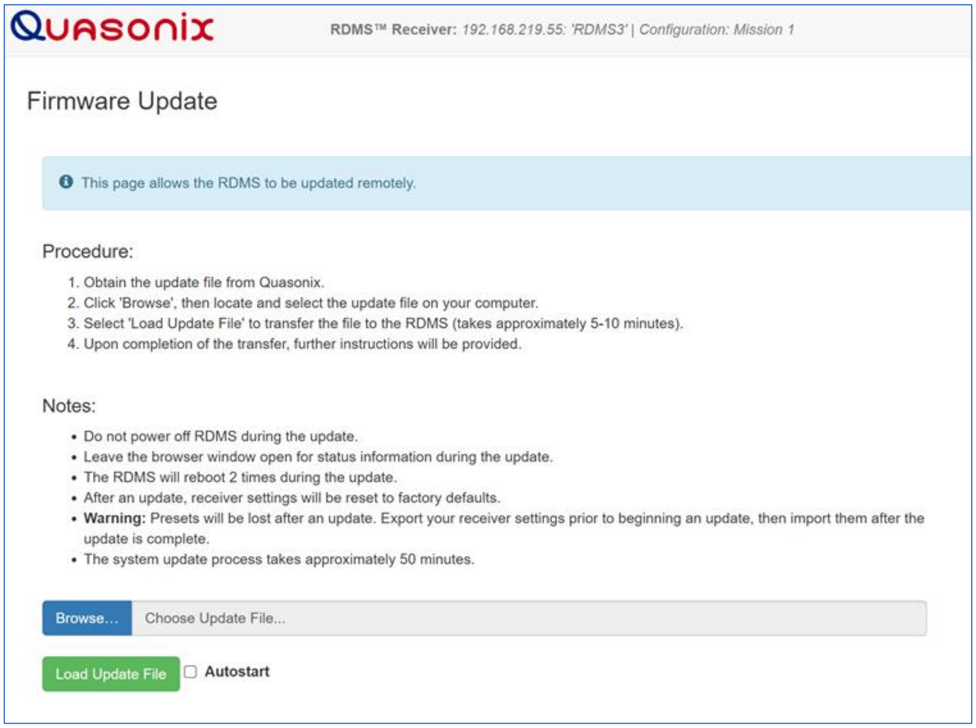


Figure 140: Firmware Update, Procedure and Notes

6. After the selected filename displays, click on the Load Update File button to transfer the file to the RDMS. **Note:** Autostart may be selected before clicking on the Load Update File button to automatically start the update process after the upload is complete. Click on the Autostart check box to select.

   The upload process takes about 5-10 minutes, depending on network speed. Upload status is shown in Figure 141.

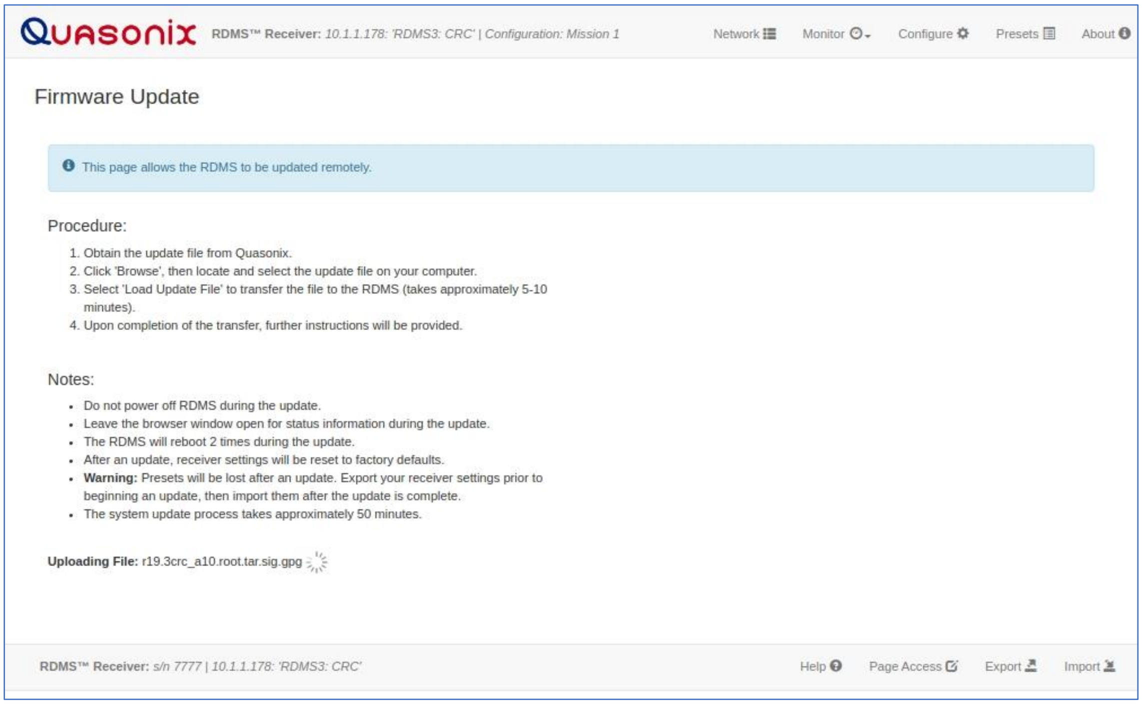


Figure 141: Firmware Update, Upload Status

7. After the file has been transferred, review the updated Notes, as shown in Figure 142.
8. Click on the Begin Update button to start the update. **Note:** If Autostart was selected previously, this step is automated. No further input is required unless an error is encountered.

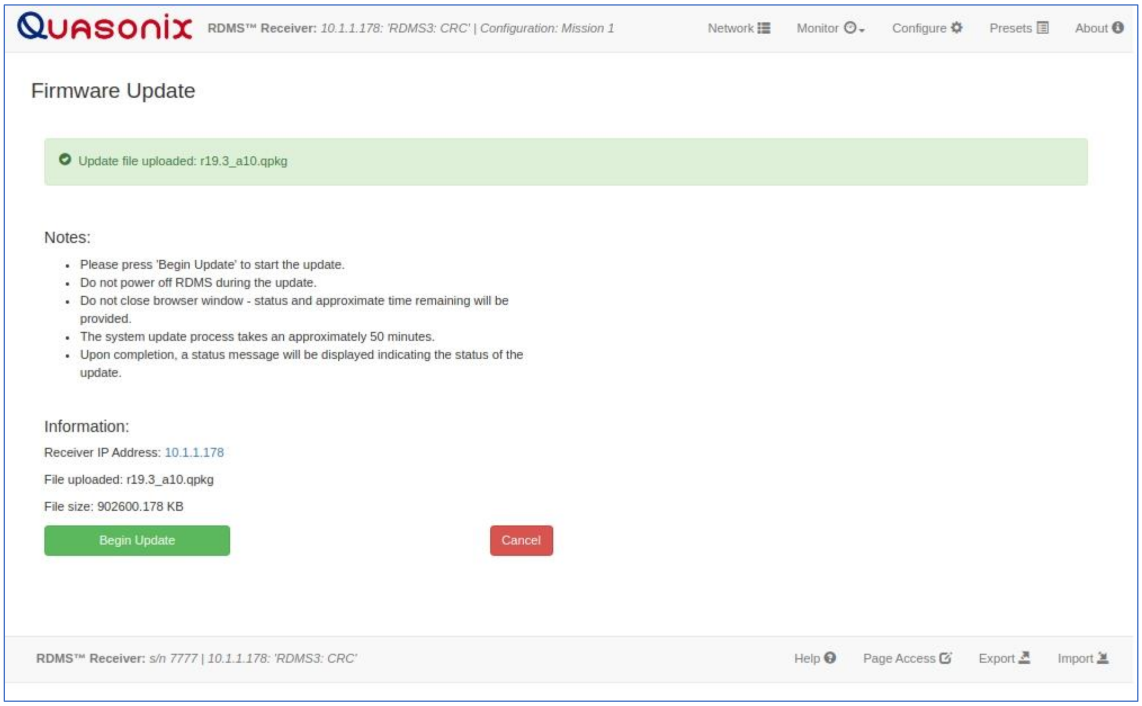


Figure 142: Firmware Update, File Selected—Ready to Update

- Do not power off the RDMS during the update
- Do not close the browser window during the update
- During the update, the status and approximate time remaining will display, as shown in Figure 143.

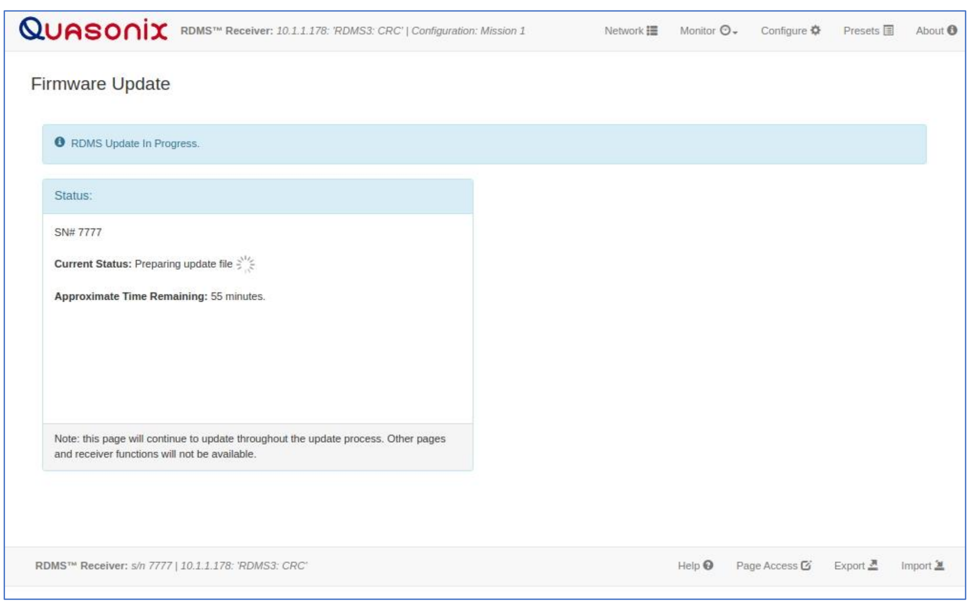


Figure 143: Firmware Update In Progress, Status

The RDMS will reboot twice during the update.

9. Upon completion, a message displays indicating the RDMS Update has completed, as shown in Figure 144.

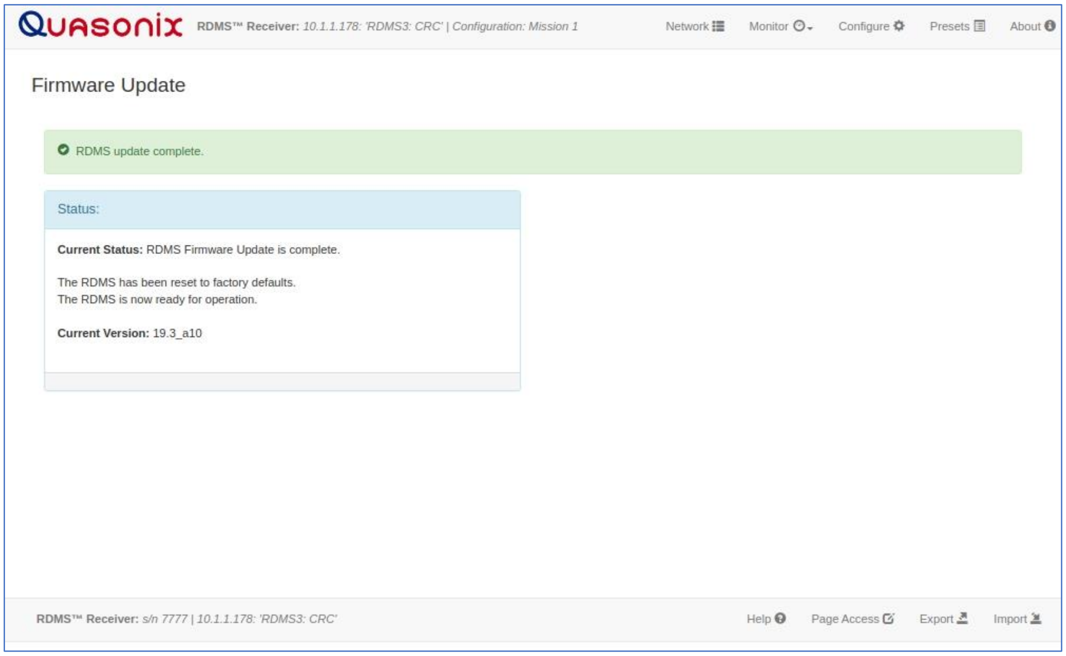


Figure 144: Firmware Update Complete

Following the update, the RDMS returns to normal operating mode and all parameters are reset to system defaults.

10. Navigate to the About screen, as shown in Figure 145, to verify that the System Version matches the firmware update version.

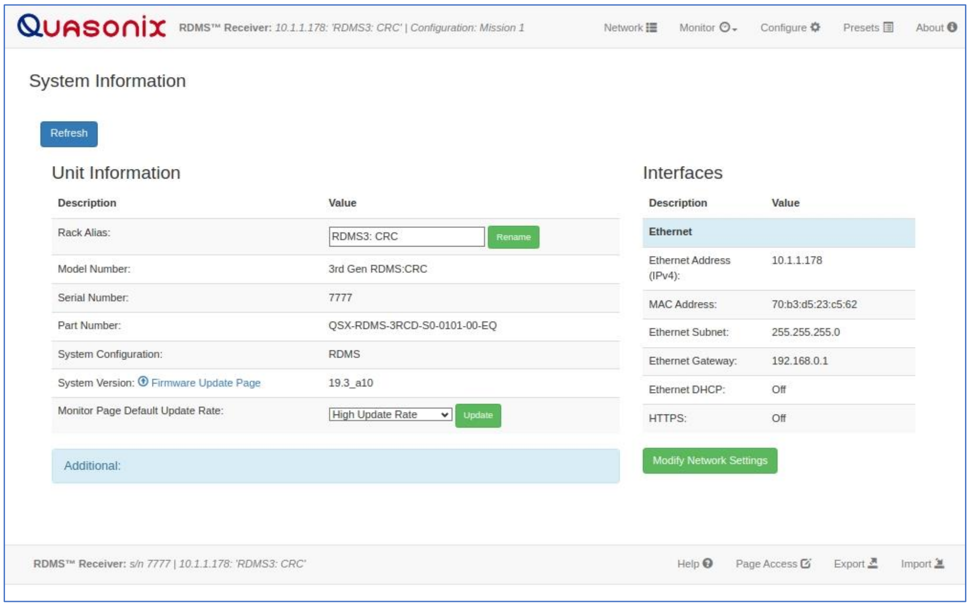


Figure 145: About Screen, System Information

If the update fails for any reason, an information screen displays, as shown in Figure 146. Follow the instructions on the screen to retry the update or return to normal RDMS operation. An error code is provided and should be noted for use in correspondence with Quasonix.

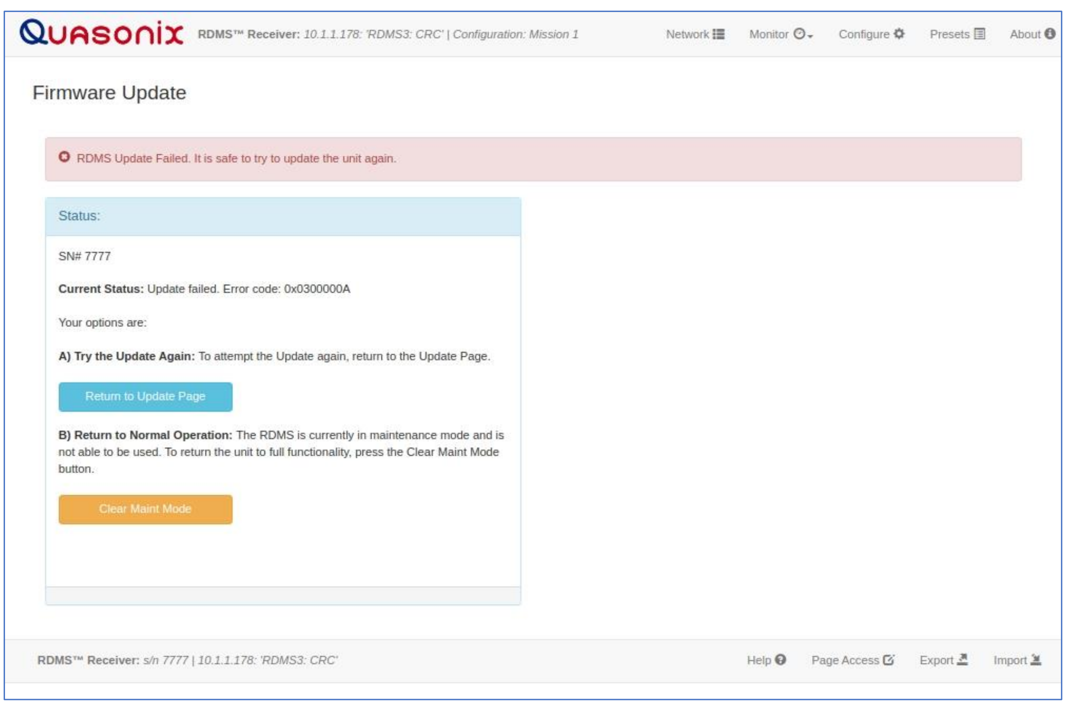


Figure 146: Firmware Update Failed Information Screen

5.6.2 Modify Network Settings

CRC network settings may be modified by the user. On the About screen >System Information, a green Modify Network Settings button displays under the Interfaces portion of the screen, as shown in Figure 147.

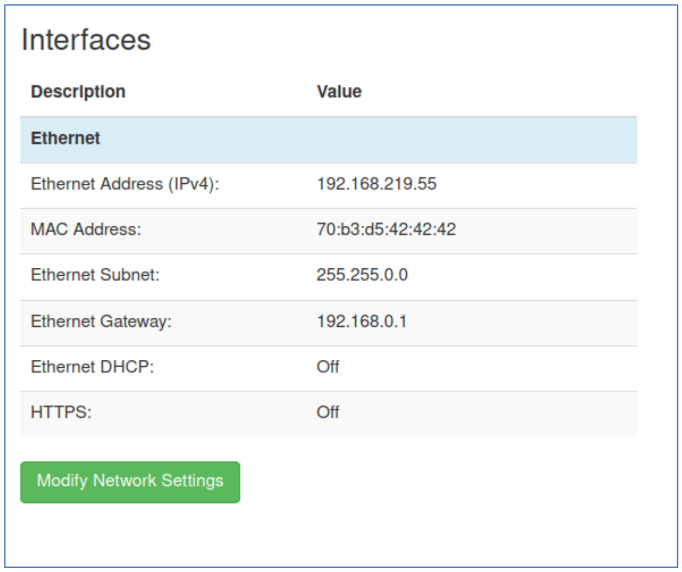


Figure 147: System Information Screen, Modify Network Settings Button

Click on the Modify Network Settings button to display the Network Settings Page, as shown in Figure 148.

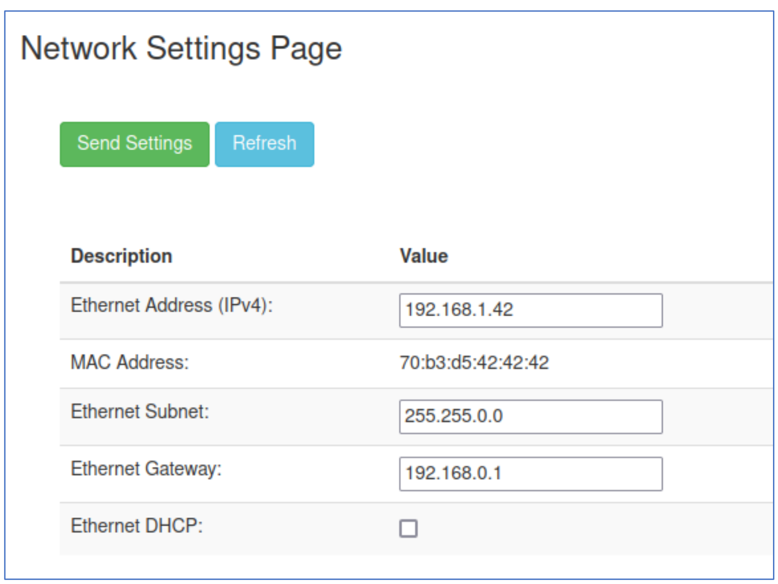


Figure 148: Network Settings Page

Users may change the Ethernet Address, Ethernet Subnet, or Ethernet Gateway by typing a new IP address in the associated field. Ethernet DHCP may be enabled or disabled by checking or unchecking the box next to the desired parameter.

Click on the Send Settings button to apply the new parameters.

5.6.3 Monitor Page Default Update Rate

The default receiver level update rate is set by a user from the About screen, Monitor Page Default Update Rate parameter, as shown in Figure 149. The drop down menu provides four update rate settings for all clients connected to the receiver. They are High, Medium, Low, and No Automatic Updates. This provides user control of the required bandwidth for client consumption.

If a rate selection is made, click on the Update button to save the change. A message displays to remind the user to manually restart the receiver. A system restart is required for the rate change to take effect.

Resetting to Factory Defaults does not affect this setting. Network bandwidth usage is roughly halved as you progress through each setting from High to Low. High Update Rate is the as-shipped default setting.

A user may change the frame reset rate temporarily at the client level. For more information, refer to the Monitor screen, Client Level Frame Rate explanation in section 5.2.5.

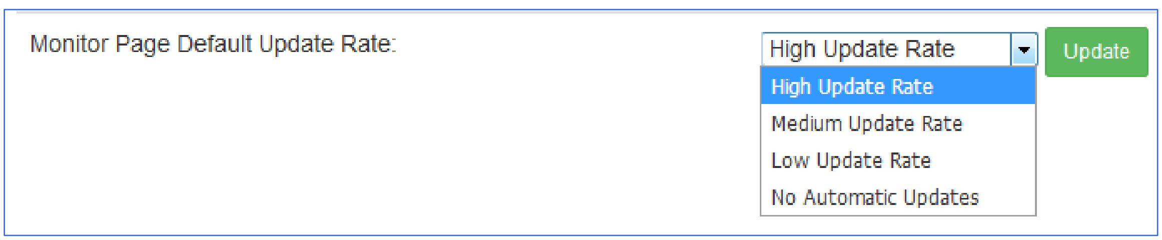


Figure 149: System Information Screen, Monitor Page Default Update Rate Field

5.7 Footer Tool Bar

The Footer Tool bar, shown in Figure 150, provides access to additional Browser Interface functionality.

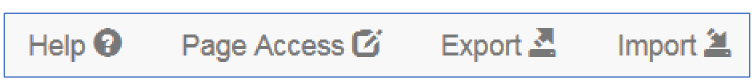


Figure 150: Browser Interface Footer Tool Bar

5.7.1 Help

The Help option on the Footer Tool bar, provides a link to the 3rd Gen Dual Channel Compact RDMS Receiver-Combiner Installation and Operation manual, an RDMS API User Guide, as well as contact information for Quasonix. The Help screen is shown in Figure 151.

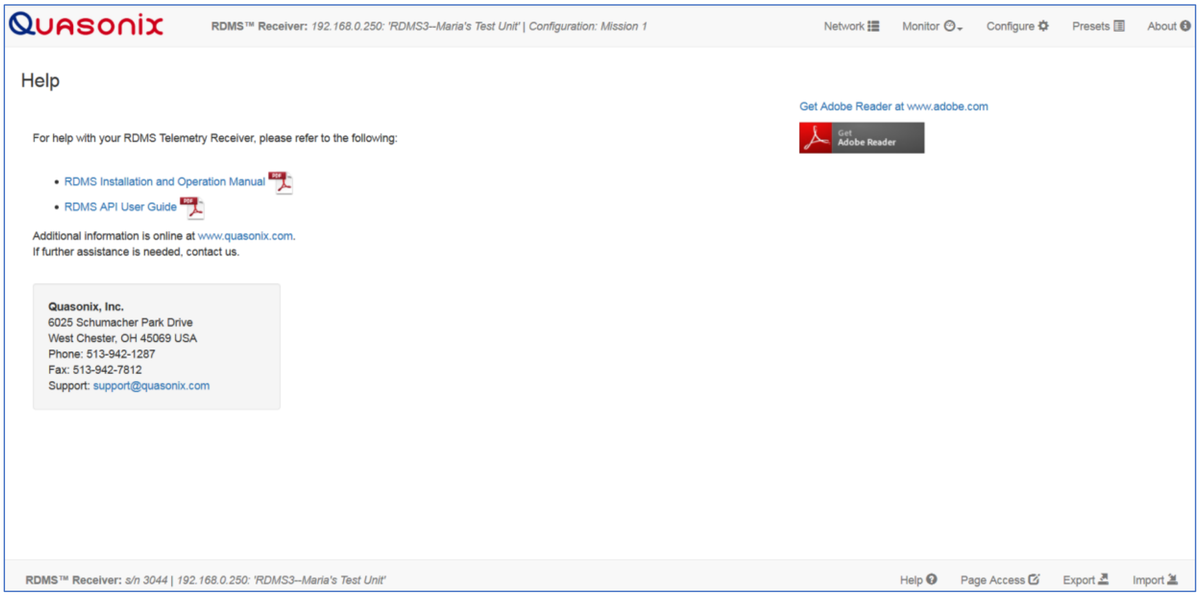


Figure 151: Help Screen

5.7.2 Page Access

The Page Access Management screen, shown in Figure 152, provides user feedback and control regarding configuration via multiple browser sessions that may be occurring on the receiver. As noted earlier, the 3rd Generation RDMS receiver uses a built-in web server to provide monitoring and control. Multiple users may access the receiver. To minimize configuration or control conflicts, the Browser Interface alerts users of potential conflicts. Users may choose to override controls to provide access to specific pages.

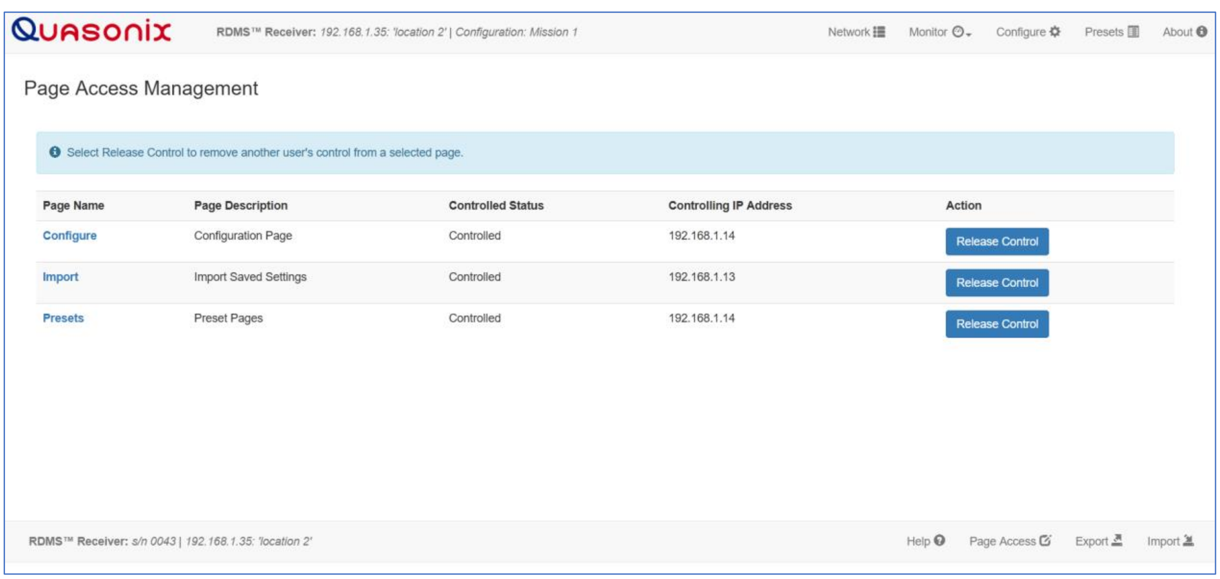


Figure 152: Page Access Management Screen

Users trying to access one of the browser screens, such as Configure, that was recently visited by another computer receive a Page Access Error message, as shown in Figure 153. The message provides a link to the Page Access Management screen so the user may review and release control as needed.

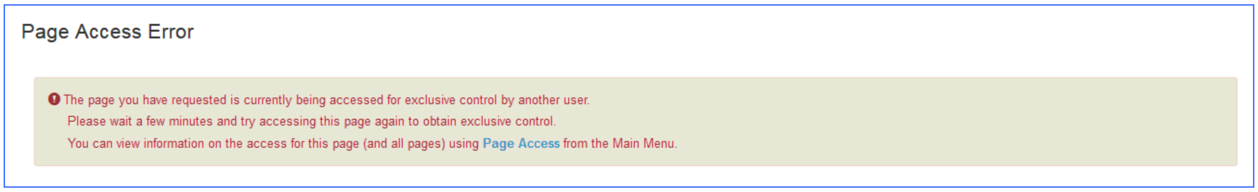


Figure 153: Page Access Error Message

5.7.3 Export

Export Configuration, shown in Figure 154, and Import Configuration provide a way for users to save and retrieve RDMS receiver settings and information. This functionality may be useful to provide a record of settings used during test missions, as a way to quickly switch between receiver setups, or as a way to backup the receiver settings. The files are saved locally, based on the browser's default settings, often the Downloads folder. These files may be moved or renamed as needed. Note, modifying the contents of the files is not recommended.

While in the Export Page, the user is able to select Current Receiver Settings, Saved Presets, and System Information by clicking on the check box associated with each option.

The Export Configuration button activates the download of the selected items into a single JSON type file that may be imported and read by the same, or other, RDMS Receivers.

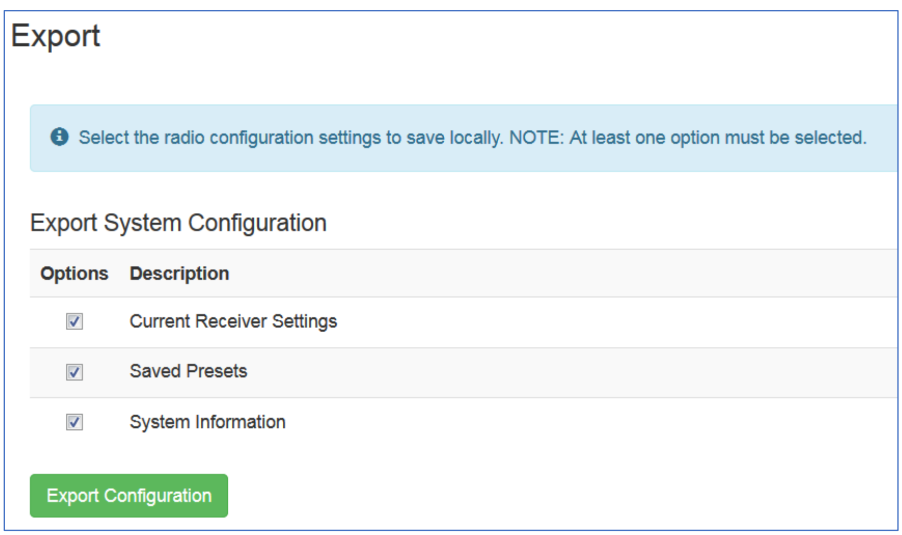


Figure 154: Export Configuration Screen

5.7.4 Import

The Import Configuration screen, shown in Figure 155, is used to import files that were previously exported (as described in the previous section).

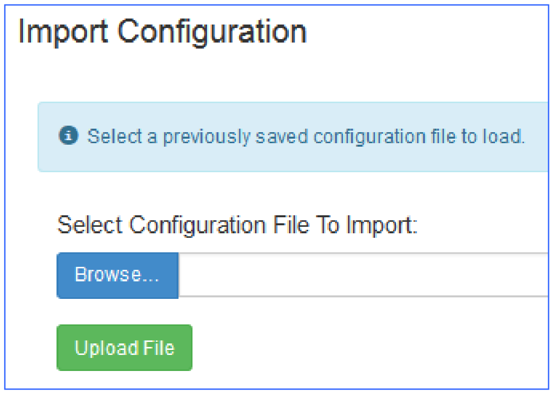


Figure 155: Import Configuration Screen

1. Click on the Browse button to open a File Upload window on the desktop.
2. Click on the Upload File button.

After the import file is selected, the Import Configuration screen allows the selection of specific items to be immediately copied to the current device, as shown in Figure 156.

Note that any settings on the receiver in the selected areas will be overwritten. This includes the Current Configuration.

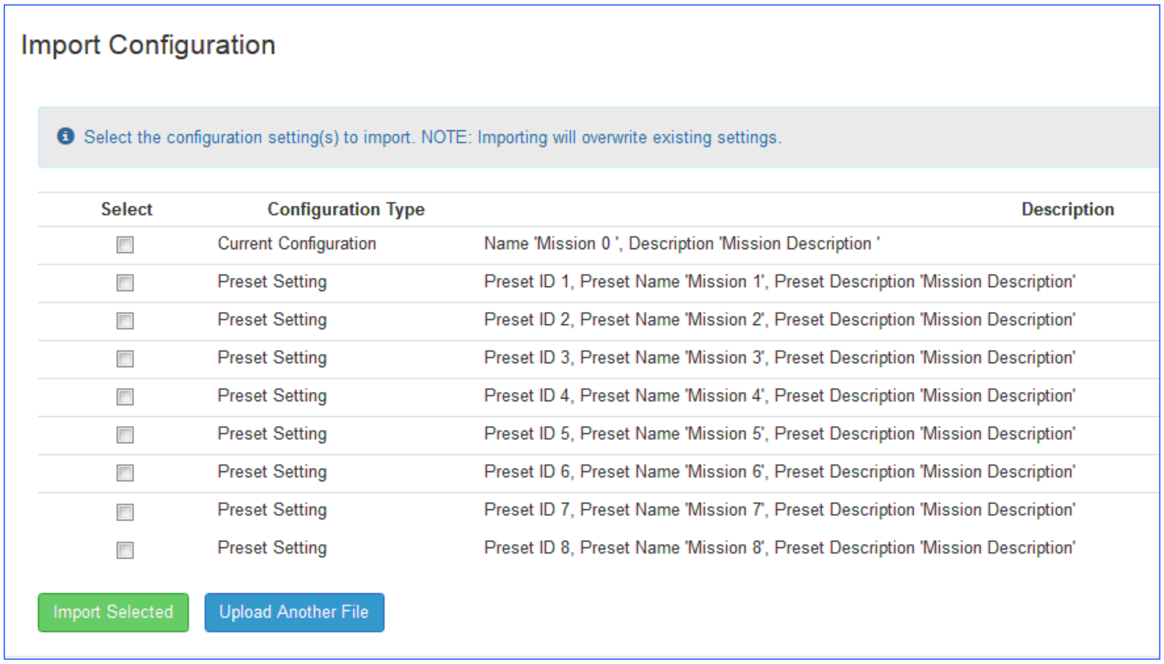


Figure 156: Import Configuration Selection Window

6 Performance Specifications

6.1 Power

The Compact RDMS ™ Receiver-Combiner operates from a nominal 28 VDC, +/- 4 VDC with a current consumption of no more than 25 Watts.

6.2 RF Frequency Error

By default, the Compact RDMS™ is capable of acquiring a signal with a frequency error of up to ±100 kHz.

6.3 Bit Error Rate

The RDMS™ meets the following BER limits, when tested with a signal source, which complies with IRIG 106-17.

Table 6: RDMS BER Specifications

BER	Maximum E_b/N_0 (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

Typical BER performance, plotted in Figure 157, is significantly superior to that tabulated above.

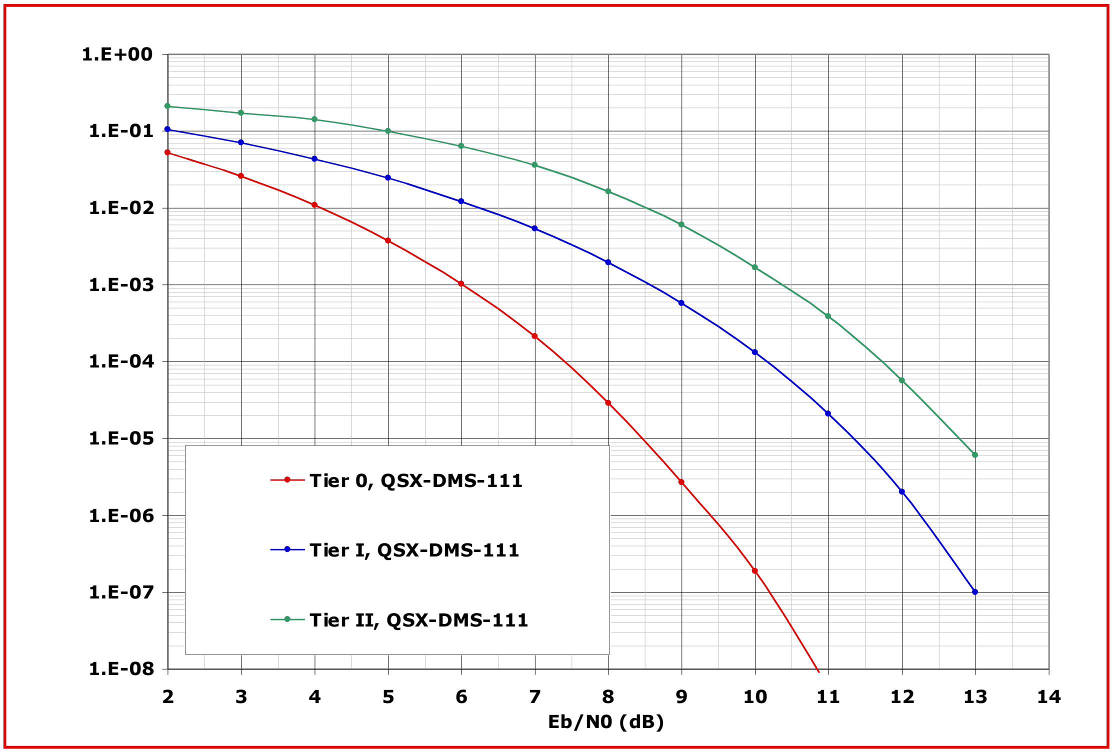


Figure 157: BER Performance for Tier 0, I, and II

6.4 Synchronization

The Compact RDMS™ offers very fast, reliable acquisition, even at very low signal to noise ratio. Synchronization time is a function of modulation type and IF frequency error. Typical SOQPSK results (from 10,000 synchronization trials) are shown in Figure 158.

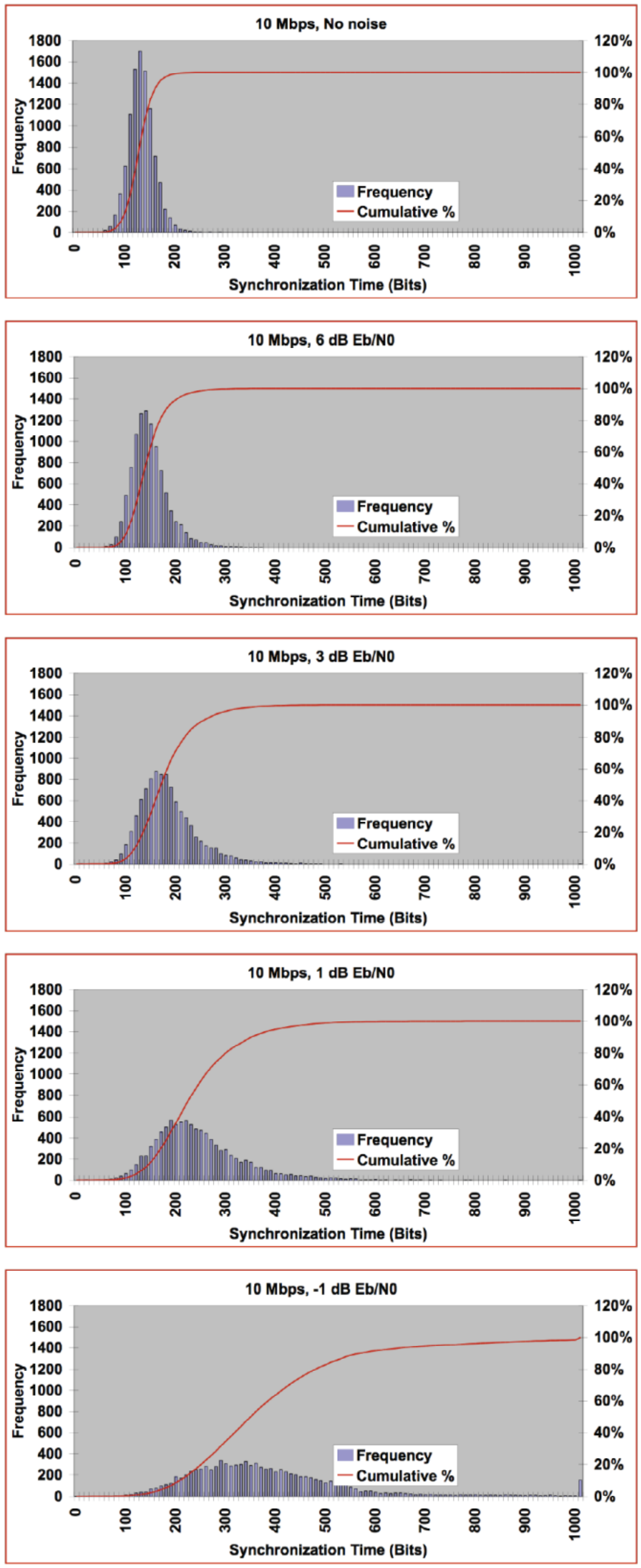
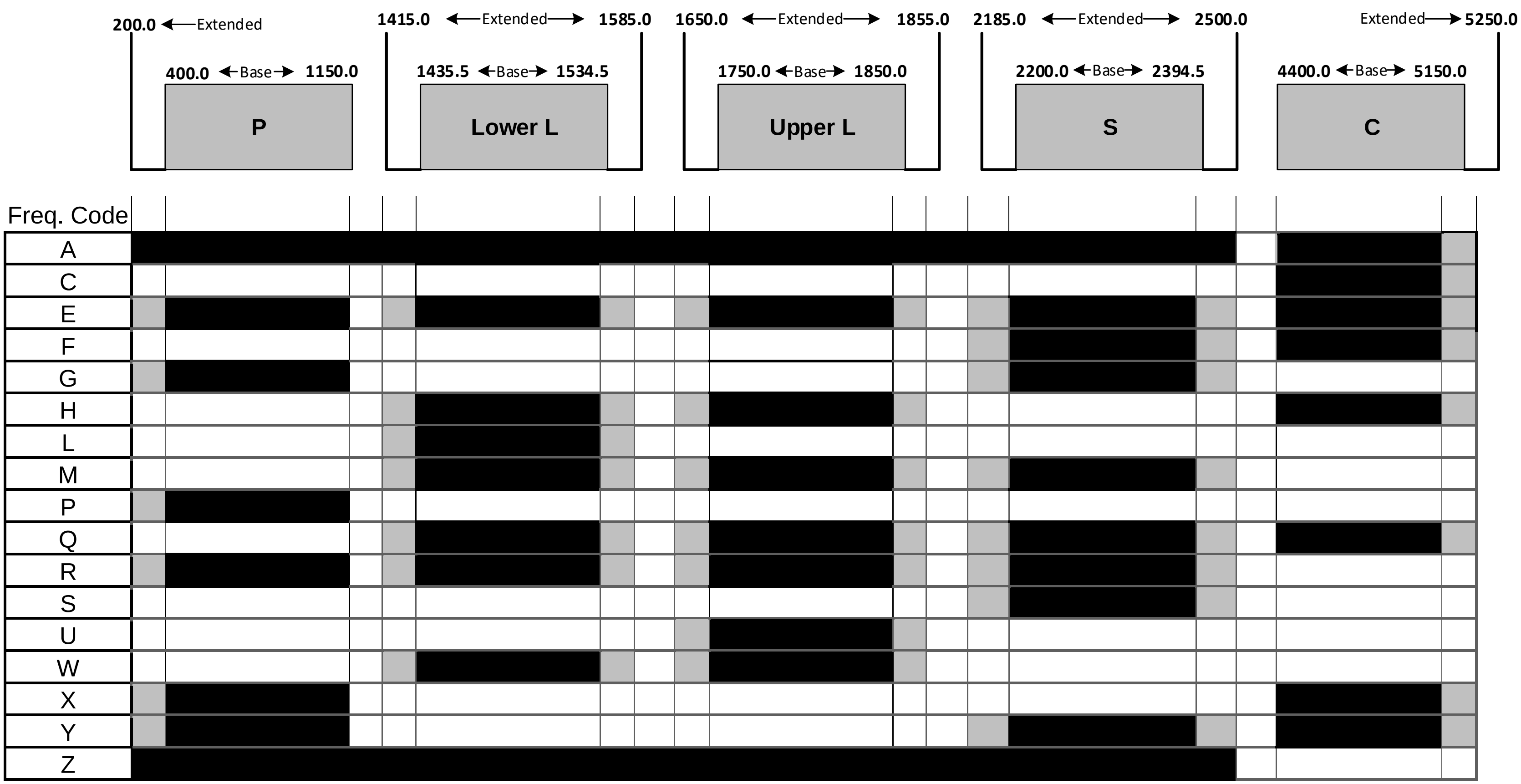


Figure 158: Synchronization Time at Various Signal-to-Noise Ratios

6.5 RF Input

Available band configurations are shown in Table 2. Two additional band codes are described in section 1.2.3.1. The input impedance is 50 ohms.

Table 7: Band Configuration Codes



Legend:
Frequency Gap
Standard (Base) Frequency Range
Extended Frequency Range (available by selecting Extended Tuning = 1 in part number)

6.5.1 Additional Band Codes

Two additional band codes are available:

- Band Code 7: Through the IF Input: 70 MHz through SAW filters, 0.075 MHz-20 MHz, 70 MHz
- Band Code T: 2025.0 MHz to 2110.0 MHz standard range

7 IF Module

The receiver’s integrated IF filter module, shown in Figure 159, includes eight (8) SAW filters, ranging in bandwidth from 250 kHz to 40 MHz in approximately one octave steps. The standard eight filters are 250 kHz, 500 kHz, 1 MHz, 2 MHz, 4.5 MHz, 10 MHz, 20 MHz, and 40 MHz. These filters serve as anti-aliasing filters ahead of the A/D converter in the demodulator itself. In addition, they can provide an added measure of adjacent channel interference rejection. The measured responses of the eight filters are shown in Figure 160 and Figure 161 (note the change of horizontal scale between the two figures).

Six additional filters are available allowing for a total of 14. The optional filters are 70 kHz, 1.4 MHz, 3 MHz, 6 MHz, 14 MHz, and 28 MHz. The measured responses of the optional filters are shown in Figure 162 and Figure 163. Contact Quasonix for information about the optional filters.

Based on the receiver’s high level of integration, the proper IF filter is automatically selected based on the current mode and bit rate settings of the demodulator. Although manual filter selection is available, it is not recommended.

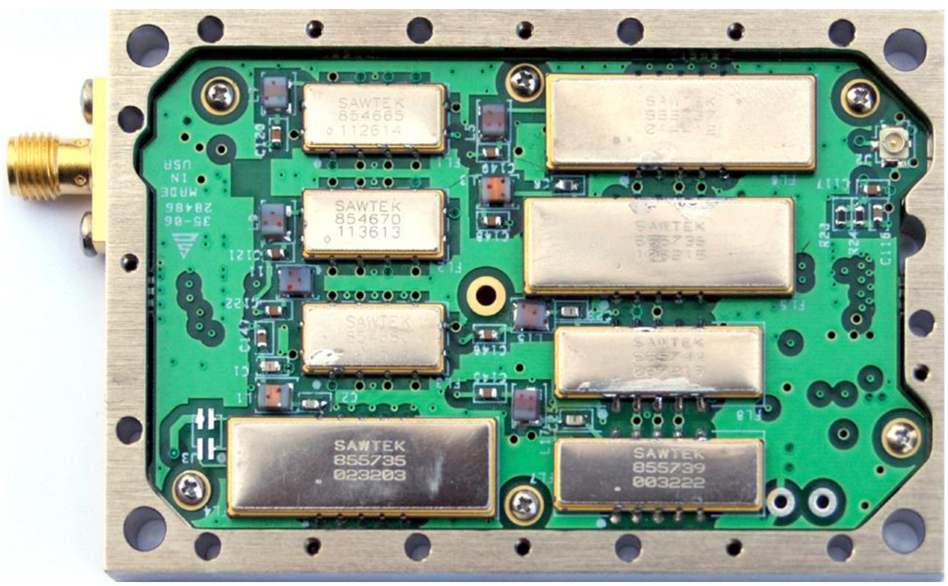


Figure 159: 70 MHz IF Module in 2” x 3” Chassis

The IF module attaches directly to the demod modules.

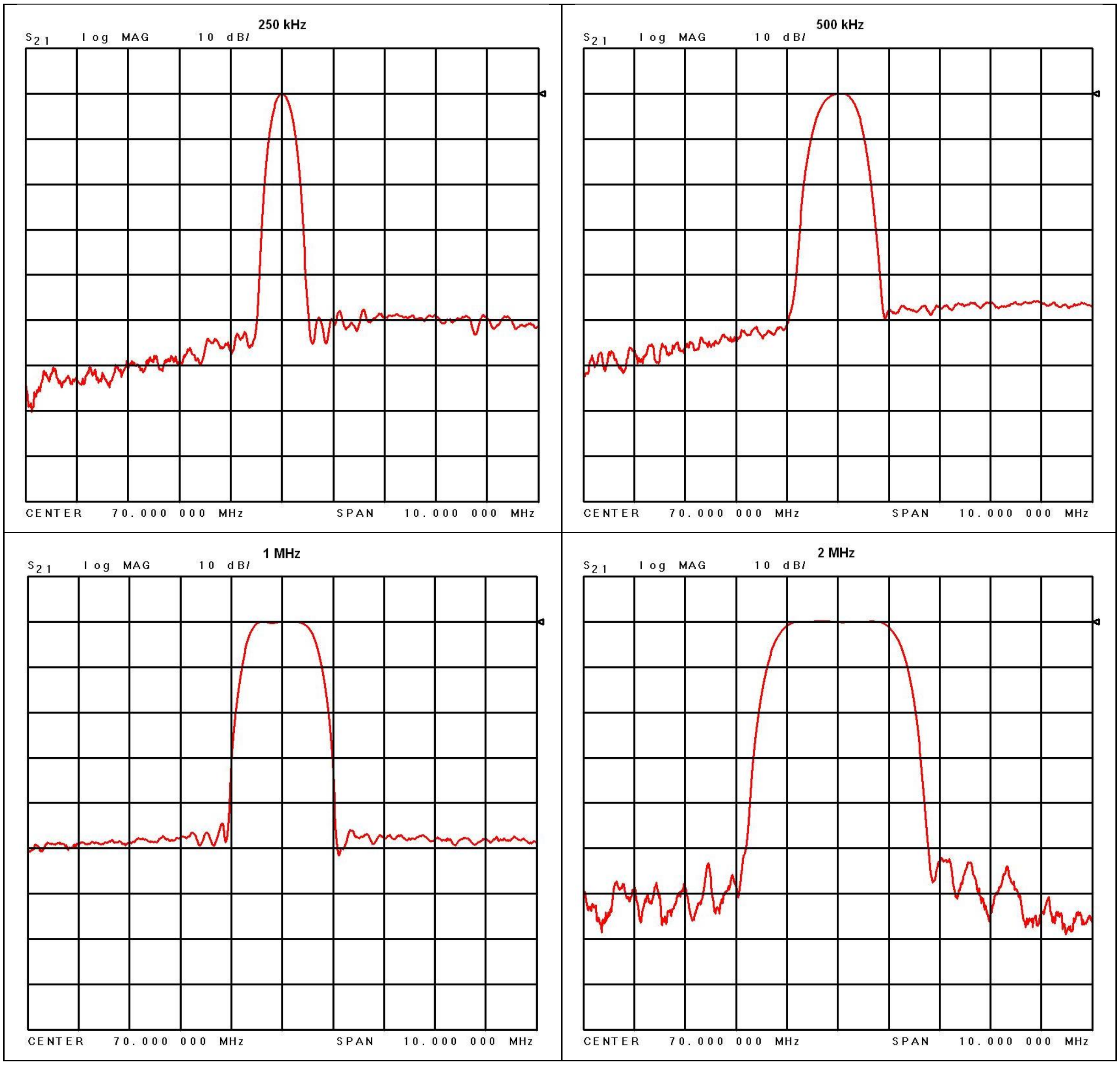


Figure 160: 70 MHz IF Module in 2” x 3” Chassis SAW Filter Responses, Narrow Group (10 MHz Span)

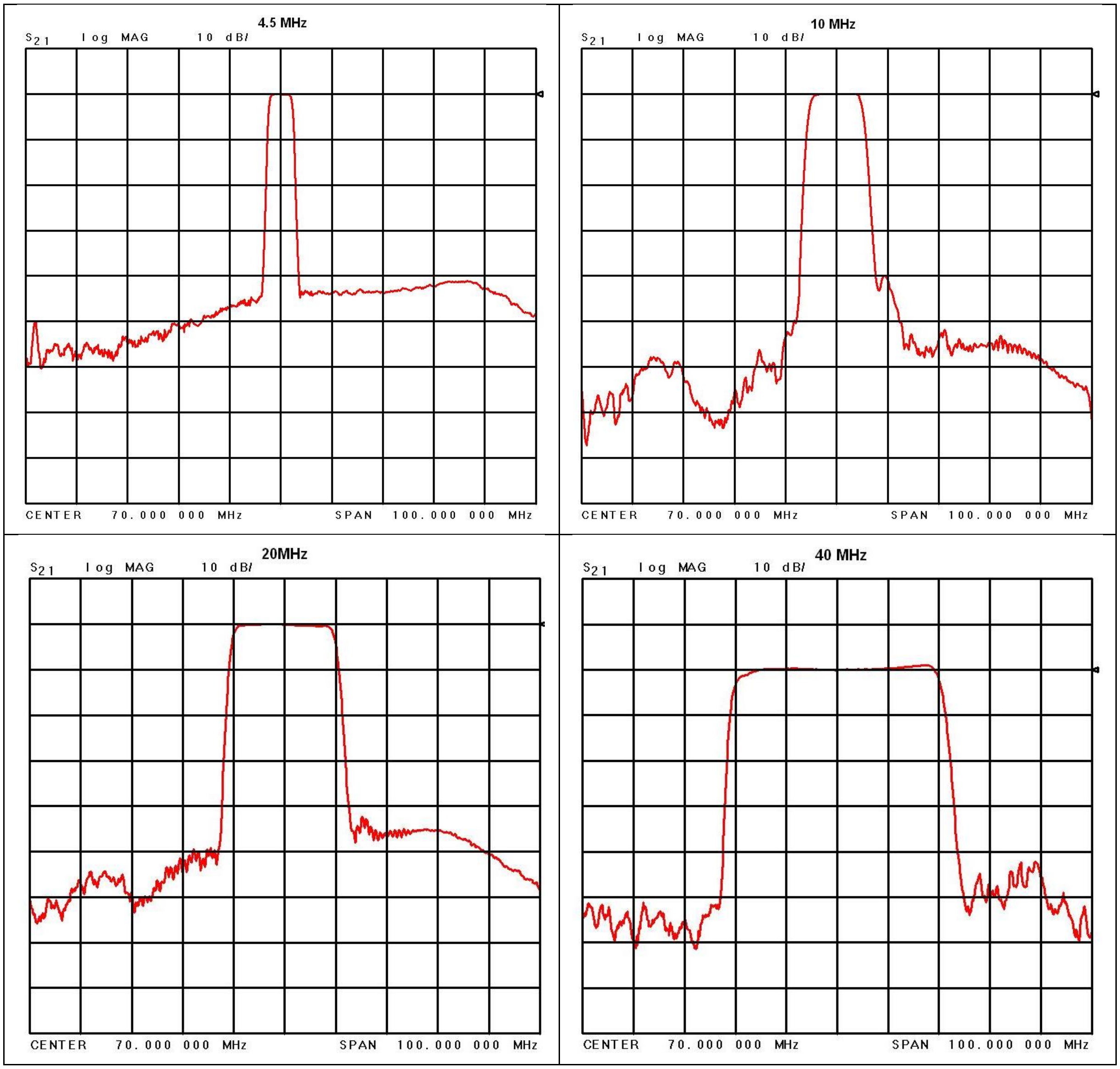


Figure 161: SAW Filter Responses, Wide Group (Plotted on 100 MHz Span)

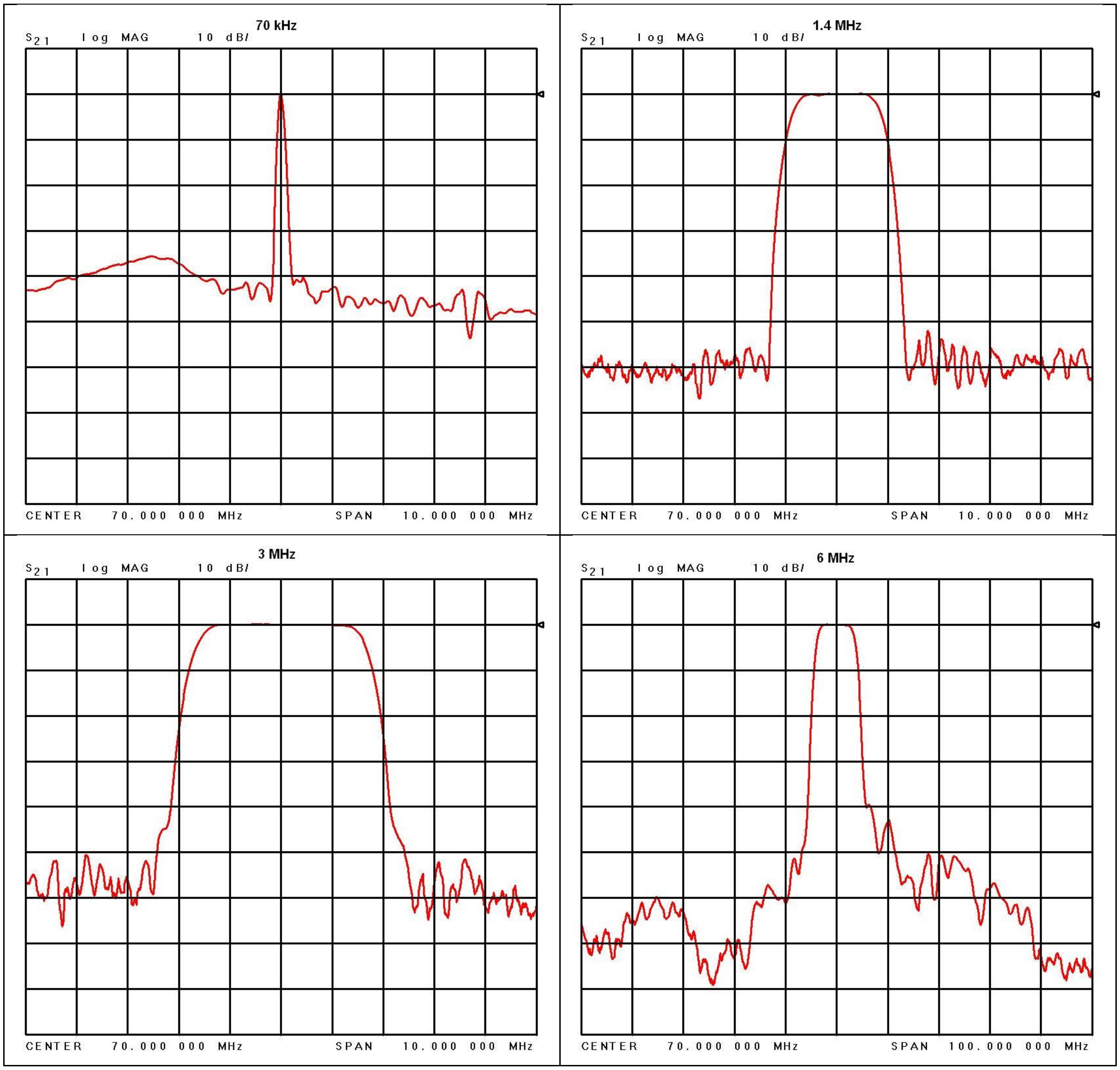


Figure 162: Optional SAW Filter Responses for 70 kHz to 6 MHz

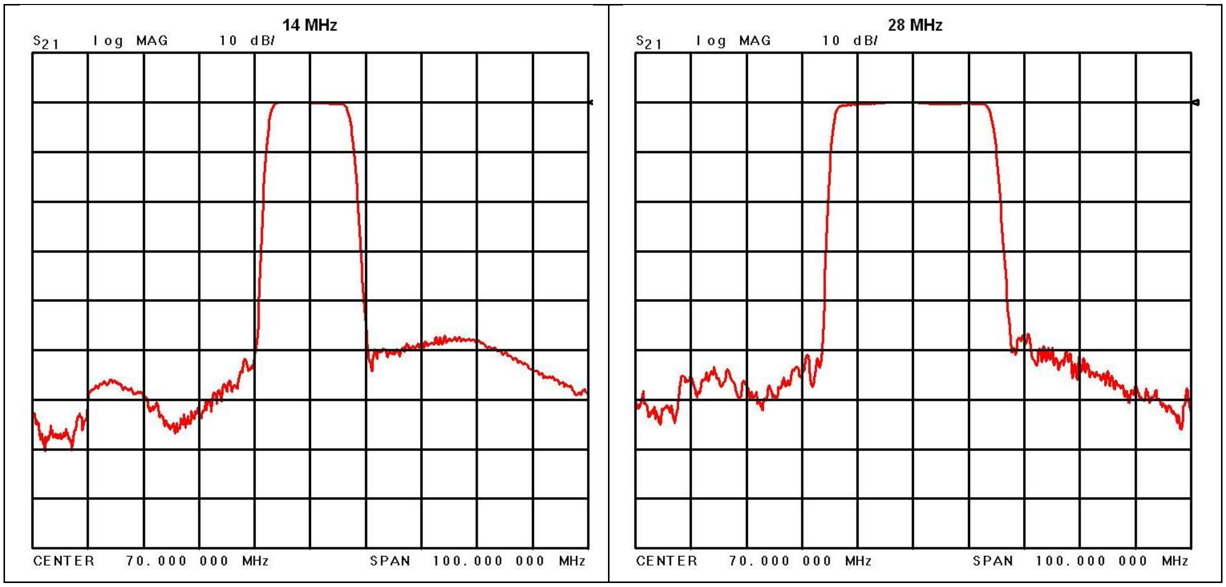


Figure 163: Optional SAW Filter Responses for 14 MHz and 28 MHz

8 Maintenance Instructions

The Dual Channel Compact RDMS™ Receiver-Combiner requires no regular maintenance, and there are no user-serviceable parts inside. Please consult the factory for any maintenance, upgrade, or repair requirements.

9 Product Warranty

The Dual Channel Compact RDMS™ Receiver-Combiner carries a standard parts and labor warranty of one (1) year from the date of delivery.

9.1 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.

9.1.1 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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10 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.

11 Appendix A –Recommended AM and AGC Settings for ACU Interfaces

11.1 AM and AGC

In a typical flight test scenario, Automatic Gain Control (AGC) tracks out slow variations in received signal strength. Ideally, the net received signal has constant signal strength except for higher-frequency amplitude modulation (AM) induced by the antenna tracking mechanism. If the antenna system uses conical scan, sinusoidal AM is induced by physical motion of the antenna feed. If the antenna system uses e-scan, square-wave AM is induced by switching between antenna elements.

The receiver demodulates the AM on the received signal and provides it to the antenna control unit (ACU). From the magnitude and phase of this AM signal, the ACU detects and corrects pointing error.

11.2 AM AGC Compensation

In some systems, vehicle rotation or other dynamics can induce additional undesired low-frequency AM. If the frequency of this undesired AM is close enough to the scan rate, the AGC will not track it out. Worse, inherent lag in the AGC may result in severe distortion of the desired AM.

AGC Compensation adjusts the AM output to neutralize these effects. This allows the AGC to fully track out undesired AM at frequencies just below the antenna scan rate. However, the compensation adds a large amount of delay to the AM output, proportional to the AGC time constant. This delay may make antenna tracking difficult or impossible. Therefore, AGC Compensation should only be enabled when:

- The antenna tracking system experiences degradation due to undesired AM at roughly 1/20 to 1/2 the antenna scan rate
- The added compensation delay on the AM signal does not cause the antenna tracking loop to become unstable; this can only be verified on a case-by-case basis

11.3 Recommended Settings

Recommended AM and AGC settings depend on three primary parameters: antenna scan type (conical or e-scan), antenna scan rate, and whether the system is subject to undesired low-frequency AM (refer to section 11.2). Table 8 describes recommended settings based on these parameters:

Table 8: Recommended AM/AGC Settings

Antenna Scan Type	Undesired Low Frequency AM?	AGC Time Constant (ms, 0.1 to 1000)	AM Bandwidth (Hz, 5 to 50,000)	AGC Compensation
Conical scan	No	1000 / ScanRate	5 * ScanRate	OFF
Conical scan	Yes	850 / ScanRate	5 * ScanRate	ON
E-scan	No	1000 / ScanRate	10 * ScanRate	OFF
E-scan	Yes	850 / ScanRate	10 * ScanRate	ON

In Table 8, ScanRate is the antenna scan rate in Hz.

For example, suppose a conical scan system with no undesired low-frequency AM has a scan rate of 30 Hz. This system has a recommended AGC Time Constant of 1000 / 30 = 33.3 ms, and an AM Bandwidth of 5 * 30 = 150 Hz, with AGC Compensation OFF.

The AGC Time Constant should *never* be set lower than recommended. Setting the AGC Time Constant higher is unlikely to affect performance, though it may degrade performance if vehicle dynamics cause relatively rapid changes in received signal strength.

The AM Bandwidth may be set lower to reduce noise on the AM signal, or higher to reduce delay on the AM signal. At the recommended settings, AM phase delay is approximately 30 degrees for typical conical scan and e-scan scan rates.

If AGC Compensation is enabled, the AGC Time Constant and AM Bandwidth should both be set only as indicated in Table 8.

12 Appendix B – Phase Noise Compensation

12.1 Trellis Demodulation Basics

Legacy Single-Symbol Detection:

- Uses basic Limiter-Discriminator operation
- Frequency in this bit above nominal → data = 1
- Frequency in this bit below nominal → data = 0
- Makes no use of adjacent symbols for error correction

Trellis Detection:

- Uses the phase tree for data detection
- Uses adjacent symbols to help decide on "iffy" bits
- Improves BER performance by 3.5 to 5.0 dB

The Phase Tree shown in Figure 164, shows all of the possible paths the phase trajectory can take over a period of seven bits. Figure 165 shows the two unique paths, based on whether the second bit is a 1 or 0.

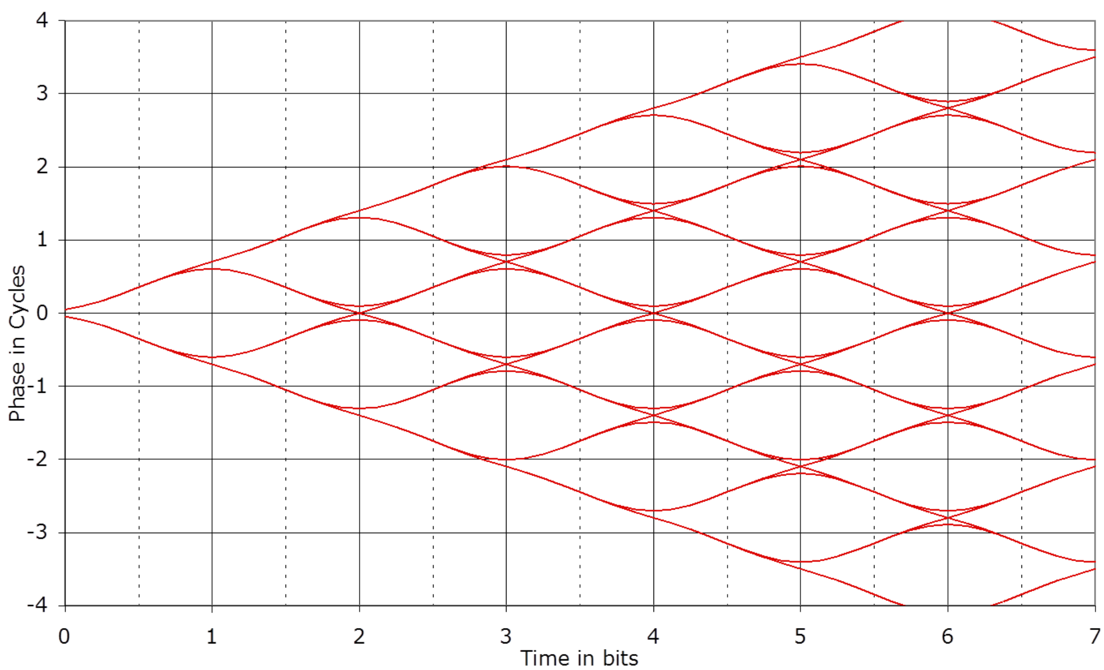

Figure 164: Ideal PCM/FM Phase Tree (h = 0.7)

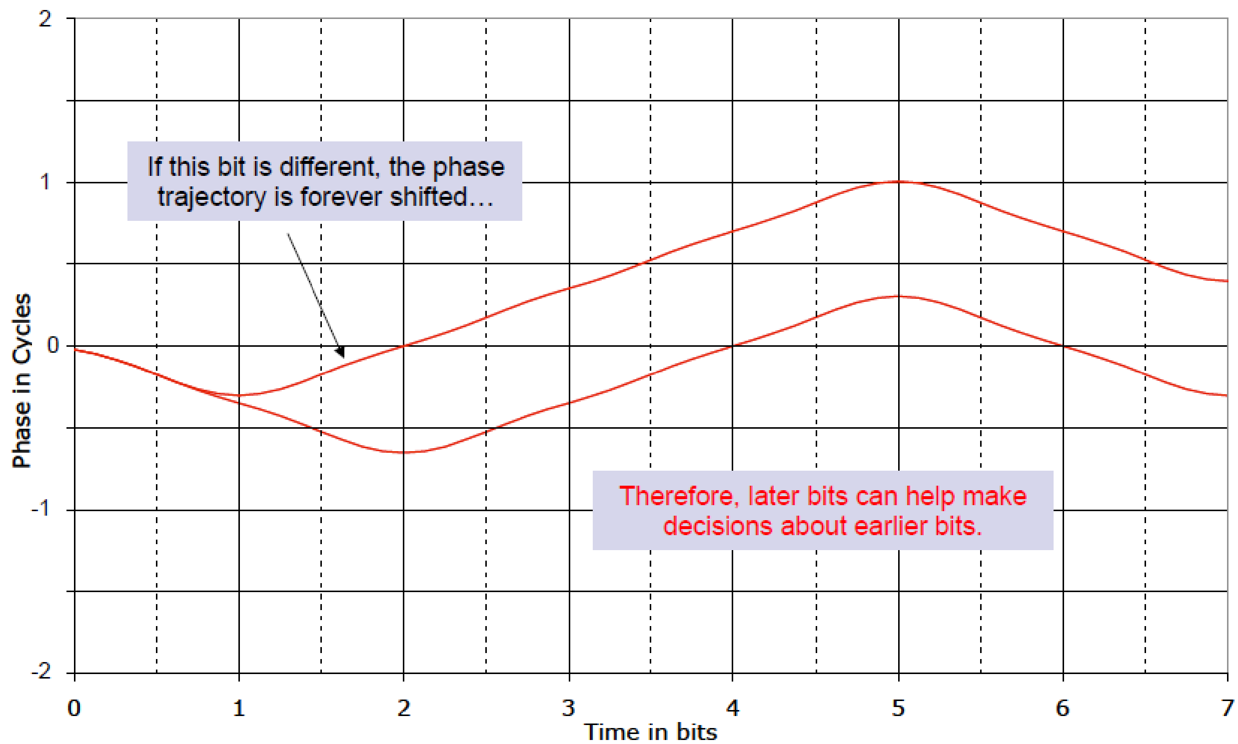

Figure 165: Phase Trajectory Never Forgets

12.1.1 Trellis Demodulation Summary

The basic premise of trellis demodulation is that the signal from the transmitter follows a known path through the phase tree. When the demodulator knows this, it can use a sequence of several symbols to help make better decisions about each individual bit. This process improves BER performance by about 3.5 to 5 dB over conventional FM detection. However, this assumes that the transmitter is really following the "known" and "correct" phase tree, and this assumption is NOT always true.

High phase noise can reduce the trellis detection gain because phase noise corrupts the tree. The following figures illustrate the differences in trellis detection gain depending on the amount of phase noise introduced.

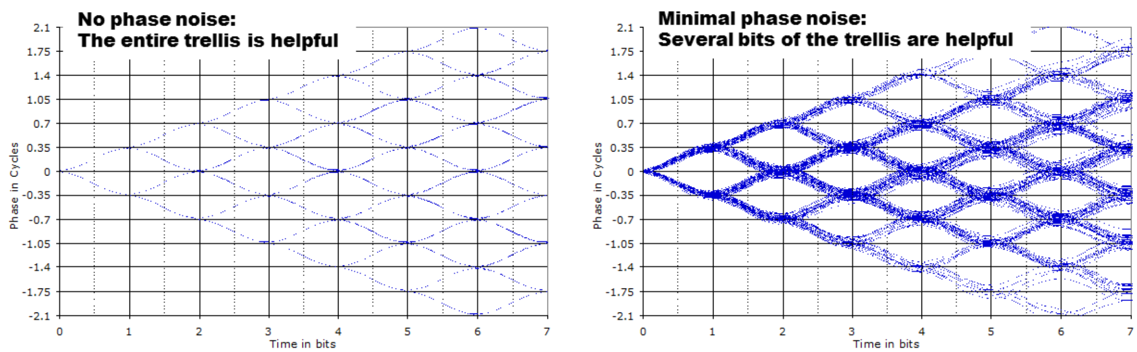

Figure 166: Trellis Detection Gain with Zero to Minimum Phase Noise

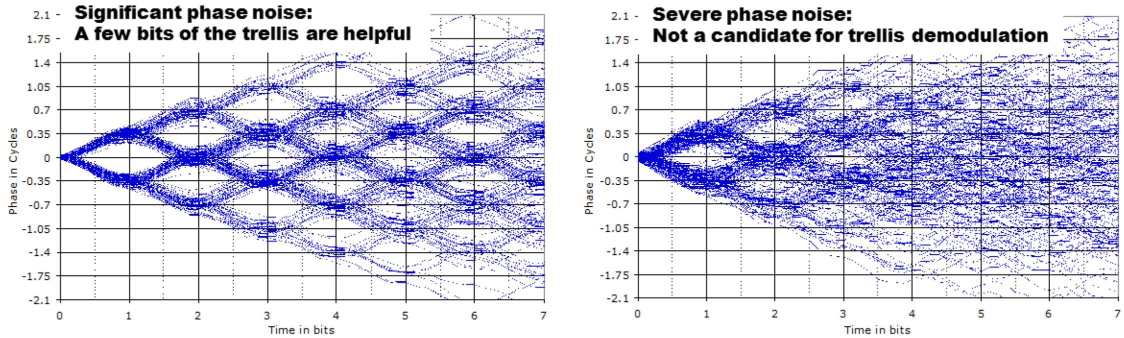

Figure 167: Trellis Detection Gain with Significant to Severe Phase Noise

12.2 Phase Noise Impact

Trellis demodulation is based on the assumption that the signal is following a predictable path through the trellis. If this is not true (due to high phase noise), then a trellis demodulator cannot provide the expected performance gain.

- Many legacy analog transmitters (a simple modulated VCO) have high phase noise.
- Vibration often further increases phase noise.
- Phase noise is generally more damaging at low bit rates.
- Phase Noise Compensation (PNC) gives back some of the trellis detection gain, by shortening the trellis observation span.

12.3 Clock Jitter Impact

Many older PCM encoders are susceptible to large inaccuracies in clock rate or have clock stability issues, especially under harsh vibration conditions. While the RDMS is capable of tracking static clock rate errors as large as 1000 ppM, excessive jitter causes the integrated bit sync to lose lock. Enabling the PNC mode opens the tracking loop bandwidth to accommodate for these issues. This increase in bandwidth does have a tradeoff. A wider tracking range allows the RDMS to deal with the additional jitter, but it may also increase synchronization times slightly, and slightly increase the minimum SNR at which the RDMS declares lock.

12.4 When to Use PNC

There is no bullet-proof test for whether PNC is needed, but DQM is pretty close. The PNC Auto setting uses DQM from both trellis and single-symbol demodulation to select which is providing better results for the present input signal. The primary downside to PNC Auto is that there is time delay switching between PNC On and PNC Off. Therefore, PNC Auto is ideal for cases where it is not obvious if PNC is needed, but it may not be suitable for cases where phase noise is rapidly variable. Enable PNC Auto or PNC On if:

- The demodulator is struggling to lock, even with good Signal to Noise Ratio (SNR). ("Good" SNR means the signal strength bar with properly zeroed AGC is green.)
- The eye pattern NEVER looks “clean,” as in Figure 168
- Symptoms get worse when the transmitter is under vibration
- Symptoms get worse at low bit rates

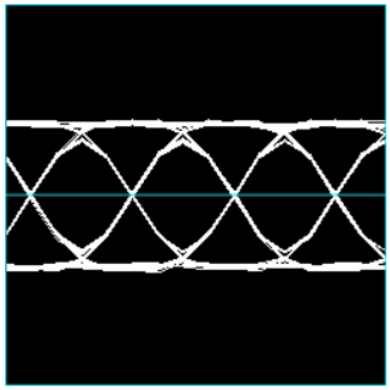

Figure 168: "Clean" Eye Pattern

12.5 Know Your Transmitter

If you know the brand and type of transmitter, these tips can help determine when to use PNC.

If your transmitter was manufactured by these companies, PNC should be OFF:

- Quasonix – guaranteed
- Nova Engineering – highly likely
- L3 – probably, but digital transmitters only

If the transmitter was manufactured by the companies below, PNC should be ON:

- Microwave Innovations
- Emhiser
- Southern California Microwave
- L3 (analog transmitters)

13 Appendix C - PCM Framer/Deframer Function

Quasonix RDMS™ receivers recognize PCM frames as defined by IRIG 106-17 Chapter 4 and Appendix 4-A. The receiver can provide basic processing of a large subset of possible frame configurations, including sync word detection, subframe ID checking, and data extraction from the frame structure (without decommutation). Within the receiver, this functionality is referred to as the PCM Deframer.

To facilitate testing the PCM Deframer, Quasonix Receiver Analyzers can generate PCM frames using external (user) data or internal test patterns for the frame payload. Within the Receiver Analyzer, this functionality is referred to as the PCM Framer.

This note describes the detailed capabilities of the PCM Framer and Deframer.

13.1 PCM Framer

The PCM Framer supports fixed-length PCM frame generation with the following parameters:

- Major frame length up to 256 minor frames
- Minor frame length up to 16,384 bits
- Minor frame sync pattern 16 to 33 bits (user-selectable pattern and length)
- Optional subframe ID (SFID) insertion (word 1 position only)

The resulting PCM frame format appears as:

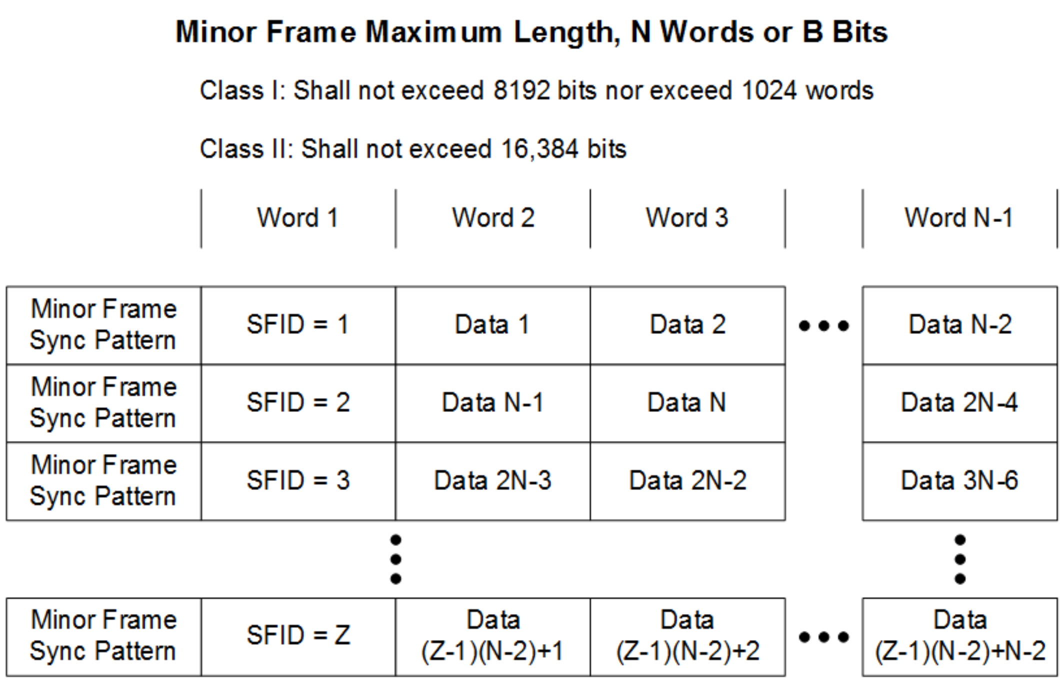

Figure 169: Frame Format with SFID Insertion Enabled

*Major Frame Length = Minor Frame Maximum Length multiplied by Z

The PCM Framer uses serial streaming data, either from an external source or an internal pattern generator, to fill the data portion of the frame. There is no mechanism to align specific sets of serial bits to Data words, and there is no mechanism to align specific data words to a given position within the frame format. Therefore, the PCM Framer cannot generate frames with data parameters suitable for decommutation. It can, however, be used to test frame synchronization and link quality via SFID verification. Further, if the serial streaming data is a known pattern, the data can be monitored by a BERT at the receiving end after data extraction.

13.2 PCM Deframer

The PCM Deframer supports **fixed-length** PCM frame recognition with the following parameters:

- Major frame length up to 256 minor frames
- Minor frame length up to 16,384 bits
- Minor frame sync pattern 16 to 33 bits (user-selectable pattern and length)
- Optional subframe ID (SFID) checking (word 1 position only)

Acquisition of PCM frame lock takes place according to the process recommended by RCC 119 Section 4.6. There are four settable parameters that are used to configure acquisition and re-acquisition:

- CORR_APERTURE – Number of bits, early or late, that the sync pattern may appear relative to other detected sync patterns and still be detected
- CORR_THRESH – Number of bits of the sync pattern that must match to declare sync pattern detect
- LOCK_THRESH – Number of valid sync pattern detects required to declare PCM frame lock
- SEARCH_THRESH – Number of invalid sync pattern detects required to declare loss of PCM frame lock (once locked)

The PCM Deframer acquires frame lock using the following states:

- Search – Detect sync pattern if correlation of any set of bits exceeds CORR_THRESH
- Check – Declare PCM frame lock if valid sync pattern appears LOCK_THRESH consecutive times
- Lock – Maintain PCM frame lock until invalid sync pattern appears SEARCH_THRESH consecutive times

SFID checking occurs whenever PCM frame lock is detected. The SFID is expected to be located in the first word after the sync pattern, as shown in Figure 169, and it is considered valid if it is one greater than the previous SFID, or if it is 1 and the previous SFID was Z (the major frame length).

The PCM Deframer cannot be programmed to perform decommutation. It can, however, optionally strip the sync pattern and SFID (if present) to leave only the frame data. If the fame data is a known pattern, it can be monitored by a BERT to measure link performance.

The RDMS™ receiver can output PCM frame lock and/or SFID valid indications on the DEMOD_LOCK and/or SYNC_DETECT back-panel outputs.

14 Appendix D – Factory Reset Values

When a reset command is activated, the frequency defaults to the lowest valid frequency for the lowest authorized band on the unit. The reset priority is:

1. PCM/FM
2. SOQPSK
3. Multi-h CPM
4. QPSK
5. STC

Reset values for each mode are listed in the following tables.

The default Frequency is 2200.000 MHz.

Table 9: PCM/FM Factory Reset Values

Parameter	Reset State
Bit Rate	1
Combiner (if available)	Off
Clock Polarity	Normal
Data Polarity	Normal
Equalizer (if available)	Off
DQ Encapsulation (if available)	Disabled
Derandomizer	Disabled
Differential Decoder	N/A
Modulation Scaling	Acquire
Modulation Persist	Off
IF Filter	Auto
Video De-emphasis	Off

Parameter	Reset State
Phase Noise Compensation	Off
Muting Timeout	1000
Output Muting	Off
Downconvert Antenna	Disabled
AGC Polarity	+ (Positive)
AGC Scale	10
AGC Time Constant	100
AGC Zero Mode	Manual
AM Bandwidth	100
AM Polarity	Normal
AM Scale	1
AGC Compensation	Enabled

Table 10: SOQPSK Factory Reset Values

Parameter	Reset State
Bit Rate	1
Modulation Scaling	N/A
Clock Polarity	Normal
Data Polarity	Normal
Derandomizer	Disabled
Differential Decoder	Enabled
IF Filter	Auto
Downconvert Antenna	Disabled
AGC Zero Mode	Manual
Convolutional Decoder	N/A
Lock Output Polarity	Active High
NRZ Encoding	N/A
Output Control	Default
Output Muting	Disabled
Phase Noise Compensation	Disabled
Tape Output	Disabled

Table 11: Multi-h CPM Factory Reset Values

Parameter	Reset State
Bit Rate	1
Modulation Scaling	N/A
Clock Polarity	Normal
Data Polarity	Normal
Derandomizer	Disabled
Differential Decoder	N/A
IF Filter	Auto
Downconvert Antenna	Disabled
AGC Zero Mode	Manual
Convolutional Decoder	N/A
Lock Output Polarity	Active High
NRZ Encoding	N/A
Output Control	Default
Output Muting	Disabled
Phase Noise Compensation	Disabled
Tape Output	Disabled

Table 12: QPSK Factory Reset Values

Parameter	Reset State
Bit Rate	1
Modulation Scaling	N/A
Clock Polarity	Normal
Data Polarity	Normal
Derandomizer	Disabled
Differential Decoder	N/A
IF Filter	Auto
Downconvert Antenna	Disabled
AGC Zero Mode	Manual
Convolutional Decoder	Disabled
Lock Output Polarity	Active High
NRZ Encoding	NRZ-L
Output Control	Default
Output Muting	Disabled
Phase Noise Compensation	Disabled
Tape Output	Disabled

Table 13: Multi-h CPM Factory Reset Values

Parameter	Reset State
Bit Rate	1
Modulation Scaling	N/A
Clock Polarity	Normal
Data Polarity	Normal
Derandomizer	Disabled
Differential Decoder	N/A
IF Filter	Auto
Downconvert Antenna	Disabled
AGC	Enabled
Convolutional Decoder	N/A
Lock Output Polarity	Active High
NRZ Encoding	N/A
Output Control	Default
Output Muting	Disabled
Phase Noise Compensation	Disabled
Tape Output	Disabled

15 Appendix E – Import Quasonix Root Authority Certificate

In order to instruct the web browser to 'trust' the TLS certificate presented by the RDMS during an HTTPS Browser Interface connection, the Quasonix Root Authority Certificate must be imported into the browser or operating system's Certificate Store. The instructions for this vary by browser and are presented below.

15.1 Firefox

When using the Firefox browser in Windows, the certificate must be imported through the Settings menu.

1. Click on the Settings button in the upper right-hand corner of the browser.
2. Select Options. The Options tab displays, as shown in Figure 170.
3. Select Privacy & Security menu item.
4. Click on the View Certificates… button to view the Certificate Manager, as shown in Figure 171.

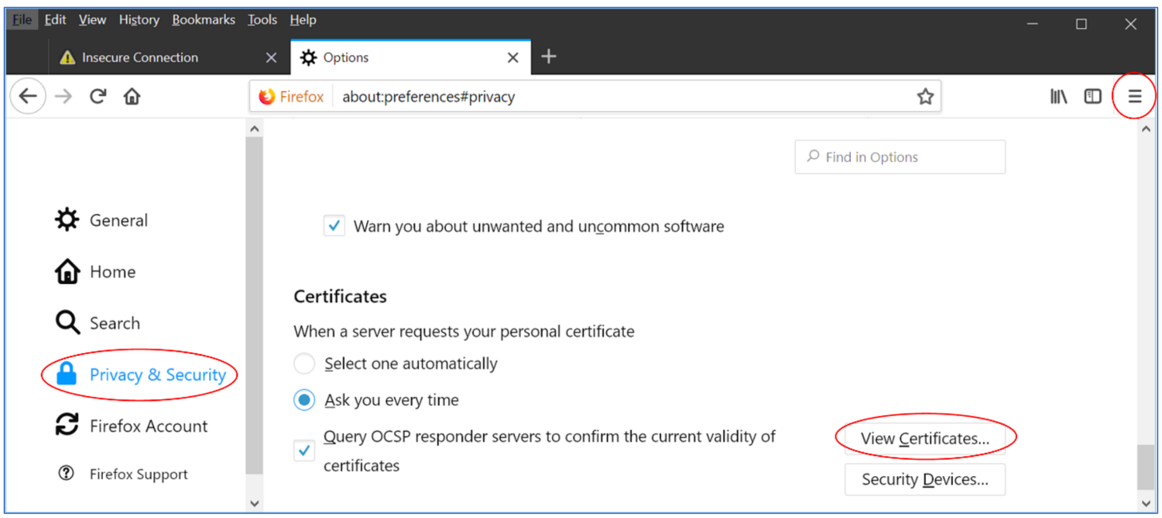

Figure 170: Firefox Options Interface

5. Select the Authorities tab.

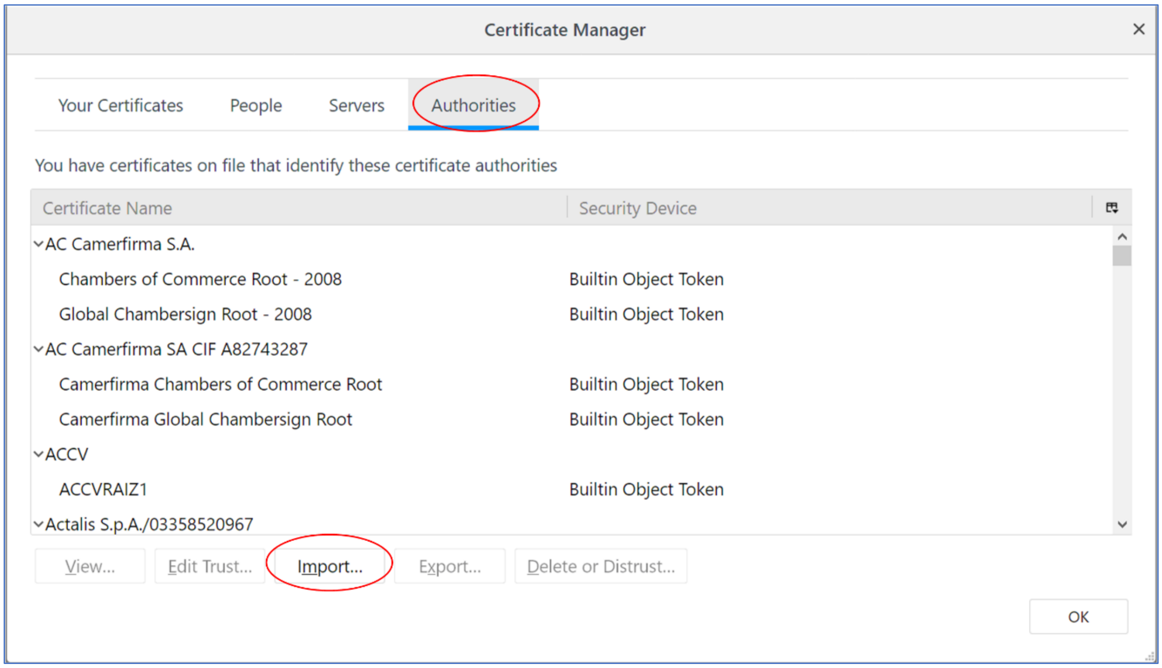

Figure 171: Firefox Certificate Manager

6. Click on the Import… button. A File Browser displays. Select the Quasonix Root Authority file obtained from Quasonix, then click on the Open button.
7. The Downloading Certificate window displays, as shown in Figure 172.

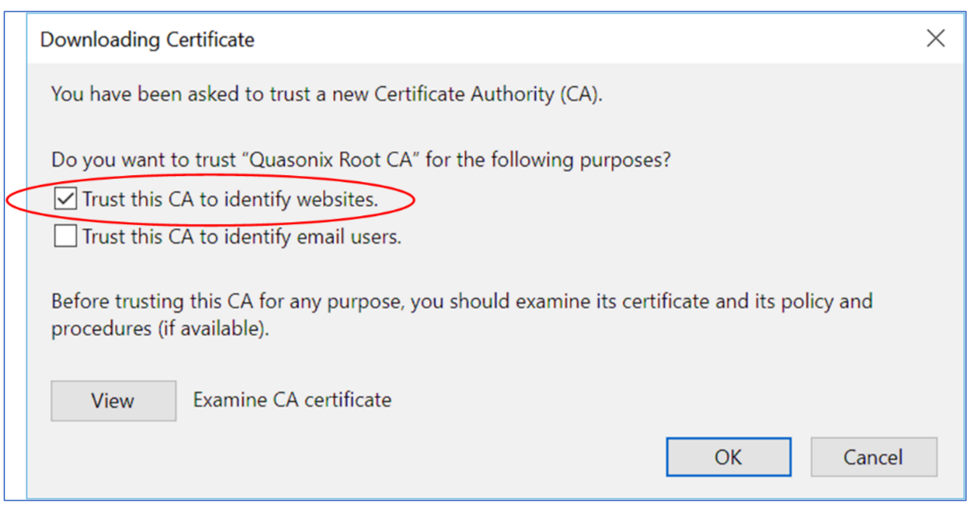

Figure 172: Firefox Downloading Certificate Window

8. Click on the View button to examine the certificate. It should match the one shown in Figure 173.
9. Check the box for Trust this CA to identify websites, then click on the OK button. The certificate has now been imported.

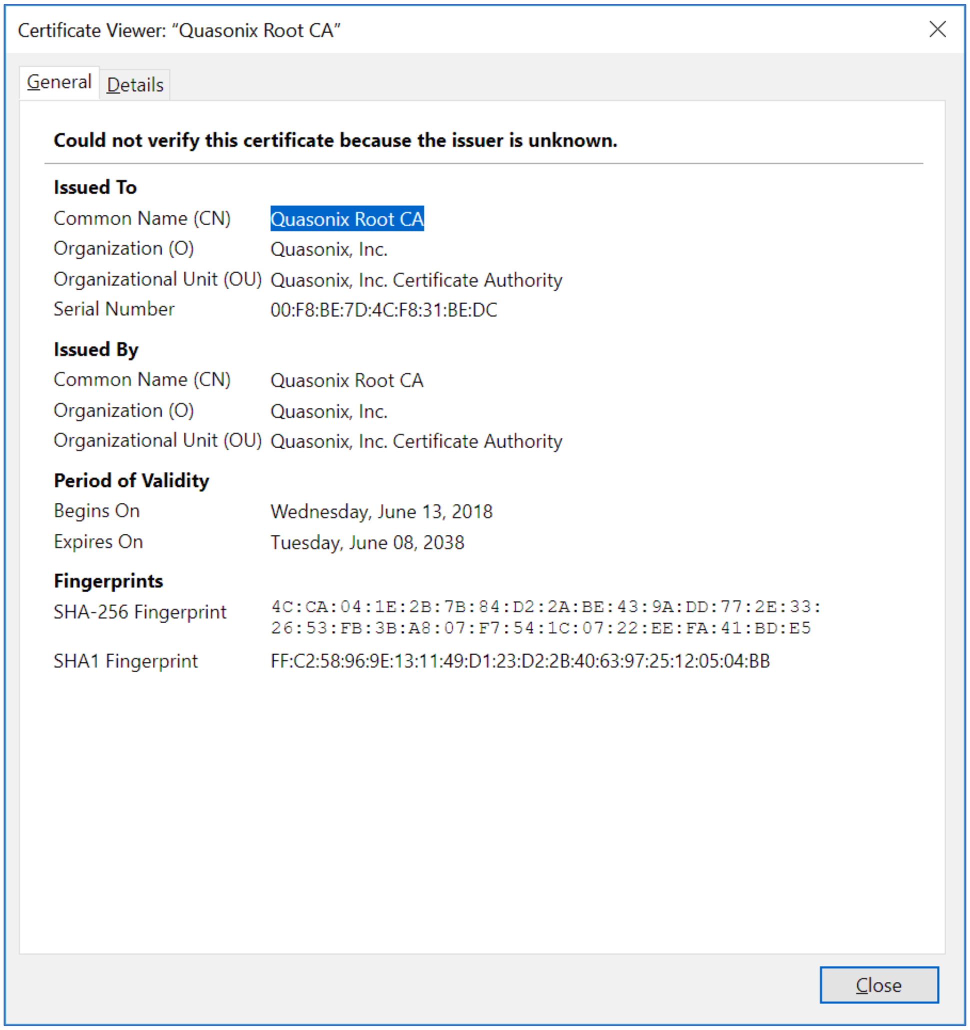

Figure 173: Firefox Certificate Viewer-Quasonix Root CA

10. Scroll through the Certificate Names in the Authorities tab of the Certificate Manager to ensure "Quasonix, Inc." is in the list, as shown in Figure 174.

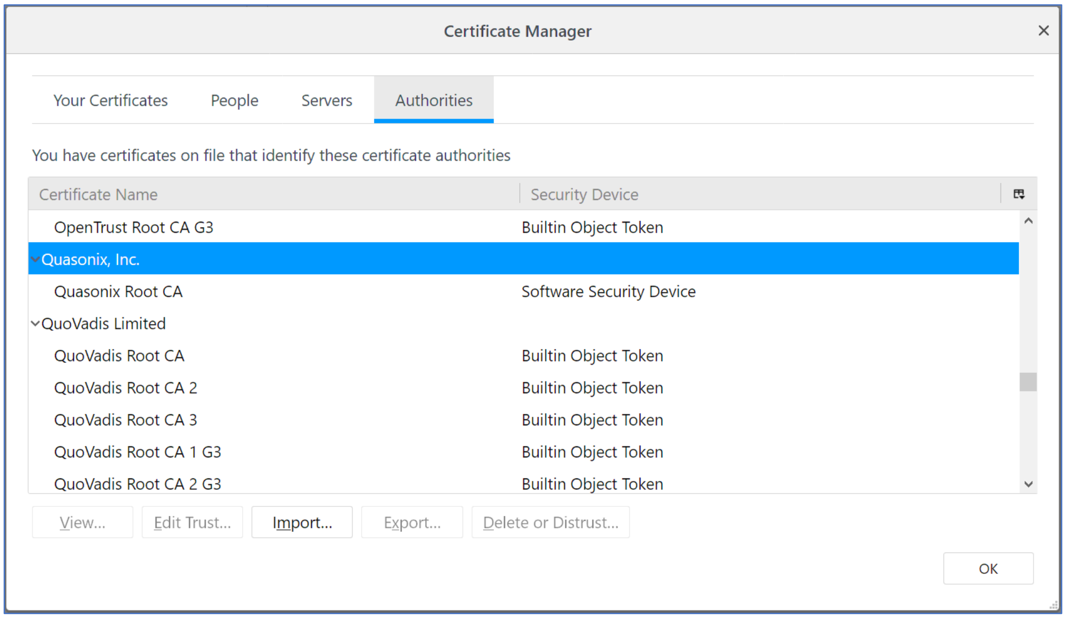

Figure 174: Firefox Certificate Manager with Quasonix Root CA Added

11. Using Firefox, browse to https://RDMS_IP, where RDMS_IP is the IP address of the RDMS.

15.2 Edge, Internet Explorer, and Chrome

To add a certificate to Edge, Internet Explorer, and Chrome, use the Windows Certificate Browser tool. After a certificate has been added to the system, it is available for use in Edge, Internet Explorer, and Chrome.

12. In Windows, click on the Start Menu, type Internet Options, then press the Enter key to open the Internet Properties screen, as shown in Figure 175.
13. Click on the Content tab.

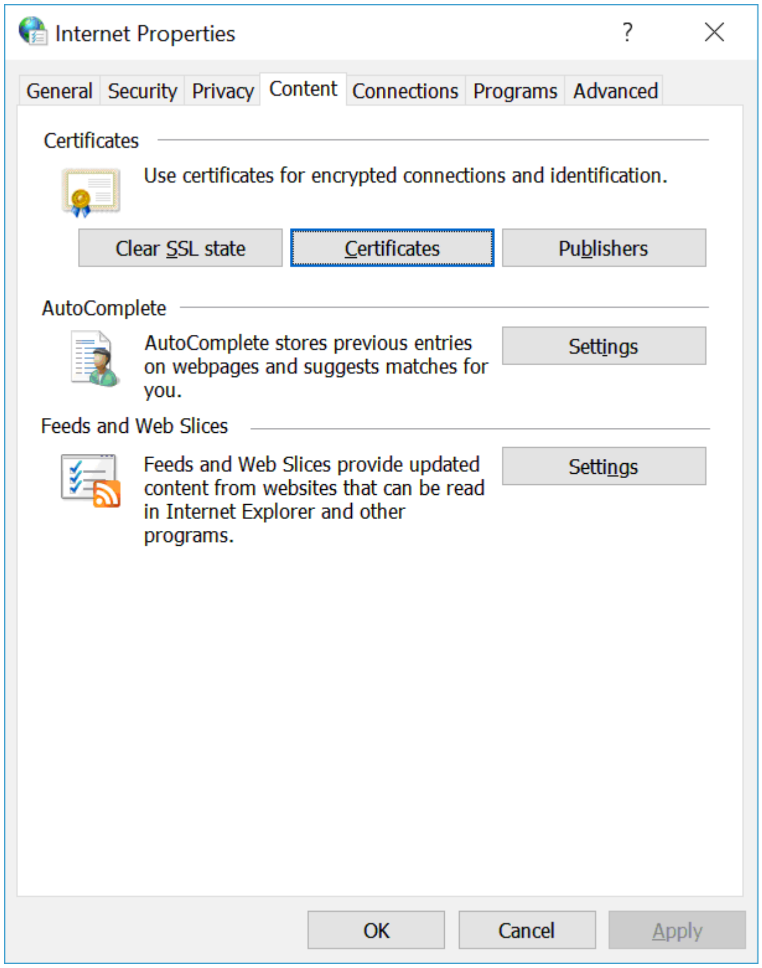

Figure 175: Internet Properties, Content Tab

14. Click on the Certificates button. The Certificates screen displays. Click on the Trusted Root Certification Authorities tab, as shown in Figure 176.

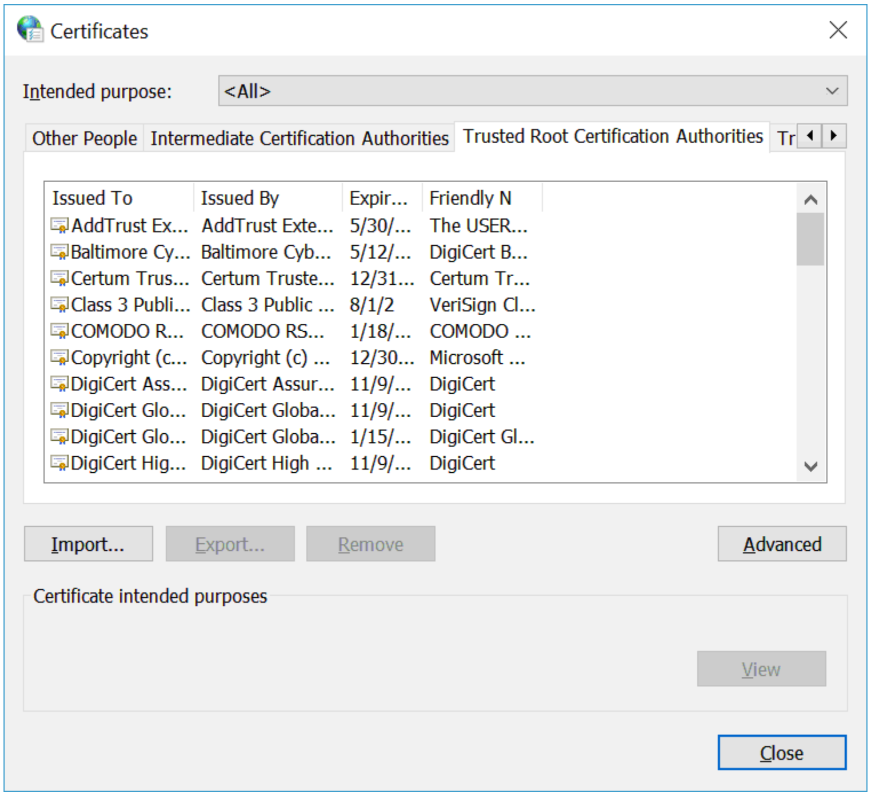

Figure 176: Certificates Screen

15. Click on the Import… button to start the Certificate Import Wizard. The Wizard is shown in Figure 177.

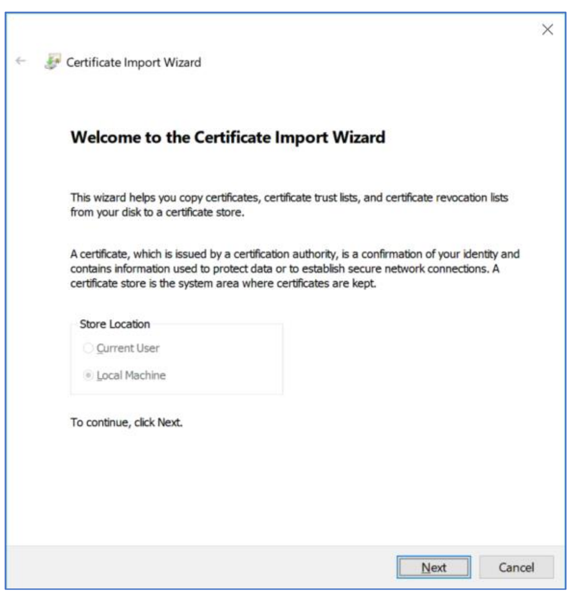

Figure 177: Windows Certificate Import Wizard

16. Click on the Next button. Click on the Browse button under File to Import.
17. Select the Quasonix Root Authority file obtained from Quasonix. Click on the Next button.

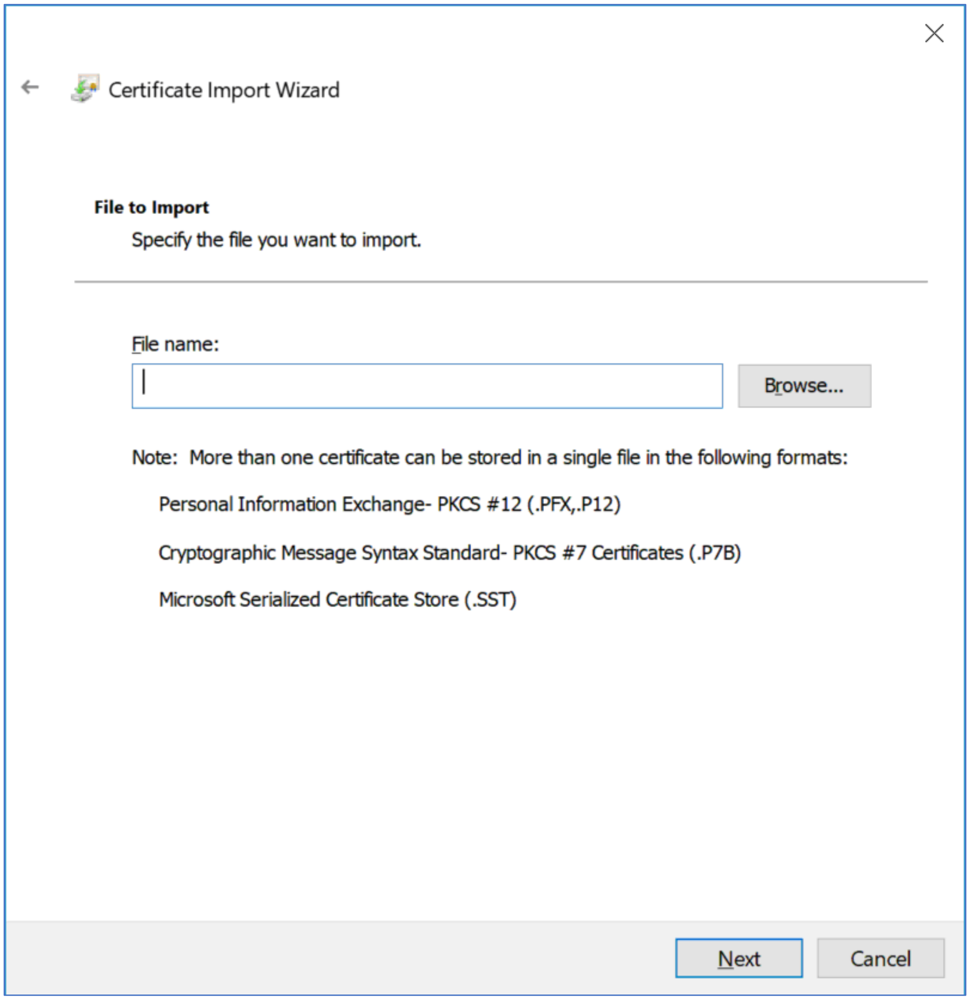

Figure 178: Windows Certificate Import Wizard-Browse

18. Select "Place all certificates in the following store."
19. Click on the Browse button, then select "Trusted Root Certification Authorities." When the Certificate Store parameter completes, click on the Next button. The Certificate Store screen is shown in Figure 179.

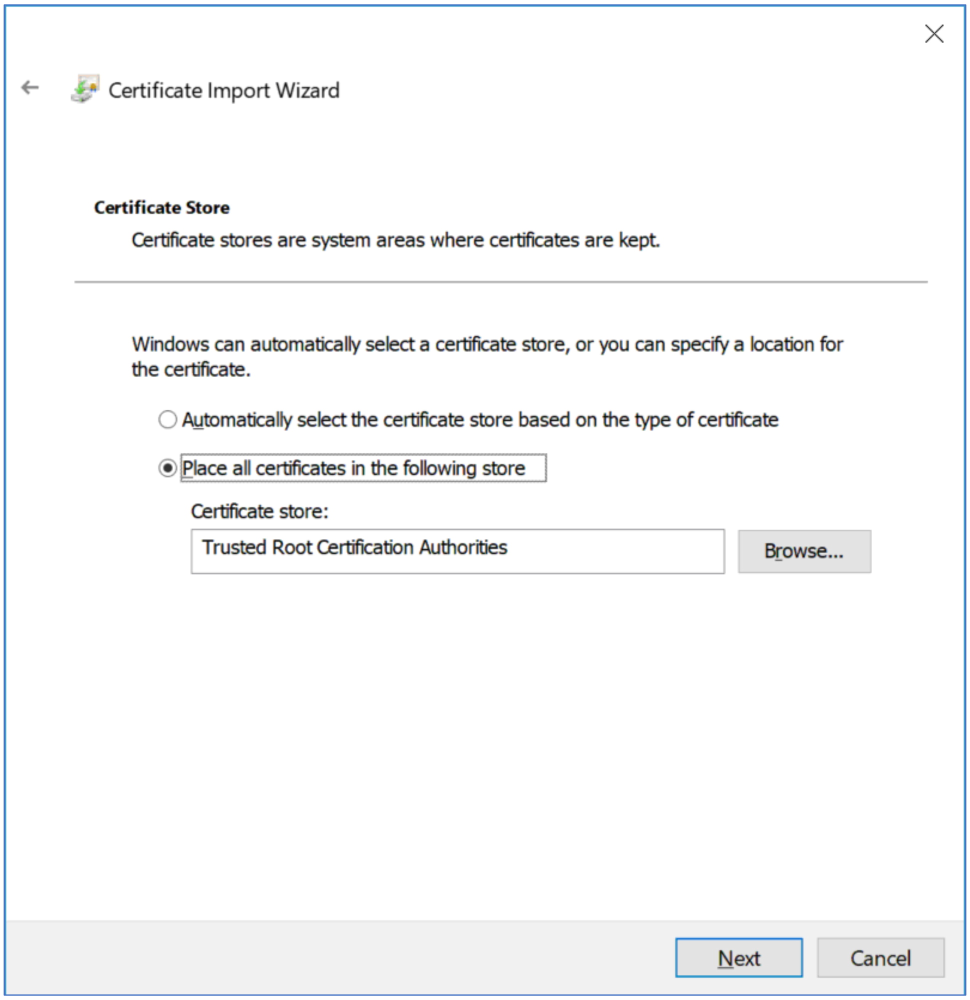

Figure 179: Windows Certificate Import Wizard-Choose Certificate Store

20. Click on the Finish button. A message displays “The import was successful.” Click on the OK button.
21. View the list of Certificates under Trusted Root Certification Authorities, and verify that Quasonix Root CA is listed, as shown in Figure 180.

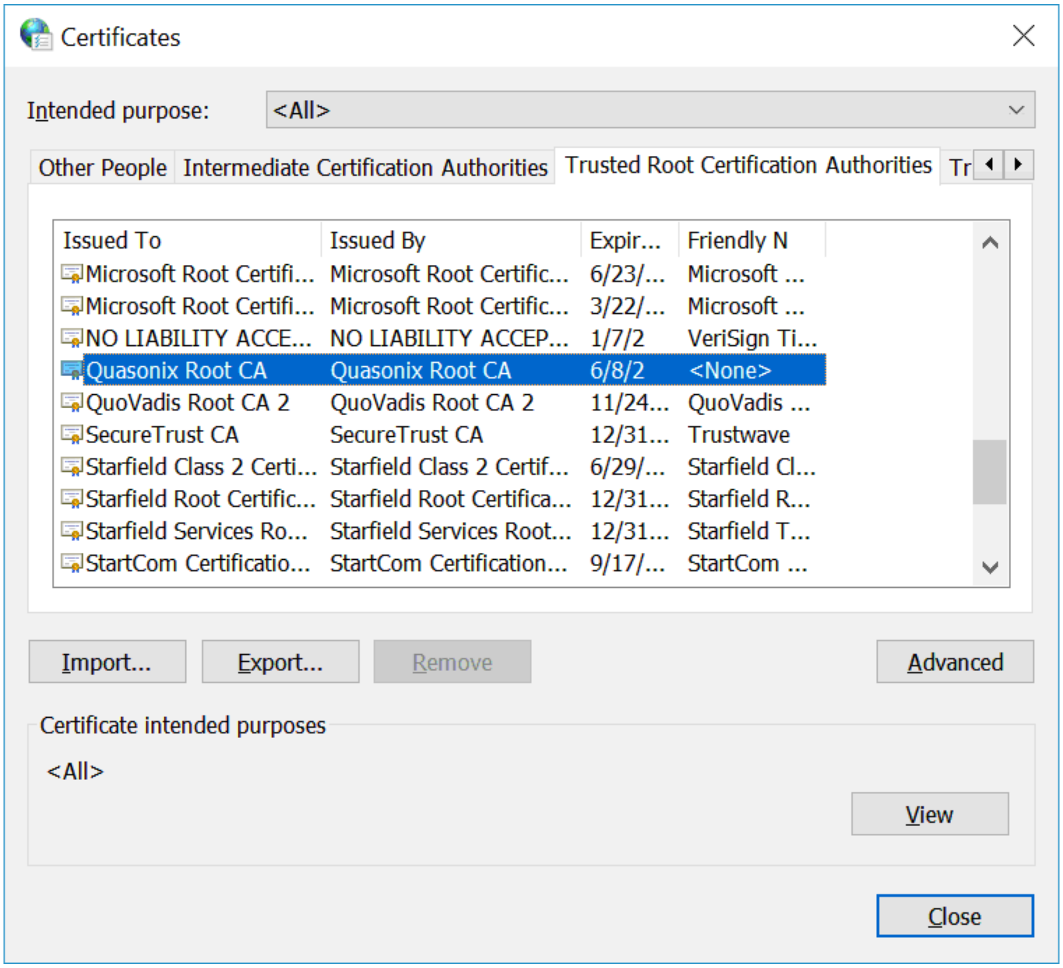

Figure 180: Certificates, Quasonix Certificate Imported

22. Using Edge, Internet Explorer, or Chrome, browse to https://RDMS_IP, where RDMS_IP is the IP address of the RDMS.

16 Appendix F – 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
CCSDS	Consultative Committee for Space Data Systems (coding standard)
CD	Compact Disk
CPM	Continuous Phase Modulation
CRC	Compact Receiver-Combiner
DB-9	D-subminiature 9 pin Serial Connector
DC	Diversity Combiner
DHCP	Dynamic Host Configuration Protocol
DPM	Digital Phase Modulation
DQ	Data Quality
DQE	Data Quality Encapsulation
DQM	Data Quality Metric
FPGA	Field Programmable Gate Array
IF	Intermediate Frequency
IP	Internet Protocol
kbps	Kilobits per second
KHz	Kilohertz
LCD	Liquid Crystal Display
LDPC	Low Density Parity Check
Mbps	Megabits per second
MCX	Snap on subminiature connector

Acronym	Description
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
QPSK	Offset 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	Surface Acoustic Wave
SDI	System Degradation Indication
SOQPSK	Shaped Offset Quadrature Phase Shift Keying
SOQPSK-TG	Shaped Offset Quadrature Phase Shift Keying –Telemetry Group
STC	Space-Time Coding
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
VDC	Voltage, Direct Current
WAN	Wide Area Network