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1 Introduction

1.1 Description

This document describes the installation and operation of the Quasonix 3rd Generation Rack-Mount RDMS™ Telemetry Receiver and is updated to match RDMS™ System Version 16. 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 intuitive front-panel interface as well as an extensible web-based browser interface, and antenna-tracking outputs, the Rack-Mount RDMS™ 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 Rack-Mount RDMS™ Telemetry Receiver is manufactured by:

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

The Rack-Mount RDMS™ (hereafter referred to as “RM RDMS™”) is available in a plethora of variations based on the number of channels, 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: Rack-Mount RDMS™ 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 filters (adds 70 kHz, 1.4, 3, 6, 14, and 28 MHz filters)
- **CS** Cybersecurity
- **EN** Ethernet Payload
- **EQ** Adaptive Equalizer
- **IP** Payload data delivered in IP format
- **K7** Viterbi Decoder (k=7, rate 1/2)

For example, a model QSX-RDMS-3R1D-Q0-1101-00-EQ is configured as shown in Table 1:

<table>
<thead>
<tr>
<th>Identifiers</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>QSX</td>
<td>Quasonix product</td>
</tr>
<tr>
<td>RDMS</td>
<td>Receiver / Demodulator / Bit Synchronizer</td>
</tr>
<tr>
<td>3</td>
<td>2 RF input channels, 3 baseband outputs, with combiner</td>
</tr>
</tbody>
</table>
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. The additional filters are 70 kHz, plus 1.4, 3, 6, 14, and 28 MHz.

1.2.2.2 Cybersecurity – CS
This option is used to address customer installation security requirements. Contact Quasonix for details.

1.2.2.3 Ethernet (EVTM) Payload, Receive Only – EN
When the EN option is enabled, the RDMS will recover EVTM encoded data and convert it from Serial Streaming Telemetry back to the original Ethernet packets. Standard SST operation is not replaced, and can still be used. This hardware must be paired with an -EN enabled transmitter for proper data recovery.

1.2.2.4 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 AQPSK, AUQPSK, and all STC modes.
1.2.2.5 Telemetry Over IP – IP

The Telemetry Over IP (TMoIP) capability packages PCM payload data into IP packets at the receiver. The receiver provides simultaneous PCM and network outputs with separate RJ-45 connectors for network control and data output. UDP and TCP protocols are available.

A web based graphical user interface (GUI) provides end-to-end TMoIP configuration, control, and status. Network Auto-Tune capability performs automatic measurement and compensation for uncertain or varying network delay and jitter. PCM serial input channels support automatic bit rate detection and IP packet size auto-configuration.

Fully configurable network parameters include DSCP/DiffServ Quality of Service, IPv4/IPv6, MTU, link speed, etc. Security features include integrated firewall with port blocking, password-authentication and user permissions, encrypted management interface, audit logging, and support for IPv6.

Detailed operating instructions are located in section 16, Appendix H of this manual.

1.2.2.6 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 adds redundant information to the transmitted data stream to help detect and correct bit errors that may occur, particularly due to predominantly Gaussian noise. Use of convolutional encoding requires a matching Viterbi decoder in the receiver to extract the source data. The 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-1, Blue Book, September 2003, Section 3.”
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:

- Rack-Mount receiver unit (1U or 3U)
- Power cord
- Ethernet cable (25 ft)
- Four (4) rubber feet with adhesive for lab bench use

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

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Receiver Section</strong></td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>Dual-conversion superheterodyne</td>
</tr>
<tr>
<td>Input RF Frequency</td>
<td>Refer to section 1.2.3</td>
</tr>
<tr>
<td>Tuning resolution</td>
<td>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</td>
</tr>
<tr>
<td>Frequency stability</td>
<td>1 ppm over temperature; 1 ppm per year aging</td>
</tr>
<tr>
<td>Reference oscillator</td>
<td>20 MHz</td>
</tr>
<tr>
<td>Noise figure</td>
<td>3.5 dB (typical), 5 dB (maximum)</td>
</tr>
<tr>
<td>LO phase noise, measured at 70 MHz IF output</td>
<td>-115 dBc/Hz @ 1 MHz offset</td>
</tr>
<tr>
<td>Maximum RF input</td>
<td>+20 dBm (+10 dBm for C-band)</td>
</tr>
<tr>
<td>Available gain (to 70 MHz IF output)</td>
<td>114 dB</td>
</tr>
<tr>
<td>Gain control</td>
<td>128 dB control range; User selectable: AGC or MGC (AGC freeze)</td>
</tr>
<tr>
<td>AGC load impedance</td>
<td>1 KOhm</td>
</tr>
<tr>
<td>AGC time constant</td>
<td>Adjustable to any value from 0.1 ms to 1000 ms</td>
</tr>
<tr>
<td>First IF bandwidth</td>
<td>60 MHz (nominal)</td>
</tr>
<tr>
<td>IF rejection</td>
<td>&gt; 90 dB</td>
</tr>
<tr>
<td>Image rejection</td>
<td>70 dB</td>
</tr>
<tr>
<td>RF input impedance</td>
<td>50 ohms</td>
</tr>
<tr>
<td>VSWR</td>
<td>3:1 Max; 2:1 Typical</td>
</tr>
<tr>
<td><strong>Second IF Section</strong></td>
<td></td>
</tr>
<tr>
<td>IF frequency</td>
<td>70 MHz</td>
</tr>
<tr>
<td>IF output level, nominal (AGC mode)</td>
<td>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 Channel 1 and 2 Mod Out: -5 dBm (3U RDMS only)</td>
</tr>
<tr>
<td>IF output impedance</td>
<td>50 ohms</td>
</tr>
<tr>
<td>VSWR</td>
<td>2:1 Max; 1.5:1 Typical</td>
</tr>
<tr>
<td>IF bandwidths</td>
<td>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</td>
</tr>
<tr>
<td><strong>Playback Demodulator IF In, Channel 1 and 2 Section</strong></td>
<td></td>
</tr>
<tr>
<td>Input Center Frequency</td>
<td>75 kHz – 20 MHz, 70 MHz through any selectable SAW filter</td>
</tr>
<tr>
<td>Input Level</td>
<td>-30 dBm ± 10 dB</td>
</tr>
<tr>
<td>Input Impedance</td>
<td>50 ohms, nominal</td>
</tr>
</tbody>
</table>
### Demodulator Section

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demodulator type</td>
<td>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)</td>
</tr>
</tbody>
</table>
| Bit Rates (after LDPC 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: -5.0 dB Eb/N0; RF Input (dBm): -115.0 (1 Mbps), -105.0 (10 Mbps)  
Tier I: -4.0 dB Eb/N0; RF Input (dBm): -114.0 (1 Mbps), -104.0 (10 Mbps)  
Tier II: -8.0 dB Eb/N0; RF Input (dBm): -118.0 (1 Mbps), -108.0 (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

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input codes</td>
<td>NRZ-L/M/S, BiΦ-L/M/S, RZ, DM-M/S, M2-M/S</td>
</tr>
<tr>
<td>Output codes</td>
<td>NRZ-L; or input code unaltered</td>
</tr>
<tr>
<td>Data and clock out</td>
<td>TTL (BNC) and RS-422</td>
</tr>
<tr>
<td>Lock detector out</td>
<td>TTL</td>
</tr>
<tr>
<td>Derandomizer</td>
<td>Standard IRIG 15-stage polynomial, selectable On/Off</td>
</tr>
</tbody>
</table>

### Video Section

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification</th>
</tr>
</thead>
</table>
| Video out (DC to 35 MHz)  | 1U—Quad wideband outputs: Ch1 and Ch2; Dual wideband outputs, Combiner  
3U—Quad wideband outputs: Ch1, Ch2, and 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

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Temperature</td>
<td>0°C to +50°C</td>
</tr>
<tr>
<td>Non-operating Temperature</td>
<td>-20°C to +70°C</td>
</tr>
<tr>
<td>Operating Humidity</td>
<td>0 to 95% (non-condensing)</td>
</tr>
<tr>
<td>Altitude</td>
<td>Up to 30,000 ft. (with the no displays options)</td>
</tr>
</tbody>
</table>

### Physical Section

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification</th>
</tr>
</thead>
</table>
| Size            | 1U rack-mount chassis: 18.95” wide, 1.72” tall, 14.00” rack depth, 14.74” overall depth  
3U rack-mount chassis: 18.95” wide, 5.22” tall, 14.06” rack depth, 14.80” overall depth |
| Weight          | 1U: 11.4 lbs. (dual-channel)  
3U: 16.0 lbs. |
| Power           | 100 to 240 VAC, 50/60 Hz                                                    |
3 Installation Instructions

3.1 Mechanical

3.1.1 1U Rack-Mount

The 1U RM RDMS™ Telemetry Receiver’s enclosure fits in a standard 19” rack, occupying just 1U of rack space. Mechanical layouts are provided in Figure 2 and Figure 3.

---

**Figure 2: Mechanical Drawing – 1U Front View**

---

**Figure 3: Mechanical Drawing – 1U Top View (Dual-channel Connectors Shown)**
3.1.2 3U Touchscreen

The 3U RM RDMSTM Telemetry Receiver’s enclosure fits in a standard 19” rack, occupying 3U of rack space. Mechanical layouts are provided in Figure 4 and Figure 5.

Figure 4: Mechanical Drawing – 3U Front View

Figure 5: Mechanical Drawing – 3U Top View (Dual-channel Connectors Shown)
3.2 Thermal

The storage temperature of the RM RDMS™ unit is rated for 0°C to +70°C, while the operating temperature is rated for 0°C to +50°C. It is recommended that the unit be kept in a temperature controlled environment to minimize the risk of operating (or storing) outside the ranges specified. In particular, the four liquid crystal displays on the front panel are extremely sensitive to low temperatures.

The RM RDMS™ features cooling vents on both sides of its aluminum chassis. These vents must be kept entirely unobstructed in order to allow for maximum airflow through the system. Whenever feasible, it is helpful to leave an open rack space above and below the RM RDMS™ for additional heat dissipation.

3.3 Electrical

The RM RDMS™ is available in single- or dual- channel configurations, with all pertinent electrical connections found on the rear panel.

3.3.1 1U Rear Panel Connections

Rear panel connectors are the same for all receivers; however, in a single-channel configuration all connectors are not active.

An optional pre-detection diversity combiner is available in the dual-channel receiver configuration. Connectors for the diversity combiner are present whether the feature is ordered or not. The electrical interface connectors for all configurations are shown in Figure 6.

![Figure 6: 1U Rear Panel](image)

Functional descriptions and electrical characteristics for each clock and data connector for channel 1, channel 2, and combiner located on the rear panel are described in Table 5. The pinout for the 1U J9, an MDM-25 D-sub connector, is shown in Table 6. The pinout for the 1U J23, an MDM-25 D-sub connector, is shown in Table 7.

The ports located on the right side of the back panel are described in Table 3.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (J31)</td>
<td>MDM-25 for Factory Use Only</td>
</tr>
<tr>
<td>HDMI (J33)</td>
<td>Currently Factory Use Only</td>
</tr>
<tr>
<td>USB (J34)</td>
<td>Currently Factory Use Only</td>
</tr>
<tr>
<td>Ethernet (J35)</td>
<td>Enables network access</td>
</tr>
<tr>
<td>Power</td>
<td>Supplies AC power to the unit</td>
</tr>
</tbody>
</table>
3.3.2 3U Rear Panel Connections

Rear panel connectors are the same for all receivers; however, in a single-channel configuration all connectors are not active.

An optional pre-detection diversity combiner is available in the dual-channel receiver configuration. Connectors for the diversity combiner, EVTM, and TMoIP are present whether the feature is ordered or not. The electrical interface connectors for all configurations are shown in Figure 7.

![Figure 7: Rear Panel](image)

Functional descriptions and electrical characteristics for each clock and data connector for channel 1, channel 2, and combiner located on the rear panel are described in Table 5.

The ports located on the right side of the back panel are described in Table 4.
### Table 4: Additional 3U Rear Panel Connectors

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Options Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>J71</td>
<td>MDM-25 for Factory Use Only</td>
<td>-</td>
</tr>
<tr>
<td>J73</td>
<td>N-connector Ethernet Via Telemetry Transmitter Output</td>
<td>EVTm</td>
</tr>
<tr>
<td>RDMS HDMI (J74)</td>
<td>Currently Factory Use Only</td>
<td>-</td>
</tr>
<tr>
<td>J75</td>
<td>10 MHz Input</td>
<td>-</td>
</tr>
<tr>
<td>J76</td>
<td>10 MHz Output</td>
<td>-</td>
</tr>
<tr>
<td>J77</td>
<td>IRIG-B Time Input</td>
<td>TMoIP</td>
</tr>
<tr>
<td>J78</td>
<td>IRIG-B Time Output</td>
<td>TMoIP</td>
</tr>
<tr>
<td>RDMS USB (J79)</td>
<td>Currently Factory Use Only</td>
<td>-</td>
</tr>
<tr>
<td>RDMS Control (J80)</td>
<td>RDMS Control or TMoIP Control</td>
<td>-</td>
</tr>
<tr>
<td>EVTM Data (J81)</td>
<td>RJ-45 (T568A) Ethernet via Telemetry Data</td>
<td>EVTm</td>
</tr>
<tr>
<td>TMOIP (J82)</td>
<td>RJ-45 (T568A) Telemetry over IP Data Stream Out</td>
<td>TMoIP</td>
</tr>
<tr>
<td>TMOIP USB (J83)</td>
<td>Keyboard/Mouse access for TMoIP</td>
<td>TMoIP</td>
</tr>
<tr>
<td>TMOIP VGA (J84)</td>
<td>SVGA HD-15 NetAcquire Video Out</td>
<td>TMoIP</td>
</tr>
<tr>
<td>Power</td>
<td>Supplies AC power to the unit</td>
<td>-</td>
</tr>
</tbody>
</table>
### Table 5: 1U and 3U Rear Panel Connector Specifications

<table>
<thead>
<tr>
<th>Receiver Nomenclature</th>
<th>1U</th>
<th>3U</th>
<th>1U</th>
<th>3U</th>
<th>1U</th>
<th>3U</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Channel 1</td>
<td>Channel 2</td>
<td>Combiner</td>
<td>Channel 1</td>
<td>Channel 2</td>
<td>Combiner</td>
</tr>
<tr>
<td></td>
<td>Connector Number/pin</td>
<td>Connector Number/pin</td>
<td>Connector Number/pin</td>
<td>Connector Number/pin</td>
<td>Connector Number/pin</td>
<td>Connector Number/pin</td>
</tr>
<tr>
<td>Clock A</td>
<td>J1</td>
<td>J15</td>
<td>J25</td>
<td>J1</td>
<td>J26</td>
<td>J51</td>
</tr>
<tr>
<td>Data A</td>
<td>J2</td>
<td>J16</td>
<td>J26</td>
<td>J2</td>
<td>J27</td>
<td>J52</td>
</tr>
<tr>
<td>Clock B</td>
<td>J9/14</td>
<td>J9/19</td>
<td>J9/25</td>
<td>J6</td>
<td>J31</td>
<td>J56</td>
</tr>
<tr>
<td>Data B</td>
<td>J9/15</td>
<td>J9/20</td>
<td>J9/24</td>
<td>J7</td>
<td>J32</td>
<td>J57</td>
</tr>
<tr>
<td>Clock C</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>J11</td>
<td>J36</td>
<td>J61</td>
</tr>
<tr>
<td>Data C</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>J12</td>
<td>J37</td>
<td>J62</td>
</tr>
<tr>
<td>Clock D</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>J16</td>
<td>J41</td>
<td>J66</td>
</tr>
<tr>
<td>Data D</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>J17</td>
<td>J42</td>
<td>J67</td>
</tr>
<tr>
<td>DAC A</td>
<td>J5</td>
<td>J19</td>
<td>J29</td>
<td>J3</td>
<td>J28</td>
<td>J53</td>
</tr>
<tr>
<td>DAC B</td>
<td>J6</td>
<td>J20</td>
<td>J30</td>
<td>J8</td>
<td>J33</td>
<td>J58</td>
</tr>
<tr>
<td>DAC C</td>
<td>J11</td>
<td>J13</td>
<td>-</td>
<td>J13</td>
<td>J38</td>
<td>J63</td>
</tr>
<tr>
<td>DAC D</td>
<td>J12</td>
<td>J14</td>
<td>-</td>
<td>J18</td>
<td>J43</td>
<td>J68</td>
</tr>
<tr>
<td>AGC OUT</td>
<td>J3</td>
<td>J17</td>
<td>J27</td>
<td>J9</td>
<td>J34</td>
<td>J59</td>
</tr>
<tr>
<td>AM OUT</td>
<td>J4</td>
<td>J18</td>
<td>J28</td>
<td>J4</td>
<td>J29</td>
<td>J54</td>
</tr>
<tr>
<td>AUX ANALOG A Out</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>J14</td>
<td>J39</td>
<td>J64</td>
</tr>
<tr>
<td>70MHz Mod out</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>J22</td>
<td>J47</td>
<td>J72</td>
</tr>
<tr>
<td>IF IN</td>
<td>J7</td>
<td>J21</td>
<td>-</td>
<td>J21</td>
<td>J46</td>
<td>-</td>
</tr>
<tr>
<td>IF Out</td>
<td>J8</td>
<td>J22</td>
<td>J32</td>
<td>J24</td>
<td>J49</td>
<td>J72</td>
</tr>
<tr>
<td>SDI</td>
<td>J9/4</td>
<td>J9/9</td>
<td>J9/10</td>
<td>J15/1</td>
<td>J40/1</td>
<td>J65/1</td>
</tr>
<tr>
<td>RS422/Clock A_p</td>
<td>J23/1</td>
<td>J23/5</td>
<td>J23/9</td>
<td>J20/1</td>
<td>J45/1</td>
<td>J70/1</td>
</tr>
<tr>
<td>RS422/Clock A_n</td>
<td>J23/14</td>
<td>J23/18</td>
<td>J23/22</td>
<td>J20/14</td>
<td>J45/14</td>
<td>J70/14</td>
</tr>
<tr>
<td>RS422/Data A_p</td>
<td>J23/2</td>
<td>J23/6</td>
<td>J23/10</td>
<td>J20/2</td>
<td>J45/2</td>
<td>J70/2</td>
</tr>
<tr>
<td>RS422/Clock B_p</td>
<td>J23/3</td>
<td>J23/7</td>
<td>J23/11</td>
<td>J20/3</td>
<td>J45/3</td>
<td>J70/3</td>
</tr>
<tr>
<td>RS422/Clock B_n</td>
<td>J23/16</td>
<td>J23/20</td>
<td>J23/24</td>
<td>J20/16</td>
<td>J45/16</td>
<td>J70/16</td>
</tr>
<tr>
<td>RS422/Clock C_p</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>J20/5</td>
<td>J45/5</td>
<td>J70/5</td>
</tr>
<tr>
<td>RS422/Clock C_n</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>J20/18</td>
<td>J45/18</td>
<td>J70/18</td>
</tr>
<tr>
<td>RS422/Data C_p</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>J20/6</td>
<td>J45/6</td>
<td>J70/6</td>
</tr>
<tr>
<td>RS422/Data C_n</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>J20/19</td>
<td>J45/19</td>
<td>J70/19</td>
</tr>
<tr>
<td>RS422/Clock D_p</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>J20/7</td>
<td>J45/7</td>
<td>J70/7</td>
</tr>
<tr>
<td>RS422/Clock D_n</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>J20/20</td>
<td>J45/20</td>
<td>J70/20</td>
</tr>
<tr>
<td>RS422/Data D_p</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>J20/8</td>
<td>J45/8</td>
<td>J70/8</td>
</tr>
<tr>
<td>RS422/Data D_n</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>J20/21</td>
<td>J45/21</td>
<td>J70/21</td>
</tr>
</tbody>
</table>

**Color Legend**

- **75 Ω BNC**
- **MDM-25**
- **50 Ω MMCX**
- **DB-9**
3.3.2.1 1U Digital Output MDM-25 D-Sub Pinout-J9

The pinout for the 1U J9, an MDM-25 D-sub connector, is shown in Table 6. Pin locations are illustrated in Figure 8.

<table>
<thead>
<tr>
<th>Pin</th>
<th>Electrical Char.</th>
<th>Pin</th>
<th>Electrical Char.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GND</td>
<td>14</td>
<td>CH1 CLK B (TTL)</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>15</td>
<td>CH1 DATA B (TTL)</td>
</tr>
<tr>
<td>3</td>
<td>CH1 Demod Lock (TTL)</td>
<td>16</td>
<td>CH1 Ones Detect (TTL)</td>
</tr>
<tr>
<td>4</td>
<td>CH1 SDI (RS-423)</td>
<td>17</td>
<td>GND</td>
</tr>
<tr>
<td>5</td>
<td>N/C</td>
<td>18</td>
<td>N/C</td>
</tr>
<tr>
<td>6</td>
<td>GND</td>
<td>19</td>
<td>CH2 CLK B (TTL)</td>
</tr>
<tr>
<td>7</td>
<td>DND</td>
<td>20</td>
<td>CH2 DATA B (TTL)</td>
</tr>
<tr>
<td>8</td>
<td>CH2 Demod Lock (TTL)</td>
<td>21</td>
<td>CH2 Ones Detect (TTL)</td>
</tr>
<tr>
<td>9</td>
<td>CH2 SDI (RS-423)</td>
<td>22</td>
<td>GND</td>
</tr>
<tr>
<td>10</td>
<td>COMB SDI (RS-423)</td>
<td>23</td>
<td>COMB Ones Detect (TTL)</td>
</tr>
<tr>
<td>11</td>
<td>COMB Demod Lock (TTL)</td>
<td>24</td>
<td>COMB Data B (TTL)</td>
</tr>
<tr>
<td>12</td>
<td>GND</td>
<td>25</td>
<td>COMB CLK B (TTL)</td>
</tr>
<tr>
<td>13</td>
<td>GND</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.3.2.2 1U RS-422 Output MDM-25 D-Sub Pinout-J23

The pinout for the 1U J23, an MDM-25 D-sub connector, is shown in Table 7. Pin locations are shown in Figure 8.

<table>
<thead>
<tr>
<th>Pin</th>
<th>Electrical Char.</th>
<th>Pin</th>
<th>Electrical Char.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CH1 CLK A RS-422_p</td>
<td>14</td>
<td>CH1 CLK A RS-422_n</td>
</tr>
<tr>
<td>2</td>
<td>CH1 DAT A RS-422_p</td>
<td>15</td>
<td>CH1 DAT A RS-422_n</td>
</tr>
<tr>
<td>3</td>
<td>CH1 CLK B RS-422_p</td>
<td>16</td>
<td>CH1 CLK B RS-422_n</td>
</tr>
<tr>
<td>4</td>
<td>CH1 DAT B RS-422_p</td>
<td>17</td>
<td>CH1 DAT B RS-422_n</td>
</tr>
<tr>
<td>5</td>
<td>CH2 CLK A RS-422_p</td>
<td>18</td>
<td>CH2 CLK A RS-422_n</td>
</tr>
<tr>
<td>6</td>
<td>CH2 DAT A RS-422_p</td>
<td>19</td>
<td>CH2 DAT A RS-422_n</td>
</tr>
<tr>
<td>7</td>
<td>CH2 CLK B RS-422_p</td>
<td>20</td>
<td>CH2 CLK B RS-422_n</td>
</tr>
<tr>
<td>8</td>
<td>CH2 DAT B RS-422_p</td>
<td>21</td>
<td>CH2 DAT B RS-422_n</td>
</tr>
<tr>
<td>9</td>
<td>COMB CLK A RS-422_p</td>
<td>22</td>
<td>COMB CLK A RS-422_n</td>
</tr>
<tr>
<td>10</td>
<td>COMB DAT A RS-422_p</td>
<td>23</td>
<td>COMB DAT A RS-422_n</td>
</tr>
<tr>
<td>11</td>
<td>COMB CLK B RS-422_p</td>
<td>24</td>
<td>COMB CLK B RS-422_n</td>
</tr>
<tr>
<td>12</td>
<td>COMB DAT B RS-422_p</td>
<td>25</td>
<td>COMB DAT B RS-422_n</td>
</tr>
<tr>
<td>13</td>
<td>GND</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 8: 1U MDM-25 D-Sub Pin Locations for J23 and J9
### 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 either user interface. The RM RDMS™ can be operated through its front panel interface or web-based browser interface (RDMS™ Browser Interface).

![Baseband Signal Timing - 0 degree clock](image)

**Figure 9: Baseband Signal Timing**

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

The RM RDMS™ also provides a 70 MHz IF output for each channel for troubleshooting purposes.

### 3.4 Browser Interface

The 3rd Generation Rack-Mount RDMS™ Receiver 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, thus eliminating the need for direct access to the front panel.

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 RDMS™.
2. Apply power to the RDMS™.
3. Open a browser on the PC.

   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 Ethernet screen on the RDMS™ front panel displays the IP address. (Refer to section 4.6.3.1.14 for additional information about the Ethernet screen.)
4. Type the IP address into the browser as:

   http://XXX.XXX.XXX.XXX

   where the X’s represent the IP address of the rack.

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

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

The RM RDMS™ can be operated through its front panel interface or via the web-based browser interface (RDMS™ Browser Interface). The browser interface is capable of configuring, maintaining, and monitoring multiple receivers within a network.

4.1 Operational Priority

With two different user interfaces available—direct front panel operation and remote control—consideration must be given to one or the other to maintain device stability.

- The front panel control takes precedence over the Browser Interface unless the front panel is displaying “Please Wait”.
- Changes saved from the Browser Interface are automatically updated on the front panel.
- Changes made on the front panel are automatically updated on the Browser Interface Monitor window; however, a user accessing the Configure window on the Browser Interface at the same time is notified of changes so unsaved modifications are not overwritten.
- Users may also access the RDMS remotely via Telnet. Telnet provides access to the individual receiver channel’s underlying serial control interface. The serial control interface is not recommended for typical Rack-Mount Receiver usage. The Telnet interface should only be accessed by advanced users. Contact Quasonix customer support before using the Telnet option.

Note: Access to this serial control interface is provided primarily for debugging purposes. Unlike the standard front panel and browser interfaces, the serial control interface within the Telnet window is not safeguarded from accidental or improper changes to the receiver’s configuration.

It is strongly recommended that users contact Quasonix Technical Support (Tel: 513-942-1287) prior to using the Terminal serial control interface.

Additional information about the Telnet interface is located in section 4.8.
4.2 Front-Panel Control

4.3 1U Front Panel Control

The 1U Rack-Mount Receiver’s comprehensive front panel interface includes (4) 64k-color liquid crystal displays (LCDs) for displaying receiver status, configuration settings, and waveform graphics; individual function keys for the most common settings; and a complete numeric keypad for convenient parameter entry.

In a single-channel configuration, waveform graphics are displayed on the left-most LCD and receiver settings are on the second LCD from the left. A static Quasonix logo is shown on the two right-most LCDs.

In a dual-channel receiver, the two LCDs located to the right of the power switch are designated for Channel 1, while the other two LCDs are designated for Channel 2.

![Front Panel Diagram for Dual-Channel Configuration](image10)

The front panel keypad is shown in Figure 11.

![Front Panel Keypad](image11)

4.4 3U Front Panel Control

The 3U front panel control interface is identical to the 1U front panel control interface except that the front panel keypad is implemented as a virtual keypad on the right touchscreen of the 3U, as shown in Figure 12.
4.5 Waveform Graphics

Each channel’s waveform graphics display provides a real-time visual representation of the received signal’s constellation, or eye pattern in the case for PCM/FM.

An example of a PCM/FM eye pattern is shown in Figure 13. An example of an SOQPSK constellation is shown in Figure 14. Additional information about waveform graphics displays, including spectrum displays, is located in section 4.6.3.2.

In addition to the eye pattern or constellation, the waveform graphics screen displays signal strength and signal quality in vertical bar graph form, a red line AGC Zero On indicator in the Signal Strength bar, and signal lock detect through a padlock icon, as shown in Figure 15.
The signal strength bar, the left of the two with the letter “S” below it, transitions from red at 0 dB Eb/N0 to green at 10 dB Eb/N0 and greater. The level in dBm is indicated above the bar.

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” below the graph. It transitions from red, being a zero (0) quality, to green, being a quality of 10. The DQM level is displayed at the top of the bar.

### 4.6 Navigation

The Rack-Mount Receiver’s traditional hierarchical menu structure is navigated using the arrow and Enter keys on the front panel keypad, as shown in Figure 16.
4.6.1 Selecting a Receiver Channel

In a single-channel configuration all front panel keys are active for the receiver. In a dual-channel configuration, Channel 1 will be active upon start-up by default. To toggle control between the channels, press the Select Unit key on the front panel keypad.

![Select Unit Key](Figure 17: Select Unit Key)

The LCD dedicated to receiver settings that is under active control features a white header bar and green text. The channel number displays in the top right hand corner of the screen. In Figure 18, “CH C” designates Combiner. When the Combiner is On, the Frequency Diversity option must be set to On to see separate Frequency selections for Channel 1 and Channel 2.

![Main Menu Settings LCD](Figure 18: Active Main Menu Settings LCD)

The Please Wait message, shown in Figure 19, displays whenever the RDMS™ is busy—generally when processing a command for longer than one second. This usually occurs during a Mode change, Ethernet configuration, or due to configuration via the Browser Interface.
4.6.2 Main Menu Settings

The available options from the Main Menu screen include the following:

- Frequency
- Frequency Diversity (Diversity Combiner On)
- Mode
- Bit Rate
- Combiner
- Data Polarity
- Clock Polarity
- Equalizer
- DQ Encapsulation
- Derandomizer
- Modulation Scaling (PCM/FM mode only)
- Modulation Persistence (PCM/FM mode only)
- Differential Decoding (SOQPSK mode only)
- AGC Menu
- AM Menu
- Options Menu
- Advanced Menu
- System Settings
- Graphics Menu

**Note:** Several of the Main Menu settings are also available via direct access function keys located to the left of the numeric keypad. These include Frequency (‘Freq’), Mode, and Bit Rate (‘Rate’). The front panel keypad is shown in Figure 20. Depending on the number of options provided with the RDMS™, some menu items may not display when the RDMS™ is powered on. To see additional LCD menu options, use the arrow keys to scroll up or down. The complete list redisplay continuously forward or backward, depending on which arrow key is pressed.
To change a setting or access a secondary menu, use the arrow keys to navigate to the parameter. When highlighted, the Enter key prompts a secondary menu screen or a setting screen, or changes the setting itself if there are only two possible states. To back out of a sub-menu, press the Escape key, ‘Esc’ on the front keypad.

4.6.2.1 Frequency

There are two methods available to the user to set the receiver’s frequency. The first one is to press the Freq key on the front panel keypad. The second method is to highlight the Frequency option on the Main Menu, then press the Enter key on the PC keyboard.

Either method displays a frequency entry screen prompting the operator to type a frequency using the rack’s front panel keypad.
The default frequency is highlighted. The user can use the front panel keypad to:

- a. Delete the entire number by pressing the left arrow key
- b. Move the cursor to the end of the number by pressing the right arrow key
- c. Begin typing the desired frequency, in MHz, using the numeric keypad

For example, to set the frequency of an S-band receiver to 2250.5 MHz, press the following key combination:

![Figure 24: Example Keypad Combination for Setting Frequency](image)

The available center frequencies are based on the band(s) and any extended options that are ordered, as shown in Table 2.

### 4.6.2.1.1 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.

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.

Refer to section 4.6.2.11, for additional information about Modulation Scaling.

### 4.6.2.2 Frequency Diversity (Available with Diversity Combiner)

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

The FreqDiversity option is toggled On or Off using the Enter key on the front panel keypad.

If there are two channels, the Combiner is set to On, and Frequency Diversity is Off, the channels are updated simultaneously and the Frequency Ch2 option does not display.

![Figure 25: Main Menu, Frequency Diversity Setting](image)

### 4.6.2.3 Mode

To set the mode, or modulation, press the Mode key on the front panel keypad for a display of the available choices. Use the keypad arrows to navigate to the desired mode, and then press the Enter key.
Due to character limitations in the on-screen menu, some modulation names have been shortened. The following table lists the modes, as they will appear on the screen in the left column, with the generally accepted naming convention in the right column.

<table>
<thead>
<tr>
<th>Screen Name</th>
<th>Actual Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCMFM</td>
<td>PCM/FM</td>
</tr>
<tr>
<td>SOQPSK</td>
<td>SOQPSK-TG</td>
</tr>
<tr>
<td>MhCPM</td>
<td>Multi-h CPM / ARTM CPM</td>
</tr>
<tr>
<td>BPSK</td>
<td>BPSK</td>
</tr>
<tr>
<td>QPSK</td>
<td>QPSK</td>
</tr>
<tr>
<td>AQPSK</td>
<td>AQPSK</td>
</tr>
<tr>
<td>AUQPSK</td>
<td>AUQPSK</td>
</tr>
<tr>
<td>OQPSK</td>
<td>OQPSK</td>
</tr>
<tr>
<td>UQPSK</td>
<td>UQPSK</td>
</tr>
<tr>
<td>DPM</td>
<td>Digital Phase Modulation</td>
</tr>
<tr>
<td>STC</td>
<td>Space Time Coding</td>
</tr>
<tr>
<td>SOQPSKLDPC</td>
<td>SOQPSK with Low Density Parity Check (LDPC) Decoder</td>
</tr>
<tr>
<td>STCLDPC</td>
<td>Space Time Coding with Low Density Parity Check</td>
</tr>
</tbody>
</table>

**Note:** Changing modes causes the receiver to reload the FPGA, which takes approximately twelve (12) seconds to complete. A ‘Please Wait’ message displays on the front panel display screen to indicate that the unit is being re-configured. The unit is temporarily unavailable during this time.
4.6.2.4 Bit Rate

There are two methods available to the user to set the receiver’s bit rate. The first one is to press the Rate key on the front panel keypad. The second method is to highlight the Bit Rate option on the Main Menu, then press the Enter key on the PC keyboard.

![Rate Key on Front Panel](image)

Either method displays a bit rate dialog screen prompting the operator to enter a bit rate using the rack’s front panel numeric keypad, in Mbps. A decimal point is only needed for bit rates with fidelity down into the kilobits per second range.

![Main Menu, Bit Rate Setting](image)

For example, to set the bit rate to 10 Mbps, press the following key combination:
If an out-of-range bit rate is entered, the maximum or minimum possible rate will be set by default. For instance, if the user attempts to set the bit rate to 50 Mbps in SOQPSK-TG mode, the receiver will default back to 46 Mbps, the highest possible rate in that particular mode.

4.6.2.5 Combiner (Optional)

A pre-detection diversity combiner is available as an option for dual-channel receivers. If diversity combining is installed on the RDMS™, it can be enabled through the Main Menu > Combiner option.

When the combiner is enabled on one channel, the second channel automatically reflects 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.

4.6.2.6 Data Polarity

The Data option on the Main Menu is for adjusting the data polarity. The parameter options are Normal and Inverted. To change the polarity, press the Enter key when the parameter is highlighted from the Main Menu. The default is Normal.
4.6.2.7 Clock Polarity

The Clock option on the Main Menu is for adjusting the clock polarity. The parameter options are Normal and Inverted. To change the polarity, press the Enter key on the front panel keypad when the parameter is highlighted on the Main Menu. The default is Normal.

4.6.2.8 Equalizer (Optional)

The (Adaptive) Equalizer option provides improved reception in multipath channels by reducing distortion. By enabling the equalizer, multipath fading is reduced and overall link availability is improved.

The Equalizer option is toggled On or Off using the Enter key on the front panel keypad.

The EQ (Adaptive Equalizer) option is currently available for use with all modes except AQPSK, AUQPSK, and all STC modes.
4.6.2.9 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 35.

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
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 = \( \min(\text{round}(-\log_{10}(LR) / 12 \cdot 2^{16})) \)  
  16-bit unsigned integer, ranges from 0 to 65,535

Likelihood Ratio (LR) = \( \frac{\text{BEP}}{(1 - \text{BEP})} \)

Easily reversed:

\[
LR = 10^{(-12 \cdot \text{DQM} / 2^{16})}
\]

\[
\text{BEP} = LR / (1 + LR)
\]

Q is defined as the “User's DQM”:

\[
Q = 12 \cdot \text{DQM} / 65536
\]

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

Examples:

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

**Figure 36: 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, press the Enter key on the front panel keypad when the parameter is highlighted on the Main Menu. The parameter options are Enable or Disable. Toggle between options to select the desired state. The default is Disabled.

**Note:** When DQE is enabled, normal bit error rate measurements cannot be made on the output data stream.
As noted above, the DQM is displayed as Signal Quality on the front panel, with a color-coded bar and a number above it (0-10).

4.6.2.10 Derandomizer

The RM RDMS™ includes a derandomizer, which can be enabled (two modes) or disabled by selecting the parameter from the Main Menu and pressing the Enter key on the front panel keypad. The default setting for the derandomizer is Off.

- Off
- IRIG – Standard running mode for non-LDPC operation
- CCSDS – Only available when an LDPC Mode is enabled (SOQPSKLDPC, or STCLDPC)
4.6.2.11 Modulation Scaling (PCM/FM Mode Only)

Modulation Scaling is a method used to retain the maximum trellis coding gain of a non-ideal FM signal. There are four possible settings: Tracking, Hold, Off, or Acquire.

4.6.2.11.1 Modulation Scaling – Tracking

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 rack 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 Tracking. 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 Tracking.

The graphing eye pattern is displayed in RED when in Tracking mode.
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 Tracking mode, the actual scaling operation functions independently in each channel.

4.6.2.11.2 Modulation Scaling – Hold

When the RDMS™ has a good lock on the target transmitter, Modulation Scaling should be set to Hold by highlighting the Mod Scaling option on the Main Menu and then pressing the Enter key on the keypad.

When Modulation Scaling is set to Hold, the graphing eye pattern is displayed in GREEN, indicating the optimal modulation index is set.

If Modulation Scaling is set to Hold, as shown in Figure 43, the active modulation scale index is also locked in on a particular setting. The modulation scale index number displays next to the Hold setting.

If an index number was entered manually using the Mod Scale Index option (on the Mod Scaling Menu), Modulation Scaling is simultaneously changed to Hold and reflects the Index value set via the Mod Scaling Menu.

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 via the Main Menu. Refer to section 4.6.2.12, Modulation Persistence.

4.6.2.11.3 Modulation Scaling – Off

The Mod Scaling Off setting is shown in Figure 45. When Modulation Scaling is set to Locked, the graphing eye pattern is displayed in GREEN, indicating the optimal modulation index is set.
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.

4.6.2.11.4 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 eye pattern will turn Yellow, as shown in Figure 48, 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 will turn 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.
4.6.2.12 Modulation Persistence (PCM/FM Mode Only)

The Mod Persist option allows the current state of the Mod Scaling setting to be retained following a power-off cycle of the rack. The default value is Off, as shown in Figure 49.

![Figure 49: Main Menu, Modulation Persistence – Off](image)

To retain a Locked index number, or to remain in Acquire mode, scroll to the Mod Persist option, then toggle the setting to On.

![Figure 50: Main Menu, Modulation Persistence – On](image)

4.6.2.13 Differential Decoding (SOQPSK Mode Only)

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.
4.6.2.14 AGC Menu

Access the Automatic Gain Control (AGC) menu from the front panel Main Menu. Select the AGC Menu, and then press the Enter key on the front panel keypad.

The AGC (Automatic Gain Control) menu, shown in Figure 53, includes the following parameters:

- Polarity (Positive/Negative)
- AGC Scale (dB/V)
- Time Constant (in ms)
- AGC Freeze
- AGC Zero Mode
- Zero AGC

4.6.2.14.1 AGC Polarity

The Polarity option is used to toggle the automatic gain control polarity between positive and negative.

The user may toggle the Polarity values by scrolling to the Polarity option and pressing the Enter key on the front panel keypad until the desired value, plus (+) or minus (-) sign, displays.
4.6.2.14.2 AGC Scale

The AGC Scale option, shown in Figure 54, adjusts the voltage of the AGC back panel BNC 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 KΩ. 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, select AGC Scale, then press the Enter key on the front panel. An entry screen (Figure 54) prompts the operator to type a new AGC Scale value, in db/V, using the rack’s front panel numeric keypad. When the new value is entered, press the Enter key on the keypad.

4.6.2.14.3 AGC Time Constant

The Time Constant option, shown in Figure 55, sets the time constant of the AGC back panel BNC 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 back panel BNC 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 Time Constant value, select Time Constant, then press the Enter key on the front panel. An entry screen (Figure 55) prompts the operator to type a new Time Constant, in milliseconds, using the rack’s front panel numeric keypad. When the new value is entered, press the Enter key on the keypad.

Refer to Appendix B for additional details about recommended AGC/AM settings.

4.6.2.14.4 AGC Freeze

AGC Freeze 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.

AGC Freeze can be enabled or disabled through the AGC Menu by pressing Enter when the parameter is selected. The Enter key acts as a toggle switch.
4.6.2.14.5 AGC Zero Mode

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 (set) manually after any frequency or IF bandwidth change, or after a power cycle; the IF bandwidth may change if the bit rate changes. If AGC was already zeroed and a user scrolls through the AGC Zero Mode options, AGC zero is cleared when Manual is selected.

- **Hold** – Means the AGC will hold 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 will hold its zero level after any frequency or IF bandwidth change, or after a power cycle.

The user may scroll through the AGC Zero Mode values by scrolling to the AGC Zero Mode option and pressing the Enter key on the front panel keypad until the desired value displays.

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

Zero AGC is used to set a baseline for background radio noise levels. The front panel displays provide visual indications whether the AGC is zeroed or not. If Zero AGC has not been set, the signal strength bar displays in gray and lacks the blue zero indication line, shown in Figure 58.

![Waveform Graphics Before Zero AGC Set](image)

Figure 58: Waveform Graphics Before Zero AGC Set

A typical application of the Zero AGC function is explained in the following example.

1. Connect the receiver to its normal RF signal source, such as antenna, LNA, cabling, and splitters.
2. Orient the receiving antenna in a direction that is expected to yield the lowest signal level that the receiver is likely to encounter, such as a cold, dark sky.
3. Activate Zero AGC under this condition. (Scroll to Zero AGC, and then press the Enter key on the front panel, as shown in Figure 59.)
4. After the Zero AGC is set, the signal strength bar changes from gray to green (if there is a signal lock), and a blue line indicates the zero value set, as shown in Figure 60. The strength bar changes from gray to red if there is no signal lock.
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.

**Note:** As mentioned in section 4.6.2.14.4, AGC Zero is cleared if a user scrolls to Manual in the AGC Zero Mode options (Manual, Hold, Hold and Save).

### 4.6.2.15 AM Menu

Access the Amplitude Modulation (AM) menu from the front panel Main Menu. Select AM Menu, then press the Enter key on the front panel keypad.
The AM (Amplitude Modulation) menu includes the following parameters:

- AM Bandwidth (00)
- AM Polarity (Positive/Negative)
- Scale (0.5-2.5)
- AGC Comp (Enabled / Disabled)

### 4.6.2.15.1 AM Bandwidth

To change the AM Bandwidth value, select the appropriate option, as shown in Figure 62, then press the Enter key on the front panel.

An entry screen prompts the operator to enter a new AM Bandwidth using the rack’s front panel numeric keypad, as shown in Figure 63. When the new value is entered, press the Enter key on the keypad.

The AM Bandwidth can be set from 5.0 to 50000.0 Hz.
4.6.2.15.2 AM Polarity

The user may toggle the AM Polarity (Figure 64) value by pressing the Enter key on the keypad until the desired value displays. Values are Positive and Negative.

![Figure 64: AM Menu, AM Polarity Highlighted](image1)

4.6.2.15.3 AM Scale

To change the AM Scale value, select the Scale option on the AM Menu, as shown in Figure 65, then press the Enter key on the front panel.

![Figure 65: AM Menu, Scale Highlighted](image2)

An entry screen prompts the operator to enter a new AM Scale using the rack’s front panel numeric keypad, as shown in Figure 66. When the new value is entered, press the Enter key on the keypad.

![Figure 66: AM Scale Entry Screen](image3)

The AM Scale has a range from 0.1 to 2.5. At its default setting of 1, the response is 2V p-p, into a 75 ohm load with a 50% AM.

4.6.2.15.4 AGC Comp

The user may toggle the Automatic Gain Control (AGC) Compensation state by scrolling to the AGC Comp option and pressing the Enter key on the front panel keypad until the desired value displays (Enabled or Disabled). Refer to Appendix B for more information about the AGC Comp function.
4.6.2.16 Options Menu

The Options Menu (Figure 69), which is accessed through the Main Menu (Figure 68), provides the following selections:

- Load Presets Menu
- Save Presets Menu
- Factory Default

4.6.2.16.1 Load Presets Menu

The Load Menu allows previously stored configuration settings from the Save Presets screen, or the system default presets, to be retrieved. (The RDMS ships with predefined presets. Presets are always available even if the user has not created any custom presets. There are no "empty" preset slots.) To load saved presets, select the appropriate option, then press the Enter key on the front panel.

The Load Presets screen, shown in Figure 70, displays eight (8) slots which contain saved preset configurations. The menu displays the file name for the preset next to the load slot. These names can be modified via the Browser Interface. The file name may be truncated on the front panel display since the Browser Interface allows up to 20
characters. Use the Up and Down arrow keys to select a load slot with desired file name displayed. Pressing the Enter key loads the stored preset and configures the receiver accordingly.

### Figure 70: Load Menu, Load Presets

<table>
<thead>
<tr>
<th>Preset</th>
<th>Ch:C</th>
<th>Mission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preset 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preset 2</td>
<td>Mission 2</td>
<td></td>
</tr>
<tr>
<td>Preset 3</td>
<td>Mission 3</td>
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<td>Preset 4</td>
<td>Mission 4</td>
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<td>Preset 6</td>
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<tr>
<td>Preset 7</td>
<td>Mission 7</td>
<td></td>
</tr>
<tr>
<td>Preset 8</td>
<td>Mission 8</td>
<td></td>
</tr>
</tbody>
</table>

#### 4.6.2.16.2 Save Presets Menu

With the 3rd Generation RDMS™ there is no such thing as an empty preset. A brand new RDMS™ contains eight default presets. The Save Presets Menu allows the current settings to be saved for convenient retrieval at a later time, or for quickly switching between configurations. The Save Presets Menu, shown in Figure 71, shares the same set of presets with the Browser Interface.

The Save Presets Menu, shown in Figure 71, illustrates the eight (8) slots for saving presets. Use the Up and Down arrow keys to select a save slot. Press the ‘Enter’ key to save the current configuration in that slot. A wait message displays while the configuration is being saved, then the front panel redisplays the Options Menu.

Quasonix’ new Browser Interface may be used to customize a preset name and description as well as select other preset parameters and advanced settings. Users of previous 2nd Generation RDMS™ receivers will find this additional flexibility an improvement over simply typing a new preset name in a front panel screen. The Browser Interface Saved Presets window, discussed in section 4.7.4, is handy for viewing complete preset descriptions. Since there is no delete presets option, this helps the user to know which presets might be overwritten.

Presets may also be exported and imported from a file saved on a connected computer. Refer to section 4.7.6.3 (Export) or section 4.7.6.4 (Import) for additional information.

### Figure 71: Save Menu, Save Presets – Slot 1 and Slot 3 Contain Saved Presets

<table>
<thead>
<tr>
<th>Preset</th>
<th>Ch:C</th>
<th>Mission</th>
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</thead>
<tbody>
<tr>
<td>Preset 1</td>
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<td>Preset 2</td>
<td>Mission 2</td>
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<td>Preset 3</td>
<td>Mission 3</td>
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<td>Preset 4</td>
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<tr>
<td>Preset 7</td>
<td>Mission 7</td>
<td></td>
</tr>
<tr>
<td>Preset 8</td>
<td>Mission 8</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Preset</th>
<th>Ch:C</th>
<th>Mission</th>
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<tbody>
<tr>
<td>Preset 1</td>
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<tr>
<td>Preset 2</td>
<td>Mission 2</td>
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<tr>
<td>Preset 7</td>
<td>Mission 7</td>
<td></td>
</tr>
<tr>
<td>Preset 8</td>
<td>Mission 8</td>
<td></td>
</tr>
</tbody>
</table>
4.6.2.16.3 Factory Default

The Factory Default option allows the user to reset each channel of the Rack-Mount Demodulator/Receivers to the factory default settings. Factory Default reset does not affect Ethernet settings or presets.

![Options Menu, Factory Default Selection and Reset in Process](image)

4.6.2.17 Advanced Menu

The Advanced Menu should only be accessed by advanced users. Contact Quasonix customer support before using these options.

The Advanced Menu, which is accessed via the Main Menu, as shown in Figure 73, provides access to the following options:

- Sync Bit Rate
- IF Filter
- Phase Noise Comp (PCM/FM mode only)
- Muting Timeout
- Output Muting
- DC Antenna
- Mod Scale Index
- Best Channel Selector
- Time Aligner
- Combiner Mode
- AFC Mode
- PCM Encoding
- LDPC Mode
- Video Output Menu
- Clk/Data Output Menu
4.6.2.17.1 Synchronize Bit Rate

Synchronize Bit Rate sets the receiver’s commanded bit rate to the value it is currently measuring on the input signal. 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.

The Sync Bit Rate option is located on the Advanced Menu, as shown in Figure 74.

To apply the measured bit rate, scroll to the Sync Bit Rate option to highlight it. Then press the Enter key on the front panel keypad. The displayed bit rate value will be set as the new bit rate.

**Note:** The measured bit rate will be set whether it is accurate or not. For proper operation, ensure that the receiver indicates it is locked (green padlock) prior to using the Sync Bit Rate function.

4.6.2.17.2 IF Filter

The receiver’s integrated IF filter module, shown in Figure 75, 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.

![Figure 75: 70 MHz IF Module in 2" x 3" Chassis](image)

The measured responses of the eight filters are shown in Figure 73 and Figure 74 (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 75 and Figure 76. Contact Quasonix for information about the optional filters.
Figure 76: 70 MHz IF Module in 2” x 3” Chassis SAW Filter Responses, Narrow Group (10 MHz Span)
Figure 77: SAW Filter Responses, Wide Group (Plotted on 100 MHz Span)
Figure 78: Optional SAW Filter Responses for 70 kHz to 6 MHz
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 via the IF Filter Menu on the front panel LCD, as shown in Figure 80, 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.

4.6.2.17.3 Phase Noise Comp (PCM/FM Mode Only)
The Phase Noise Comp option, shown in Figure 81, is used to set the Phase Noise Compensation value to On or Off.
The user may toggle the Phase Noise Compensation value by pressing the Enter key on the front panel keypad until the desired value displays.

**4.6.2.17.4 Muting Timeout**

The Muting Timeout option, shown in Figure 82 is used to set a timeout value (in milliseconds). This setting is used to determine when to mute (stop sending data) when the Muting option is set to On.

A dialog screen displays prompting the operator to enter a new Muting Timeout value (in milliseconds) using the rack’s front panel numeric keypad. The valid range is 0 to 46016 milliseconds. The Muting Timeout Entry screen is shown in Figure 83. When the new value is entered, press the Enter key on the keypad.
4.6.2.17.5 Output Muting

The Output Muting option, shown in Figure 84, is used to set the muting value to On or Off. When the Output Muting option 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.

The user may toggle the Muting value On or Off by pressing the Enter key on the front panel keypad until the desired value displays.

4.6.2.17.6 DC Antenna

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

The user may toggle the DC Antenna value On or Off by pressing the Enter key on the front panel keypad until the desired value displays.

- When the downconverting antenna is not available, this command displays only an assumed value.
- The downconverting antenna setting only applies to C band frequencies.
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. If there is a downconverting antenna, it is ignored. The receiver is tuned to the actual P band frequency and the automatic spectral inversion is disabled.

### 4.6.2.17.7 Mod Scale Index

The Mod Scale Index option, shown in Figure 86, 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.

When modulation scale index is set, the Modulation Scaling option 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 Mod Persist from the Main Menu. Refer to section 4.6.2.12, Modulation Persistence.
To change the Modulation Scale Index, select Mod Scale Index, then press the Enter key on the front panel.

A dialog screen displays prompting the operator to enter a new modulation scale index using the rack’s front panel numeric keypad. The valid modulation scale index range is 0.350 to 8.000. The Index Entry screen is shown in Figure 87. When the new value is entered, press the Enter key on the keypad.

To clear any locked 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.

4.6.2.17.8  Best Channel Selector

The Best Channel Selector option, shown in Figure 88, is used to set the Best Channel Selector value to On or Off. When this option is On, the combiner data output selects the best channel (1, 2, or Combiner) based on DQM.

The user may toggle the Best Channel Selector value by pressing the Enter key on the front panel keypad until the desired value displays.
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 89.

Figure 89: 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 4.6.2.9 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 RDMSTM BCS outputs leverages the strengths of both.

4.6.2.17.8.1 Best Channel Selector Indicator

Best Channel Selector 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, as shown in Figure 90.

![Figure 90: Best Channel Indicator Example](image)

Each demodulated signal (Channel 1, Combiner, and Channel 2) is represented by a character in the BCS 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 combiner 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

One useful way to read this display is “[bright green signal] has data quality of [indicated value].” In the example above, this becomes “the combiner has data quality of 10.”

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 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.

Figure 91 illustrates a good signal for Channel 1 and Channel 2, with the best signal being selected from the Combiner.

![Figure 91: Best Channel Indicator-Combiner](image)

Figure 92 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 92: Best Channel Indicator-Ch 1](image)

Figure 93 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 93: Best Channel Indicator-Ch 2

Figure 94 illustrates BCS Off.

Figure 94: Best Channel Indicator Off (Grey)

4.6.2.17.9 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.
Enabling the (combiner) time aligner, as shown in Figure 95, lets it determine when to operate (with no user intervention).

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.

4.6.2.17.10 Combiner Mode

The Quasonix RDMS™ Combiner can operate in one of two modes: Maximal Ratio or Best Source.

Maximal Ratio combining provides the best pre-detection combining possible, as long as the Channel 1 and Channel 2 input signals can be phase- and time-aligned by the Combiner. In this mode, the Combiner aligns the signals and, using an accurate measure of signal quality, generates their weighted sum. This sum contains the best of both signals plus uncorrelated noise, resulting in up to 3 dB improvement in effective SNR over each individual channel.

Best Source combining is a suboptimal method of combining, but it works for cases in which the Channel 1 and Channel 2 input signals cannot be phase- and time-aligned by the Combiner. Such cases would be rare, but one possible case might be spatial diversity over larger distances than the Combiner Time Aligner can compensate. In this mode, the Combiner continuously selects the channel with better signal quality, so there is no improvement in
performance relative to the current best channel. Because Best Source combining is used when proper alignment of the two signals may not be achievable, the Time Aligner should be disabled when this Combiner Mode is selected.

Note: The Best Channel Selector (section 4.6.2.17.10) does not replace, but virtually obsoletes, the Diversity Combiner Best Source mode. In any application where phase- and time-alignment are possible, even if only occasionally, it is recommended that the Diversity Combiner Maximal Ratio mode be used in conjunction with enabling the Best-Channel Selector.

4.6.2.18 AFC Mode

AFC (Automatic Frequency Control) Mode, shown in Figure 97, 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. Therefore, AFC is particularly applicable to lower bit rates and may be automatically overridden to Off at higher bit rates, regardless of the user specified AFC mode.

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. There are three possible settings: Off, Track, or Hold. In general, Quasonix recommends setting the AFC Mode to Off if possible.

The user may toggle the AFC mode by pressing the Enter key on the front panel keypad until the desired value displays.

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 section 4.9.1.3 for AFC command details.

4.6.2.18.1 AFC Mode – Off

The AFC Mode Off setting is shown in Figure 98. In this mode, 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. In general, Quasonix recommends setting the AFC Mode to Off.
4.6.2.18.2 AFC Mode – Track
When AFC Mode is set to Track, as shown in Figure 99, 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.

4.6.2.18.3 AFC Mode – Hold
When AFC Mode is set to Hold, as shown in Figure 100, 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.
4.6.2.19 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: Bi\(\phi\), level
- Biphase-M: Bi\(\phi\), mark
- Biphase-S: Bi\(\phi\), 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, Bi\(\phi\), 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.

The user may select the PCM Encoding value by pressing the Enter key on the front panel keypad, and then selecting the appropriate value from the PCM Encoding selection screen, shown in Figure 102.
4.6.2.20 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 104. 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 4.6.2.18 for additional information about AFC Mode.
Note: LDPC Mode always displays on the Advanced Menu. Selected values are NOT active unless the waveform Mode is SOQPSKLDPC or STCLDPC.

4.6.2.21 Video Output Menu

The Video Output Menu, which is accessed via the Advanced Menu, as shown in Figure 105, provides access to the following options:

- Channel A Output
- Channel B Output
- Channel A Scale
- Channel B Scale
- Tape Out Freq (MHz)
- FM De-emphasis (PCM/FM mode only)

4.6.2.21.1 Channel A Output

The Channel A Output option, shown in Figure 106, 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 9.
Table 9: Normal (Default) Video Output Signals

<table>
<thead>
<tr>
<th>Mode</th>
<th>I/Video A</th>
<th>Q/Video B</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCM/FM</td>
<td>Eye Pattern</td>
<td>Unused (0 Volts)</td>
</tr>
<tr>
<td>SOQPSK, SOQPSK/LDPC</td>
<td>Noncoherent I/Q Baseband</td>
<td>Noncoherent I/Q Baseband</td>
</tr>
<tr>
<td>MHCPM</td>
<td>Noncoherent I/Q Baseband</td>
<td>Noncoherent I/Q Baseband</td>
</tr>
<tr>
<td>BPSK</td>
<td>I Baseband</td>
<td>Unused</td>
</tr>
<tr>
<td>QPSK, OQPSK, AQPSK, UQPSK, AUQPSK</td>
<td>I Baseband</td>
<td>Q Baseband</td>
</tr>
<tr>
<td>DPM</td>
<td>I Baseband</td>
<td>Unused</td>
</tr>
</tbody>
</table>

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).

4.6.21.2 Channel B Output

The Channel B Output option, shown in Figure 107, 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 9. 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).
4.6.21.3 Channel A Scale

The Channel A Scale option, shown in Figure 108, 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.

To change the Channel A Scale setting, select the Channel A Scale option, then press the Enter key on the front panel. A dialog screen displays prompting the operator to enter a new Channel A scale setting using the rack’s front panel numeric keypad. When the new value is entered, press the Enter key on the keypad.

4.6.21.4 Channel B Scale

The Channel B Scale option, shown in Figure 109, 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.

To change the Channel B Scale setting, select the Channel B Scale option, then press the Enter key on the front panel. A dialog screen displays prompting the operator to enter a new Channel B scale setting using the rack’s front panel numeric keypad. When the new value is entered, press the Enter key on the keypad.
4.6.2.21.5 Tape Out Frequency

The Tape Out Frequency option, shown in Figure 110, 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.

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

The FM De-emphasis option, shown in Figure 111, 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.
The user may toggle the FM De-emphasis value by pressing the Enter key on the front panel keypad until the desired value displays.

4.6.2.22 Clk/Data Output Menu (1U Receiver)

The Clk/Data Output Menu, which is accessed via the Advanced Menu, as shown in Figure 112, provides access to the following options:

- Channel A Output
- Channel B Output

4.6.2.22.1 Channel A Output

The Channel A Output options, shown in Figure 113, 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 DQE is enabled in the Main Menu, the output is encapsulated, otherwise it will 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
4.6.2.22.2 Channel B Output

The Channel B Output options, shown in Figure 113, 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 DQE is enabled in the Main Menu, 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

4.6.2.23 Clk/Data Output Menu (3U Receiver)

The Clk/Data Output Menu, as shown in Figure 115, provides access to four channels in a 3U receiver:

- Channel A Output
- Channel B Output
- Channel C Output
- Channel D Output

Clock and data output for the additional 3U channels functions the same as the channel selections in a 1U receiver.
4.6.2.24 Test Utilities

The Test Utilities selections, accessed via the Advanced Menu, as shown in Figure 116, provide access to the following options:

- Noise Generator
- Test Generator

4.6.2.24.1 Noise Generator

The Noise Generator, shown in Figure 117, 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
• Noise Level - Sets the noise level to use in the test in dB $E_b/N_0$, as shown in Figure 118

4.6.2.24.2 Data Generator

The Data Generator option, shown in Figure 119, 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.

• Test Data – Enable or disable test data generation
• Data rate in Mbps – Typing a number in this field sets the data rate in Mbps

• Pattern – Sets the data pattern produced by the data generator; 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 $2^5-1$ 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”

• Inversion – Set to Normal or Inverted; 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
• Randomization – Enable or disable IRIG 106 15-bit randomization; *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.

![Data Generator, Randomization](image)

**Figure 124: Data Generator, Randomization**

### 4.6.3 System Settings

Access the System Settings menu from the front panel Main Menu. Select System Settings, then press the Enter key on the front panel keypad.

![Main Menu, System Settings Selection](image)

**Figure 125: Main Menu, System Settings Selection**

The System Settings menu includes the following parameters:

- System Info
- Ethernet
- Web Server
- Fan Control
- System Update
4.6.3.1 System Info

The System Info screen, shown in Figure 127, is a display only screen. It provides the following information about the RDMS™.

The System Info screens provide all of the pertinent network settings for the rack unit, including: RDMS model number, Serial Number, System Version, the FPGA version number, software version numbers, DHCP status, IP Address, IP Subnet address, MAC address, Alias, and Secure Name.

4.6.3.1.1 Model

Model describes the type of Quasonix receiver in use.

4.6.3.1.2 Serial Number

Serial number describes the Quasonix manufacturing serial number which identifies this specific RDMS™ receiver.

4.6.3.1.3 System Version

System Version describes the firmware version in use in this RDMS™ receiver.
4.6.3.1.4 FP Version
FP Version describes the FPGA version loaded in this RDMS™ receiver.

4.6.3.1.5 Ch1, Ch2, ChC Version
The Ch1, Ch2, and ChC Version numbers describe the software versions installed on each individual brick in the RDMS™ receiver.

4.6.3.1.6 DHCP
The DHCP option, when enabled, allows the rack unit to automatically receive an IP address from the local DHCP server. If DHCP is turned off, then the user must choose a valid IP address for the unit.

4.6.3.1.7 IP Address
The IP address for the rack unit will either be assigned to it automatically through the use of DHCP, or it must be entered by the user. When choosing an IP address, it is critical that the address is unique; otherwise the unit will not operate within the network properly. It is strongly recommended that the user contact their network administrator to receive a reserved address for this purpose.

4.6.3.1.8 Subnet
The subnet mask identifies the portion of the IP address used as a host identifier for the subnet in which the Quasonix rack unit participates. It is expressed in a quad-dotted decimal representation, just like the unit’s IP address. The most common subnet mask is 255.255.255.0, which means that the unit’s last 8-bit number (i.e. 0 through 255) uniquely identifies it within its sub-network.

4.6.3.1.9 Gateway
The Gateway address displays the Gateway network IP address.

4.6.3.1.10 MAC
The MAC (Media Access Control) is a hardware address uniquely identifying the RDMS™ receiver on the local communication network.

4.6.3.1.11 Alias
This optional parameter is used to provide an alternative name to a rack in addition to the IP Address. The default alias name is RDMS3. The Alias is set via the Browser Interface. When using the Browser Interface (refer to Section 4.7), the alias can be used to quickly identify a particular rack in the displayed list. Examples of a rack alias might be “RDMSLab1”, “TestLabLevel4”, or “XYZProjectRDMS”.

4.6.3.1.12 System IP
The System IP address for the rack unit is assigned automatically. It will always match the IP Address unless the RDMS is a TMoIP unit. In a TMoIP unit, the System IP is the TMoIP address.

4.6.3.1.13 Secure Name (Currently Unavailable)
RDMS™ racks may be configured two different ways, depending on the preferred structure. A Group Identifier (ID) is used to provide a unique name for each RDMS™. In the first configuration, racks may be named based on department, such as Lab, Development, Production, Demonstration, etc. In the second configuration, racks may be named for independent users, such as Office1, B4Btest, TestX, etc.

4.6.3.1.14 Ethernet
The Ethernet screen, shown in Figure 128, is used to set the DHCP mode, the IP Address, Subnet, and Gateway address.
4.6.3.1.14.1 DHCP
This is the Dynamic Host Configuration Protocol. On some networks, the DHCP assigns dynamic IP addresses to the devices on the network—in other words, it assigns a new IP address each time the user connects to the network. Some networks manage the DHCP manually.

To change the DHCP setting, press the Enter key on the keypad to toggle between On and Off.

4.6.3.1.14.2 IP Address
The IP Address must be assigned manually when DHCP is not in use on a network.

1. To assign an IP address, use the down arrow on the keypad to highlight the IP Address (Figure 129), then press the Enter key.
2. Type the IP address in the IP Address entry screen (Figure 130), then press the Enter key.
3. To exit without making a change, press the Esc key.

4.6.3.1.14.3 Subnet
The IP Subnet must be assigned manually when DHCP is not in use on a network.

1. To assign an IP subnet, use the down arrow on the keypad to highlight the IP Subnet (Figure 131), then press the Enter key.
2. Type the IP subnet in the IP Subnet entry screen (Figure 132), then press the Enter key.
3. To exit without making a change, press the Esc key.

4.6.3.1.14.4 Gateway
The Gateway address is used to set the Gateway network IP address, if required. Contact your network administrator for the correct gateway address.

1. To assign the Gateway IP address, use the down arrow on the keypad to highlight Gateway (Figure 133), then press the Enter key.
2. Type the Gateway address in the Gateway entry screen (Figure 134), then press the Enter key.
3. To exit without making a change, press the Esc key.

4.6.3.1.14.5 TMoIP Address
In an RDMS TMoIP unit, the TMoIP address displays on the Ethernet screen, as shown in Figure 135. The TMoIP address for the rack unit is assigned automatically.
4.6.3.1.15 Web Server

The Web Server screen, shown in Figure 136, is used to set the HTTPS server parameter On or Off. This parameter may only be set from the front panel of the receiver. The current setting is displayed with the Ethernet parameters on the System Information window and is accessed via the About screen in the Browser Interface.

Note: When turning HTTPS On or Off, the web server must restart and may take up to one (1) minute to accept connections from a web browser.

HTTPS is a widely-used secure communication extension to HTTP that uses Transport Layer Security (TLS) to encrypt all communications between the client and server. It also enables authentication of the accessed website via a system of verified and trusted certificates. Enabling HTTPS on the RDMS ensures that the connection is being made to an authentic RDMS, and that all communications between the web browser and RDMS are secure.

Connection to the RDMS HTTPS server requires a Quasonix Root Authority certificate, obtained from Quasonix. This certificate is generated by Quasonix, and is used to verify the server certificates presented by the RDMS upon HTTPS connection with a web browser. The Quasonix Root Authority certificate must be imported into the browser prior to making an HTTPS connection to the RDMS. If a connection is made without importing the certificate, the user could see one of the following security/privacy errors from the browser:
Your connection is not secure

The owner of 192.168.222.22 has configured their website improperly. To protect your information from being stolen, Firefox has not connected to this website.

Learn more...

- Report errors like this to help Mozilla identify and block malicious sites

Go Back  Advanced

Figure 137: Firefox HTTPS Connection Without Quasonix Certificate Imported

This site is not secure

This might mean that someone's trying to fool you or steal any info you send to the server. You should close this site immediately.

- Go to your Start page

Details

Your PC doesn't trust this website's security certificate.

Error Code: DLG_FLAGS_INVALID_CA

Go on to the webpage (Not recommended)

Figure 138: Edge HTTPS Connection Without Quasonix Certificate Imported
In order to instruct the browser to ‘trust’ the certificate provided by the RDMS, the user must import the Quasonix Root Authority certificate. Instructions for importing the certificate into the browser vary by application and are located in section 18, Appendix J.
After the Quasonix Root Authority certificate has been imported into the browser, the browser will indicate a secure connection to the RDMS, as seen in Figure 141 though Figure 144. Connect to the HTTPS Browser Interface by entering “https://” followed by the IP address of the RDMS (for example, https://192.168.222.22). When the connection is made, you may operate the interface just as you would with the standard HTTP interface. The browser indicates a secure connection by displaying a padlock image in the address bar.

**4.6.3.1.16 Fan Control**

The Fan Control screen, shown in Figure 145, is used to alter the fan speed on the receiver. When Dynamic is set to On, the fan speed adjusts up or down depending on the temperature of the internal bricks or rack controller board. When it is Off, the fans run in the default mode.
4.6.3.1.17 System Update (RDMS Local Update)

The RDMS now supports a firmware update using local USB media. This feature relies on an encrypted and signed firmware update file provided by Quasonix upon release of all versions after R15.

Note: The R15 update is a 'gatekeeper' release and must be performed prior to updating to R16 or beyond. If required, please contact Quasonix to request an R15 update card.

To perform a local update:

1. Obtain a firmware update file from Quasonix.
2. Transfer the update file to the root directory of a USB thumb drive, then plug the drive into the RDMS via the back port, or via the front port with an adapter.
   - The USB drive must be 32 GB, or smaller, and must be formatted as FAT32 (Windows) or Ext4 (Linux).
   - The update file must NOT be renamed, and must be the only update file on the USB drive.
3. Access the System Update screen, as shown in Figure 146. Press the Enter key.
4. Select Perform Local Update, then press the Enter key.

After pressing Enter, the front panel displays the Perform Local Update screen, as shown in Figure 148.
5. Select OK, then press Enter to start the update.

The front panel displays the RDMS3 Local Update screen, as shown in Figure 148.

![Image of RDMS3 Local Update Screen](image1)

**Figure 148: RDMS3 Local Update Screen**

6. Press Enter to search the USB drive for the update file.

7. If a proper update file is found, the name of the file displays on the front panel along with additional instructions, as shown in Figure 149.

![Image of RDMS3 Local Update Screen, Update File Selected](image2)

**Figure 149: RDMS3 Local Update Screen, Update File Selected**

8. Press Enter to start the update. The RDMS copies the update file from the USB drive and begins the update.
• Do not power off the RDMS during the update.
• During the update, a status displays, as shown in Figure 150.
• The RDMS will reboot twice during the update.
• After the first reboot, the front panel displays are automatically updated first. This update may cause
  the screens to be blank for several minutes while they are being updated.

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

9. Navigate to the System Settings screen, then select, as shown in Figure 151, to verify that the System
Version matches the firmware update version.

4.6.3.2 Graphics Menu

Access the Graphics menu from the front panel Main Menu. Select Graphics Menu, then press the Enter key on the
front panel keypad.

The Graphics menu includes the following parameters:

• Graph Type
• Signal Strength
4.6.3.2.1 Graph Type

There are two available graph types on the Graphics Menu: Spectrum or a pattern based on the selected mode. The user may toggle between graph types by pressing the Enter key on the front panel keypad until the desired value displays. Press the Esc key on the front panel keypad to back out of the Graphics Menu.

Examples of the Eye Pattern (PCM/FM) (Figure 153), Constellation (SOQPSK) (Figure 154), Constellation (STC) (Figure 159 and Figure 160), and Spectrum (Figure 155 and Figure 156) are shown in the associated figures.
### Multi-h CPM (MHCPM)

The “constellation” for MHCPM, shown in Figure 157, is synthetic in nature. The waveform is really just a 4-ary FSK signal with very narrow tone spacing and a smooth pulse shape that produces a very compact spectrum. To achieve the detection efficiency comparable to single symbol PCM/FM or SOQPSK, the frequencies of the tones periodically change to extend the length over which phase trajectory of different data sequences can rejoin. This increases the minimum distance, thereby improving the Eb/No performance.

Since the MHCPM waveform is heavily filtered, there is no traditional “eye” opening that can be viewed with an oscilloscope. Therefore, a synthetic two point constellation display is produced from the output of the trellis detector that is required to demodulate and recover the data. The trellis detector effectively computes the correlation between the received signal and all possible phase trajectories that could have been generated by the transmitter. For each data symbol, the one with the largest correlation is declared to be the winner, and two data bits are produced. The "constellation" display is created by multiplying the correlation value (real and imaginary) by the sign of the individual data bit (+1 for 1, -1 for 0). This produces a “BPSK"-like constellation with two ideal dots at 0 degrees (x = 1, y=0), or 180 degrees (x = -1, y=0). It behaves like a BPSK constellation in the sense that dots farther apart on the x axis indicate a better signal, the dot spread relates to SNR, and dots that tilt to the left or right show phase rotation.
In the Space-Time Coding (STC) mode of operation, the data stream is encoded into two separate signals that each contain a complete copy of the source data. These two signals are transmitted simultaneously on the same RF frequency (usually over two separate antennas) to produce a radiated over-the-air signal that eliminates antenna self-interference and improves message detectability with a similar bandwidth requirement as a conventional SOQPSK system. The trade-off for these substantial benefits is an increase in receiver processing complexity. Unlike traditional telemetry waveforms that are easy to process by looking at either the frequency or phase representation, STC consists of the sum of two unsynchronized phase modulated signals with seemingly unrelated data that must be recombined to recover the original source data.

While the spectrum display is virtually the same as the SOQPSK spectrum when the RDMS is running in STC mode, the receiver display looks quite different than the usual SOQPSK constellation, as shown in Figure 159. The individual parts of the display are labeled in Figure 160.

Since no traditional constellation exists for this mode, the RDMS displays the relative strength of each signal, the difference in time of arrival between them, and the received strength of the embedded pilot sequences. In a typical application, one of the signals is transmitted out the top antenna of a vehicle while the other signal is transmitted from the bottom. In this setup, the height of the green line above the blue graduated horizontal bar represents the relative strength of the top antenna, while the length of the green line below the bar represents the strength of the bottom. The small green square within the multicolor bar represents the time difference of arrival in increments of ¼ of a bit period with all the way to the left or right representing a full bit period. Performance is optimal in the green zone and degrades if it progresses into the yellow and red zones.

The indicators on the right side of the screen, receive signal level (dBm) and DQM, are exactly the same as in the other modes.
4.6.3.2.2 Signal Strength

There are two Signal Strength options, Absolute or Relative. The user may toggle the Signal Strength value by pressing the Enter key on the front panel keypad until the desired value displays.

When Absolute is selected, the actual signal strength is displayed.

When Relative is selected, the signal strength displayed is relative to AGC Zero.

A value of zero on the front panel signal display, indicates no input signal. A value above zero indicates how strong the signal is above no input.
Figure 161: Main Menu, Graphics Menu Selection and Graphics Menu, Signal Strength
4.7 Browser Interface

The Browser Interface provides the user with full configuration, control, and monitoring capabilities for one or multiple rack-mount 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 162, and five selections that display a variety of parameters for each available channel. The Browser Interface defaults to the Network screen.

![Figure 162: RDMS™ Browser Interface Header Tool Bar](image)

4.7.1 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, signal quality, 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 4.6.2.9.

Figure 163 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 164 shows a closeup of the right half of the Network screen with combiners only displayed. Figure 165 shows a closeup of the left side of the Network screen with the Configure and Monitor buttons.
3rd Generation Rack-Mount RDMS™

Figure 163: Network Screen with Multiple Receivers and Active Channels

Figure 164: Network Screen, Closeup of Left Side, Combiners Only
4.7.2 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 166.

The unit information displays in the Monitor view, as shown in Figure 167.
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 168.

![Monitor Screen for RDMS™ with Only One Channel Available](image)

Figure 168: 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 169, or displayed in the center of the screen between Channel 1 and Channel 2 when the combiner is Off, as shown in Figure 170.
4.7.2.1 Signal Graph and Signal Indicators

The Signal Graph, shown in Figure 171, provides a separate window for monitoring the receiver's constellation or eye pattern. The graphical display, included for each channel, mimics the graphical display on the front panel of the rack-mount receiver. Depending on the modulation chosen, the monitor will either display an eye pattern for PCM/FM, or a signal constellation for the other modes.

To the right of the Signal Graph is the Signal Indicators window, also shown in Figure 171.

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

- Signal Lock detection
- Signal Strength
- Data Quality Metric (DQM)
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.

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. When a signal of -100 dBm or higher is detected, the bar turns green to signify “good” signal strength. The Strength bar is red if the signal level is below -100 dBm.

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 4.7.3.17.

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 172) indicates AGC is not zeroed and the value is invalid
- Small “r” displayed next to the RSSI label indicates AGC Zero Relative was selected
The Data Quality Metric (DQM) graph displays to the right of the Strength graph. The DQM range is 0 to 10, with 10 being the best possible quality.

**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 green signal lock indicator.

### 4.7.2.2 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 173.
4.7.2.3 Diversity Combiner

If the optional diversity combiner is installed and enabled between two channels, then a Signal image and a DQM graph display in the area between the two channels on the Monitor. The Diversity Combiner with a signal lock (green) is shown in Figure 174.

![Diversity Combiner Link with Locked Signal](image)

Figure 174: 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. Refer to front panel section 4.6.2.17.8.1 for detailed information and examples of the BCS display.

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

4.7.2.4 Monitor Selective Display Options

The down arrow next to the Monitor option on the Menu Bar, shown in Figure 175, 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 175: Monitor Display Menu

Figure 176: Monitor Full Display (Default)
Figure 177: Monitor Eye Pattern/Constellation Display Only

Figure 178: Monitor PSD (Spectrum) Only
4.7.2.5 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 4.7.5.1.

4.7.3 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 181.
4.7.3.1 Combiner (Optional)

A pre-detection diversity combiner is available as an option for dual-channel receivers. If diversity combining is installed on the RDMS™, it can be enabled by clicking on the check box in the Combiner field, as shown in Figure 182.

![Figure 182: Configure Screen, Combiner Section](image)

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.

4.7.3.1.1 Frequency Diversity (Available with Diversity Combiner)

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.

4.7.3.2 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 183). Click on any field within the Configure screen to change and save settings for Channel 1, Channel 2, or both channels (Figure 184).
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.

**Note:** The Equalizer is currently available for use with all modes except AQPSK, AUQPSK, and all STC modes.
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, Time Aligner, and Diversity Combiner Mode 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 186. Other notifications display in red text on the right side.
4.7.3.2.1 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 187.

![Figure 187: Settings Window, Data Polarity Selection](image)

4.7.3.2.2 Derandomizer Settings
The Derandomizer defaults to Off. Click on the drop down arrow to display the menu, then select the desired option (Figure 188). 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).

![Figure 188: Settings Window, Derandomizer Drop Down Menu](image)

4.7.3.2.3 Differential Decoding Settings (SOQPSK Only)
The Differential Decoding option is set to On or Off by clicking on the check box (Figure 189) to enable or disable the differential decoding in SOQPSK mode. Differential Decoding defaults to enabled.
4.7.3.3 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, Diversity Combiner Mode, PCM Encoding, and LDPC Mode (SOQPSK only), as shown in Figure 190. 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, as shown in Figure 191.
4.7.3.3.1 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.

4.7.3.3.2 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.
4.7.3.3.3  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.

4.7.3.3.4  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.

4.7.3.3.5  AFC Mode
The AFC (Automatic Frequency Control) Mode option, shown in Figure 193, 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 section 4.9.1.3 for AFC command details.

Figure 193: Advanced Settings Window, AFC Mode Menu

4.7.3.3.5.1  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.
4.7.3.3.5.2 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.

4.7.3.3.5.3 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.

4.7.3.3.6 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. Refer to section
4.6.2.17.8 for Best Channel Selector details.

Figure 194: Advanced Settings Window, Best Channel Selector Checked

4.7.3.3.7 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 195, lets it determine when to
operate (with no user intervention).
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.

4.7.3.4 Diversity Combiner Mode

The Quasonix RDMS™ Combiner can operate in one of two modes, Maximal Ratio or Best Source, as shown in Figure 196. Click on the drop down arrow to display the menu, then select the desired option.
Maximal Ratio combining provides the best pre-detection combining possible, as long as the Channel 1 and Channel 2 input signals can be phase- and time-aligned by the Combiner. In this mode, the Combiner aligns the signals and, using an accurate measure of signal quality, generates their weighted sum. This sum contains the best of both signals plus uncorrelated noise, resulting in up to 3 dB improvement in effective SNR over each individual channel.

Best Source combining is a suboptimal method of combining, but it works for cases in which the Channel 1 and Channel 2 input signals cannot be phase- and time-aligned by the Combiner. Such cases would be rare, but one possible case might be spatial diversity over larger distances than the Combiner Time Aligner can compensate. In this mode, the Combiner continuously selects the channel with better signal quality, so there is no improvement in performance relative to the current best channel. Because Best Source combining is used when proper alignment of the two signals may not be achievable, the Time Aligner should be disabled when this Combiner Mode is selected.

Note: The Best Channel Selector (section 4.6.2.17.8) does not replace, but virtually obsoletes, the Diversity Combiner Best Source mode. In any application where phase- and time-alignment are possible, even if only occasionally, it is recommended that the Diversity Combiner Maximal Ratio mode be used in conjunction with enabling the Best Channel Selector.

### 4.7.3.5 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: Bi\(\phi\), level
- Biphase-M: Bi\(\phi\), mark
- Biphase-L: Bi\(\phi\), space
- Biphase-M: Bi\(\phi\), mark
- 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 197.

![Figure 197: Advanced Settings Window, PCM Encoding Drop Down Menu](image)

### 4.7.3.6 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 104. 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 4.7.3.3.5 for more information about AFC Mode.

Select the desired encoding format from the drop down menu, as shown in Figure 198.

Available LDPC Mode options are:

- \( k = 4096, r = \frac{1}{2} \)  
- \( k = 1024, r = \frac{1}{2} \)  
- \( k = 4096, r = \frac{2}{3} \)  
- \( k = 1024, r = \frac{1}{2} \)  
- \( k = 4096, r = \frac{2}{3} \)  
- \( k = 1024, r = \frac{4}{5} \)

Note: LDPC Mode always displays on the Advanced Settings Menu. Selected values are NOT active unless the waveform Mode is SOQPSKLDPC or STCLDPC.

### 4.7.3.7 Channel A Video Output

The Channel A Video Output option, shown in Figure 199, 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 10. 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).
Table 10: Normal (Default) Video Output Signals

<table>
<thead>
<tr>
<th>Mode</th>
<th>I/Video A</th>
<th>Q/Video B</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCM/FM</td>
<td>Eye Pattern</td>
<td>Unused (0 Volts)</td>
</tr>
<tr>
<td>SOQPSK, SOQPSK/LDPC</td>
<td>Noncoherent I/Q Baseband</td>
<td>Noncoherent I/Q Baseband</td>
</tr>
<tr>
<td>MHCPM</td>
<td>Noncoherent I/Q Baseband</td>
<td>Noncoherent I/Q Baseband</td>
</tr>
<tr>
<td>BPSK</td>
<td>I Baseband</td>
<td>Unused</td>
</tr>
<tr>
<td>QPSK, OQPSK, AQPSK, UQPSK, AUQPSK</td>
<td>I Baseband</td>
<td>Q Baseband</td>
</tr>
<tr>
<td>DPM</td>
<td>I Baseband</td>
<td>Unused</td>
</tr>
</tbody>
</table>

4.7.3.8 Channel B Video Output

The Channel B Video Output option, shown in Figure 200, 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 10. 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).

4.7.3.9 Channel A Video Scale

The Channel A Video Scale option, shown in Figure 201, 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.
4.7.3.10 Channel B Video Scale

The Channel B Video Scale option, shown in Figure 202, 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 202: Advanced Settings Window, Channel B Video Scale](image)

4.7.3.11 Tape Output Frequency

The Tape Out Frequency option, shown in Figure 203, 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 203: Advanced Settings Window, Tape Output Frequency](image)

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

The FM De-emphasis option, shown in Figure 204, 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 204: Advanced Settings Window, FM De-emphasis](image)

4.7.3.13 Advanced PCM/FM Settings

The Advanced PCM/FM Settings window is shown in Figure 205. 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.
4.7.3.13.1 Modulation Index Scaling Mode
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.

Modulation Index Scaling Mode contains four settings: Track, Hold, Off, and Acquire. Modulation Scaling is a method used to retain the maximum trellis-coding gain of a non-ideal FM signal. For additional functional details, refer to section 4.6.2.11 Modulation Scaling in the front panel section.

4.7.3.13.2 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 207.
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 4.7.4.1.

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 rack 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.

### 4.7.3.13.3 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.

When modulation scale index is set via the front panel of the receiver, the Modulation Scaling option is simultaneously changed to Hold. The Hold notation includes the new index number that the operator has chosen.
To change the Modulation Scale Index in the *Browser*, 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 208. Use the steps in section 4.7.3.13.1 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 209. 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 Main Menu. Refer to section 4.6.2.12, Modulation Persistence.

![Advanced PCMFM Settings Window, Modulation Scale Index Current Value, Read Only](image)

**Figure 208: Advanced PCMFM Settings Window, Modulation Scale Index Current Value, Read Only**

![Mod Index Scaling Mode/Hold, Modulation Scale Index with Edit Field](image)

**Figure 209: 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.

### 4.7.3.13.4 Phase Noise Compensation

The Phase Noise Compensation (PNC) option is used to set the Phase Noise Compensation value to On or Off. Refer to Appendix C in section 11 for detailed information about PNC.

### 4.7.3.14 System Settings

The System Settings window, shown in Figure 210, includes the following settings:

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

The Antenna Controls section contains the following parameters for AGC (Automatic Gain Control) and AM, as shown in Figure 211.

- 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

4.7.3.14.2 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 212.
4.7.3.14.3 AGC Scale
The AGC Scale option adjusts the voltage of the AGC back panel BNC 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. Refer to AGC Scale on the front panel, section 4.6.2.14.2, for an example.

4.7.3.14.4 AGC Time Constant
The Time Constant option sets the time constant of the AGC back panel BNC 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 back panel BNC 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.

4.7.3.14.5 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 213.
4.7.3.14.6 AGC Zero Mode

The AGC Zero Mode option is shown in Figure 214. 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.
4.7.3.14.7 AGC Compensate
The user may enable AGC Compensation by clicking on the check box. Refer to Appendix B for more information about the AGC Compensation function.

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

4.7.3.14.9 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 215.

![Figure 215: Antenna Controls Window, AM Polarity Drop Down Menu Selections](image)

4.7.3.14.10 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.

4.7.3.14.11 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 216.

![Figure 216: Antenna Controls Window, D/C Antenna Selection Checked](image)
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.

### 4.7.3.15 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 217.

![Figure 217: Output Controls Window](image)
The Channel A Output options, shown in Figure 218, 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 DQE is enabled in the Main Menu, the output is encapsulated, otherwise it will 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 218: Output Controls, Clock/Data Output Channel A](image)

The Channel B Output options, shown in Figure 219, 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 DQE is enabled in the Main Menu, 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 219: Output Controls, Clock/Data Output Channel B](image)

### 4.7.3.16 Clock/Data Output Controls (3U Receiver)

The Clock/Data Output Controls section, as shown in Figure 220, provides access to four channels in a 3U receiver:

- **Channel A Output**
- **Channel B Output**
- **Channel C Output**
- **Channel D Output**

Clock and data output for the additional 3U channels functions the same as the channel selections in a 1U receiver.
4.7.3.17 Test Utilities

The Test Utilities selections, accessed via the Advanced Menu, as shown in Figure 221, provide access to the following options:

- Noise Generator
- Test Generator
The Noise Generator selection, shown in Figure 222, 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 222

![Figure 222: Test Utilities, Noise Generator-Test Noise Drop Down Menu](image)

- **Noise Level** - Sets the noise level to use in the test in dB $E_b/N_0$, as shown in Figure 223

![Figure 223: Test Utilities, Noise Generator-Noise Level Selection](image)

The Data Generator option, shown in Figure 224, 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.
Test Data – Enable or disable test data generation, as shown in Figure 225

Data rate in Mbps – Typing a number in this field sets the data rate in Mbps, as shown in Figure 226

Pattern – Sets the data pattern produced by the data generator, as shown in Figure 227; 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 227: Data Generator, Pattern Selection](image)

• Inversion – Set to Normal or Inverted, as shown in Figure 228; 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 228: Data Generator, Inversion Drop Down Menu](image)

• Randomization – Enable or disable IRIG 106 15-bit randomization, as shown in Figure 229; not recommended for PNI5 data, due to potential conflict between the sequence generator and the randomizer, both of which are based on the same generator polynomial

![Figure 229: Data Generator, Randomization Drop Down Menu](image)

4.7.3.18 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 230. One or two buttons are available depending on the number of channels and the combiner mode.
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 RSSI bar graph. If AGC is not zero, the graph is grey and there is no AGC Zero value displayed, as shown in Figure 231. When AGC is zero, the bar graph is not grey and the AGC Zero value is displayed, as shown in Figure 232.
4.7.3.18.1 RSSI Display

The RSSI display has two modes depending on the option selected in the RSSI Display drop down menu, shown in Figure 230.

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 172) indicates AGC is not zeroed and the value is invalid
- A small “r” displayed next to the RSSI label indicates AGC Zero Relative was selected
4.7.3.19 Reset to Factory Defaults Button

The Reset to Factory Defaults button, shown in Figure 234, sends a command to reset the RDMS hardware to factory default settings. During the process, the Browser Interface is temporarily unavailable.

![Advanced Buttons, Reset to Factory Defaults Button](image)

4.7.3.20 Shutdown Hardware Button

The Shutdown Hardware button, shown in Figure 235, 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:

- Cycle the power switch on the front panel of the RDMS receiver
- Remove AC power, then reapply using a remotely controllable power source, such as a network controlled power strip

![Advanced Buttons, Shutdown Hardware Button](image)

4.7.4 Presets

The Presets functionality is accessed via the Presets option on the Tool bar, as shown in Figure 236.
4.7.4.1 Save Presets

Accessed from the Presets option in the Tool Bar, Saved Presets screen, shown in Figure 237, 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 238 and Figure 239.
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 240. The contents and layout of this screen is similar to the Configure 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 241. 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. Longer preset names display in the Browser Interface, but may be truncated on the front panel of the RDMS™ when the preset file name exceeds 14 or 15 characters. This does not affect preset functionality.
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, Time Aligner, and Diversity Combiner Mode 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. 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 242.

![Figure 242: Preset: View or Modify Preset Screen, Information Successfully Saved Message](image)

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 243.
4.7.4.2 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 244.

When the Saved Presets screen displays (Figure 245), click on the green Load Preset button on the line containing the desired preset.
While the preset is loading, the front panel on the receiver displays a wait message, as shown in Figure 246. The preset is finished loading when the wait message no longer displays.

**Figure 246: Loading Preset Please Wait Message on Front Panel**

### 4.7.5 About

To access the System Information screen, click on the About option on the Tool bar, as shown in Figure 247.

**Figure 247: 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 249, then click on the Rename button.
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 250. 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 4.7.2.5.

### 4.7.5.2 Interfaces

The Interfaces side of the System Information screen displays the current Ethernet settings. They are read only.

### 4.7.6 Footer Tool Bar

The Footer Tool bar, shown in Figure 252, provides access to additional Browser Interface functionality.
4.7.6.1 Help
The Help option on the Footer Tool bar, provides a link to the Rack-Mount RDMS Installation and Operation manual, an RDMS API User Guide, as well as contact information for Quasonix. The Help screen is shown in Figure 253.
4.7.6.2 Page Access

The Page Access Management screen, shown in Figure 254, 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 254: Page Access Management Screen](image)

The closeup images in Figure 255 and Figure 256 show the pages (screens) being accessed, their status, the controlling IP Address for the RDMS receiver, the time when control was acquired, and the length of time the user has been in control.

![Figure 255: Page Access Management-Closeup of Left Side](image)

![Figure 256: Page Access Management-Closeup of Right Side](image)
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 257. The message provides a link to the Page Access Management screen so the user may review and release control as needed.

![Page Access Error]

**Figure 257: Page Access Error Message**

4.7.6.3 Export

Export Configuration, shown in Figure 258, 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.

![Export Configuration]

**Figure 258: Export Configuration Screen**

4.7.6.4 Import

The Import Configuration screen, shown in Figure 259, is used to import files that were previously exported (as described in the previous section).
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 260.

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

![Figure 259: Import Configuration Screen](image)

![Figure 260: Import Configuration Selection Window](image)
4.7.6.5  Admin (Quasonix Factory Use Only)

The Admin link on the footer tool bar is used for Quasonix factory use only.

![Quasonix RDMS Administration Window](image)

Figure 261: Quasonix RDMS Administration Window
4.8 Access via Telnet

Telnet provides access to the individual receiver channel’s underlying serial control interface. The serial control interface is not recommended for typical Rack-Mount Receiver usage. The Telnet interface should only be accessed by advanced users. Contact Quasonix customer support before using these options.

Note: Access to this serial control interface is provided primarily for debugging purposes. Unlike the standard front panel and browser interfaces, the serial control interface within the Telnet screen is not safeguarded from accidental or improper changes to the receiver’s configuration.

It is strongly recommended that users contact Quasonix Technical Support (Tel: 513-942-1287) prior to using the Terminal serial control interface.

1. In a command window, type: `telnet open {IP address of the receiver to connect to} 8888`.
2. Press the Enter key on the keyboard.

![Figure 262: Telnet Into Terminal](image)

The next screen (Figure 263) shows the RDMS channel subscribed to by Telnet.

Method 1-Use the Subscribed Channel

3. At this point, the user may ignore the instructions on the screen and press the Enter key again.

![Figure 263: Channel Subscribed](image)

The command prompt for the mode in the subscribed channel displays immediately, as shown in Figure 264. This is a portal to the receiver’s serial control interface and allows the user to communicate to the individual receiver “brick” using its basic command protocol.
Method 2-Unsubscribe and use a different channel

Look at the second Telnet screen again (Figure 265).

1. Follow the on-screen instruction and press the ` key. This is the very first key on the left side of the keyboard under the tilde (~).

2. The RDMSIII Telnet Command Menu is shown in Figure 266.
The command menu is used to unsubscribe from connections and reconnect to a specific channel. Figure 267 shows all connections being unsubscribed.

Figure 267: RDMSIII Telnet Command Menu-Unsubscribe All Channels

In Figure 268, the user typed a 1 to subscribe (connect) to channel 1. At this point, the user may press the Enter key to continue, as described in Method 1.
All Quasonix serial commands are alphabetic characters, followed by 0, 1, or 2 arguments. If the command is issued with arguments, there must be a space after the alphabetic characters. The commands are not case sensitive.

All commands generate a response of one or more lines. The length of the response depends on the verbosity level (set by the VL command – this is an advanced command). The last response line is always the currently selected mode (PCMFM, SOQPSK, CPM, or PSK), followed by the character “+” or “>”, depending on the version of the firmware. This prompt signifies that the RDMS™ is ready to accept new characters.

A complete list of available serial commands can be found in section 4.9 or by typing HA.
4.9 Tier 0 (PCM/FM), Tier I (SOQPSK-TG), and Tier II (MULTI-H CPM) Commands

The following table describes all receiver user commands. Listed are the command code, name, description of the command, whether specific options must be ordered or the command is standard on all receivers, and whether the command is restricted to specific waveform modes.

Multiple commands may be typed on a command line if they are separated by a semicolon “;”. There is a limit of 256 characters per command line, including semicolons. Commands with no parameters request status only.

Refer to command HA in section 4.9.1.25 for specific help in reading the command sets.

Refer to section 4.9.1 for additional command set detail and examples. Complete information is also available in the command Help.

For example:

**PCM/FM>FR 2200.5; BR 6.000; AGC**

results in the following:

*Frequency set to 2200.5 MHz*

*Bit Rate set to 6.000 Mbps*

and status for all AGC parameters are displayed as:

*AGC control enabled*

*AGC control mode RF*

*AGC automatic mode select enabled*

*AGC zero mode Auto*

*AGC zeroed at -110.22 dBm (13.38 dB attenuation)*

*AGC auto zero hold threshold 0.000 dB*

*AGC auto zero time constant 0.250 seconds*

*AGC loop total power 13.375 dB*

*Bulk attenuator AGC control enabled, switched out*

Ctrl Y repeats the command sequence without having to retype the commands.
### Table 11: Standard and Optional User Commands

<table>
<thead>
<tr>
<th>Mnemonic</th>
<th>Name</th>
<th>Description</th>
<th>Option (s) Required</th>
<th>Mode Restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>?</td>
<td>Help Message</td>
<td>Displays abbreviated list of available Help commands</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>ACU</td>
<td>Antenna Control Unit</td>
<td>Report or set antenna control unit automatic gain control (AGC) settings</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>AEQ</td>
<td>Adaptive Equalizer</td>
<td>Report equalizer status and control adaptive equalizer settings</td>
<td>EQ</td>
<td>None</td>
</tr>
<tr>
<td>AFC</td>
<td>Automatic Frequency Control</td>
<td>Report or set a variety of automatic frequency control parameters</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>AHM</td>
<td>Analog High Speed Mixer</td>
<td>Displays and controls high speed (video) output mixer settings</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>AHO</td>
<td>Analog High Speed Output (Tape Output)</td>
<td>Displays and controls high speed (video) output settings</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>ALM</td>
<td>Analog Low Speed Mixer</td>
<td>Displays and controls low speed (video) output mixer settings</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>ALO</td>
<td>Analog Low Speed Output</td>
<td>Displays and controls low speed (ACU) output settings</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>AL</td>
<td>Lock Status Command</td>
<td>Reports system lock status</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>BCS</td>
<td>Best Channel Selector</td>
<td>Displays and controls best channel selector settings</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>BER</td>
<td>Bit Error Rate</td>
<td>For Bit Error Rate commands and information, refer to Appendix A, Bit Error Rate Testing</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>BR</td>
<td>Bit Rate</td>
<td>Report or set baseband bit rate</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>CLH</td>
<td>Command Line History</td>
<td>Reports last 25 commands issued</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>CMB</td>
<td>Combiner Control</td>
<td>Displays and controls combiner settings</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>Mnemonic</td>
<td>Name</td>
<td>Description</td>
<td>Option (s) Required</td>
<td>Mode Restriction</td>
</tr>
<tr>
<td>----------</td>
<td>-------------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>CP</td>
<td>Clock Polarity</td>
<td>Report or set clock polarity inversion state</td>
<td>Standard</td>
<td>For Asynch PSK (legacy) modes, CP A and CP B must be specified separately</td>
</tr>
<tr>
<td>DA</td>
<td>Downconverting Antenna</td>
<td>Displays and controls receiver C band to P band downconverting antenna</td>
<td>P band enabled receiver</td>
<td>None</td>
</tr>
<tr>
<td>DD</td>
<td>Differential Decoding</td>
<td>Enable or disable differential decoding</td>
<td>Standard</td>
<td>SOQPSK</td>
</tr>
<tr>
<td>DHI</td>
<td>High Speed Digital Input</td>
<td>Displays and controls high speed digital input settings</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>DHO</td>
<td>High Speed Digital Output</td>
<td>Displays and controls high speed digital output settings</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>DLI</td>
<td>Low Speed Digital Input</td>
<td>Displays and controls low speed digital input settings</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>DLO</td>
<td>Low Speed Digital Output</td>
<td>Displays and controls low speed digital output settings</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>DOM</td>
<td>Digital Output Muting</td>
<td>Control shut down of clock and data outputs</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>DP</td>
<td>Data Polarity</td>
<td>Report or set data polarity inversion state</td>
<td>Standard</td>
<td>For Asynch PSK (legacy) modes, DP A and DP B must be specified separately</td>
</tr>
<tr>
<td>DQ</td>
<td>Data Quality Encapsulation and Metrics</td>
<td>Display and control data quality encapsulation and DQ metrics</td>
<td>Standard</td>
<td>ARTM modes</td>
</tr>
<tr>
<td>DR</td>
<td>Derandomizer State</td>
<td>Report or set the derandomizer state</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>DSO</td>
<td>Digital Status Output</td>
<td>Control the source, polarity, and override states</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>FEC</td>
<td>Forward Error Correction Mode</td>
<td>Report FEC status for enabled modes</td>
<td>-K7</td>
<td>Legacy PSK</td>
</tr>
<tr>
<td>FL</td>
<td>Force Lock Indication</td>
<td>Diagnostic tool to force the system to indicate locked or unlocked</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>FM</td>
<td>FM Demodulator Settings</td>
<td>Display and control FM demodulator settings</td>
<td>Standard</td>
<td>PCM/FM</td>
</tr>
<tr>
<td>Mnemonic</td>
<td>Name</td>
<td>Description</td>
<td>Option(s) Required</td>
<td>Mode Restriction</td>
</tr>
<tr>
<td>---------</td>
<td>-----------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>--------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>FPD</td>
<td>Front Panel Display Status</td>
<td>Display data sent to the rack used to keep the front panel displays updated</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>FR</td>
<td>Frequency</td>
<td>Report or set receiver center frequency</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>HA</td>
<td>Advanced Help Command</td>
<td>Displays Help commands not frequently used or with more complex construction than the basic two character Help commands</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>HT</td>
<td>HyperTrack</td>
<td>Displays and controls HyperTrack settings</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>IF</td>
<td>IF Filter Control</td>
<td>Display and control IF filter settings</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>LDPC</td>
<td>Low Density Parity Check</td>
<td>Display and control Forward Error Correction settings</td>
<td>Standard</td>
<td>SOQPSKLDPC or STCLDPC</td>
</tr>
<tr>
<td>MI</td>
<td>Modulation Index</td>
<td>Report or Set Modulation Index Tracking or Acquire</td>
<td>Standard</td>
<td>PCM/FM</td>
</tr>
<tr>
<td>MO</td>
<td>Modulation</td>
<td>Report or set modulation setting</td>
<td>Standard</td>
<td>Limited to modes installed</td>
</tr>
<tr>
<td>OCM</td>
<td>Output Clock Measurement</td>
<td>Displays measured output clock frequency</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>PDC</td>
<td>PCM Decoding</td>
<td>Controls digital decoding such as NRZ-L, NRZ-M, and bi-phase</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>PER</td>
<td>Parameters Erase</td>
<td>Erases the stored parameter set for the current mode; Upon power cycle, resets current operating parameter set to factory default values</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>PERA</td>
<td>All Parameters Erase</td>
<td>Reset all modes to factory default values</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>PL</td>
<td>Input Power Level</td>
<td>Reports or sets the current input power level setting</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>PLD</td>
<td>Parameters Load</td>
<td>Loads the stored parameter set into the current operating parameter set</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>PNC</td>
<td>Phase Noise Compensation</td>
<td>Report or set phase noise compensation state</td>
<td>Standard</td>
<td>PCM/FM</td>
</tr>
<tr>
<td>Mnemonic</td>
<td>Name</td>
<td>Description</td>
<td>Option(s) Required</td>
<td>Mode Restriction</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>PRS</td>
<td>Reset Defaults</td>
<td>Restores factory default parameters for the unit Default is currently the lowest number modulation supported by the transmitter with the selected band and frequency limits</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>PSV</td>
<td>Parameters Save</td>
<td>Writes the current operating parameter set into a (previously erased) stored parameter set</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>RFD</td>
<td>Reset Defaults</td>
<td>Reset all parameters to factory default values Erases all parameter data Resets to default Mode</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>QT</td>
<td>Query Temperature</td>
<td>Report the temperature in degrees Celsius</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>SDI</td>
<td>Signal Degradation Information</td>
<td>Sets signal degradation information enable or disable parameters</td>
<td>Standard</td>
<td>SOQPSK</td>
</tr>
<tr>
<td>SI</td>
<td>Spectrum Inversion</td>
<td>Accounts for downconverting antenna spectral inversion</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>SN</td>
<td>Show Serial Number</td>
<td>Report the serial number for the unit</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>SV</td>
<td>Save Parameters</td>
<td>Saves the current parameters in non-volatile memory, including frequency, modulation, bit rate, data polarity, clock polarity, AGC state, verbosity level, etc.</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>SYS</td>
<td>System Status Tracking</td>
<td>Displays the system status of the receiver</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>TO</td>
<td>Tape Out</td>
<td>Displays and controls tape output settings</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>TOD</td>
<td>Time of Day</td>
<td>Sets the current calendar date and time of day</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>UP</td>
<td>Show Options</td>
<td>Displays the current hardware configuration and options on the receiver</td>
<td>Standard</td>
<td>None</td>
</tr>
<tr>
<td>Mnemonic</td>
<td>Name</td>
<td>Description</td>
<td>Option (s) Required</td>
<td>Mode Restriction</td>
</tr>
<tr>
<td>----------</td>
<td>------</td>
<td>-------------</td>
<td>---------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>VE</td>
<td>Version</td>
<td>Report the current Firmware (software) version information for the receiver; displays the current application, FPGA, and adaptive equalizer versions</td>
<td>Standard</td>
<td>None</td>
</tr>
</tbody>
</table>

4.9.1 Additional Command Set Details

4.9.1.1 Antenna Control Unit – ACU

The ACU command displays and controls the antenna control unit settings.

ACU [M <m>|C <e>|O <s>]

M <m> - Sets antenna control mode to <m>

where: <m> - Control mode

M – AGC time constant and AM bandwidth set manually
S – AGC time constant and AM bandwidth set based on antenna scan

C <e> - Sets AGC compensated AM enable to <e>

where: <e> - Enable

0 – Disabled
1 – Enabled

O <s> - Sets antenna control output to <s>

where: <s> - Signal source

0 – Channel 0
1 – Channel 1
C – Combiner

ACU [S [T <t>|R <r>]] – Antenna scan settings

T <t> - Sets antenna mode scan type to <t>

where: <t> - Scan type

C – Conical scan
E – E-scan

R <r> - Sets antenna mode scan rate to <r>, 10.00 to 50.00 Hz
ACU [AM [<p>|S <s>|B <b>]] – Antenna control unit AM settings

<p> - Sets AM output polarity to <p>

where: <p> - Polarity

{0|+} – Normal
{1|-} – Inverted

S <s> - Sets AM output scale to <s>, -128.0 to 128.0

B <b> - Sets manual mode AM detector bandwidth to <b>, 5.00 to 50000.00 Hz

ACU [AGC [<p>|S <s>|T <n>]] – Antenna control unit AGC settings

<p> - Sets AGC output polarity to <p>

where: <p> - Polarity

{0|+} – Normal
{1|-} – Inverted

S <s> - Sets AGC output scale to <s>, 1.0 to 50.0 dB/V

T <n> - Sets manual mode AGC time constant to <n>, 0.1 to 1000.0 ms

Examples:

ACU Report ACU related status
 PCMFM$acu
 ACU mode manual
 AGC compensated AM on
 Antenna scan type conical
 Antenna scan rate 30.0 Hz
 Manual AM bandwidth 100.0 Hz
 Manual AGC time constant 100.0 ms
 AM output polarity +
 AGC output polarity +
 AGC output scale 10.0 dB/V
 AM scale 1.0

ACU AGC 0 Set polarity to Normal
 ACU AGC 1 Set polarity to Inverted
 ACU AGC S 42.0 Set AGC output scale to 42.0 dB/V
 Valid range is 1.0 to 50.0 dB/V
 ACU AGC T 222.0 Set manual mode AGC time constant to 222.0 ms
 Valid range is 0.1 to 1000.0 ms
4.9.1.2 Adaptive Equalizer Control – AEQ

The AEQ command displays and controls adaptive equalizer settings.

**AEQ [<e>|H [E|Q]|HE<tt>|HQ <tt>|HD <tt>]**

- `<e>` - Sets adaptive equalizer enable to `<e>`
  - where: `<e>` - Enable
    - 0 – Disabled
    - 1 – Enabled

**AEQ H `<e>`** - Sets equalizer auto hold enable to `<e>`

- `<e>` - Sets adaptive equalizer enable to `<e>`
  - where: `<e>` - Enable
    - 0 - Disabled
    - 1 - Enabled

**HE `<tt>`** - Sets EQ hold below Eb/N0 `<tt>`, -20.000 to 30.000 dB or -100.000 is Off

**HQ `<tt>`** - Sets EQ hold below DQM BEP `<tt>`, 1.00042e-12 to 0.5 or 1.0 is Off

**HD `<tt>`** - Sets EQ hold/run delay `<tt>`, 10 to 60000 ms or 0 is Off

**AEQ T [<e> [-h][<f>][<r>]]** - Sets equalizer tracking display enable to `<e>` in format `<f>` at rate `<r>`

- where: `<e>` - Enable
  - 0 - Disabled
  - 1 - Enabled

- `<f>` - Format (last used, if not specified)
  - N - Normal
  - C - CSV

- `<r>` - Display rate `<r>`, 100 to 60000 ms (500 ms if not specified)

Options:
- `-h` - Do not display header

**AEQ [M {CMA|DD} <k>]**

- M CMA `<k>` - Sets EQ CMA Mu to `<k>`, 0.000 to 0.003906
- M DD `<k>` - Sets EQ CMA Mu to `<k>`, 0.000 to 0.003906
AEQ [K {FF|FB} <k>]
   K FF <k> - Sets EQ feed forward proportional constant to <k>, 0.000 to 0.999985
   K FB <k> - Sets EQ feedback proportional constant to <k>, 0.000 to 0.999985

AEQ [MT {CMA|DD} <t>]
   MT CMA <k> - Sets CMA MSE threshold to <k>, 0.000 to 0.999985
   MT DD <k> - Sets DD MSE threshold to <k>, 0.000 to 0.999985

AEQ [CT <t>] - Sets confidence threshold to <t>, 0.000 to 3.999939

AEQ [AR <e]|C <e>|R <r>|DD <e>]
   AR <e> - Sets auto reset enable to <e>
   C <e> - Sets power centering enable to <e>
   R <e> - Sets reset <r>
       where: <r> - Reset
           0 - Run
           1 - Reset
   DD <e> - Sets decision directed enable to <e>
       where: <e> - Enable
           0 - Disabled
           1 - Enabled

AEQ TAPS [DFT][ <f>][ <o>]] - Display equalizer source <s> in format <f> with options <o>
   where: <f> - Format
       N - Display using normal format - default
       C - Display using CSV format
   where: <o> - Options
       IQ - Display complex values using CSV format - default
       POL - Display polar values using CSV format
       G - Display as graphic only

Examples:
AEQ Report equalizer status
   PCMFM$aeq
   Adaptive equalizer enabled
   EQ auto hold disabled
Decision directed error is NOT in use
Decision directed enabled
Reg enabled
Mean squared error (CMA) 0.014893
Mean squared error (DD) 0.855225
Average confidence 0.040588

Equalizer filters not reset
Equalizer IS in auto reset
Auto reset enabled

AEQ 0  Disable adaptive equalizer
AEQ 1  Enable adaptive equalizer
AEQ H x  Set equalizer hold below Eb/N0 to a value between -20.000 and 30.000 dB;
          -100.000 sets equalizer hold to Off
AEQ T 0  Disable equalizer information tracking display
AEQ T 1  Enable equalizer information tracking display

4.9.1.3  Automatic Frequency Control – AFC
The Automatic Frequency Control command reports or sets various AFC parameters.

AFC [M <m>|H <t>|C [A|<c>|]|L <m>|T {L|H} <t>|R <e>] or AFC SYS <d>
         M <m> - Sets AFC mode to <m>
             where: <m> - mode
                 O – Off
                 H – Hold
                 T – Track
         H <t> - Sets AFC hold below Eb/N0 <t>, -20.000 to 30.000 dB or -100.000 is off
         C A – Sets AFC coefficient to be automatically set based on bit rate
         C <c> - Sets AFC coefficient to <c>, 0.0003511 to 46.018 seconds
         L <m> - Sets AFC correction limit to <m>, 0.000006 to 46.666661 MHz
         T L <t> - Sets AFC power detect low threshold to <m>, 0.000000 to 0.999985
         T H <t> - Sets AFC power detect high threshold to <m>, 1.000015 to 65536.000000
         O <e> - Sets AFC data path override enable to <e>
             where: <e> - enable
                 0 – Disabled
I – Enabled

SYS <d> - Sets the AFC status tracking display mode to <d>

where: <d> - display mode

D – Detected
C – Compensated

The Sys d setting is used to change whether detected or compensated offset is displayed in the SYS output.

AFC C – Sets the automatic frequency control coefficient

Examples:
AFC C A Set AFC coefficient to be automatically set based on bit rate
AFC C 0.00001 Set AFC coefficient to 0.00001 seconds (ten times slower tracking than default)
Valid range is 4.389e-05 to 5.752 seconds

AFC H – Sets the automatic frequency control hold threshold below Eb/N0

Example:
AFC H 6.000 Set AFC to automatically hold tracking below 6.000 dB Eb/N0
Valid range is -20.000 dB to 30.000 dB; -100.000 dB is Off

AFC L – Sets the automatic frequency control correction limit

Example:
AFC L 42.123456 Set AFC correction limit to 42.123456 MHz
Valid range is 0.000006 to 46.666661 MHz

AFC M – Sets the automatic frequency control mode

Examples:
AFC M O Set AFC to Off
AFC M H Set AFC to Hold
AFC M T Set AFC to Track
AFC M A Set AFC to Auto

AFC P <p> – Sets the automatic frequency control hold period

Example:
AFC P 5007 Set AFC hold period to 5007 µs
Valid range is 0.000 to 4294967296.000 µs; initialized value is 5000 µs

AFC T – Sets the automatic frequency control power detect threshold

Example:
**AF T 0.0000**

Set AFC to power detect threshold to 0.000
Valid range is 0.000 to 1.000

Example:

**AFC**

AFC auto operation mode Off
AFC tracking auto hold below 6.00000 dB Eb/N0
Compensated frequency offset -0.004606 MHz
Detected frequency offset -0.004718 MHz
Duty cycle 0.08%
Auto AFC bandwidth is enabled
AFC coefficient 0.03573 seconds
AFC limit 0.50000 MHz
AFC power threshold 0.000

**4.9.1.4 Automatic Gain Control – AGC**

The Automatic Gain Control command reports and sets a variety of AGC parameters. Additional AGC commands are described in separate subsections 4.9.1.4.1 through 4.9.1.4.7.

**AGC [-V]** – Shows advanced AGC status

**AGC [<e>]** – Sets the AGC enable to <e>

where: <e> - Enable

0 – Disabled
1 – Enabled

Example:

**AGC (shows total actual power attenuation readings)**

AGC control enabled
AGC control mode RF
AGC automatic mode select enabled
AGC zero mode Manual
AGC zeroed at -60.36 dBm (60.38 dB attenuation)
AGC auto zero hold threshold 0.000 dB SNR
AGC auto raising zero time constant 0.250 seconds
AGC auto lowering zero time constant 0.250 seconds
AGC loop total attenuation 60.062 dB
Bulk attenuator AGC control enabled, switched out CMFM$agc
AGC control enabled
AGC control mode RF
AGC automatic mode select enabled
AGC zero mode Manual
AGC zeroed at -60.36 dBm (60.38 dB attenuation)
AGC auto zero hold threshold 0.000 dB SNR
AGC auto raising zero time constant 0.250 seconds
AGC auto lowering zero time constant 0.250 seconds
AGC loop total attenuation 60.062 dB
Bulk attenuator AGC control enabled, switched out

4.9.1.4.1 Automatic Gain Control Bulk Attenuation – AGC BA
The AGC BA x command sets the bulk attenuation parameters. The bulk attenuator has three modes In, Out, and Auto. Setting the bulk attenuator to In or Out removes the bulk attenuator from AGC control and forces it In or Out, respectively. Setting it to Auto allows the AGC mode to control it.

There are no hard value limits for the switch in/out threshold at input power due to variances in other parameters such as gain, calibration, and temperature. It will clip to a minimum or maximum value and report that setting.

The bulk attenuation switch out threshold is forced to match the switch in threshold when the AGC is in IF mode. This is to prevent the AGC from attempting to switch the bulk attenuator while using a path that doesn’t have a bulk attenuator.

AGC [BA \[<e>|V <a>|D <t>|[I|O <t> [A]]\]] – AGC bulk attenuation settings

- <e> - Sets bulk attenuation control enable to <e>
  - where: <e> - Enable
    - 0 – Disabled, switched out
    - 1 – Enabled, switched in
    - A – AGC control enabled

- V <a> - Attenuation value to <a>, 0.0000 to 511.9375 dB

- D <t> - Switch out threshold delta attenuation <t>, -255.5 to -0.0 dB

- I|O <t> - Switch In|Out threshold at input power <t>, in dBm

- I|O <t> A – Switch In|Out threshold at attenuation <t>, 0.0 to 255.5 dB

Examples:
AGC BA 1 Bulk attenuator AGC control enabled, switched in
AGC BA V 17.000 Set attenuation value to 17.000 dB
  Valid range 0.0000 to 511.9375 dB
AGC BA D 33.3 Set switch out threshold delta attenuation to -33.3 dB
  Valid range -255.5 to -0.0 dB
AGC BA I x Set switch in threshold at input power to x dBm
AGC BA O x Set switch out threshold at input power to x dBm

4.9.1.4.2 Automatic Gain Control Data Settings – AGC DATA
The AGC DATA command is used to set the AGC table attenuation value for a specific attenuator along with an attenuation or data operation value. Parameter values are explained below.
AGC DATA [<p> <a> = <v>|<o>] – AGC data settings

- Set AGC table attenuation <p>, attenuator <a> to attenuation <v> dB

where:

- <p> - 0.0 to 255.5 dB
- <a> - Attenuator A, B, C, D, E
- <v> - Attenuation 0.0 to 31.5 dB or ‘MIN’ or ‘MAX’
- <o> - Data operation
  - LOAD – Load data
  - ERASE – Erase data
  - SAVE – Save data

Example:
AGC DATA 2.2 E MIN Set AGC table attenuation to 2.2 dB for attenuator E with attenuation of minimum

4.9.1.4.3 Automatic Gain Control Mode – AGC M

The AGC M command sets the automatic gain control loop mode.

AGC [M <m>] – Sets the AGC loop mode to <m>

where: <m> - AGC control mode

- A – Automatically select mode based on source
- R – Use RF attenuators
- I – Use IF attenuators

Setting the AGC Mode to Auto automatically sets the AGC mode to RF/IF based on IF input path (which is based on the receiver frequency).

Setting the AGC Mode to RF forces control of the RF attenuators and (if the bulk attenuator is set to Auto) the bulk attenuator under AGC control.

Setting the AGC mode to IF forces control of the IF attenuators under AGC control and disables AGC control of the bulk attenuator. This also forces AGC Zero to Auto because when playing back recorded signals, such as demod/playback-demod, the noise floor changes as the AGC in the original recording holds the signal power steady and allows the noise floor to move. The dynamic range of the AGC closely matches the dynamic range of the auto zero.

Examples:
AGC M A Automatically select mode based on source
AGC M R Set AGC control mode to use RF attenuators
AGC M I Set AGC control mode to use IF attenuators

4.9.1.4.4 Automatic Gain Control Loop Parameter – AGC L

The AGC L command sets AGC loop parameters.
AGC [L {P <t>|S <t>|A <t>|D <d>|C <t>|T <d>}] – Set AGC loop parameter

- **P <t>** - Sets period to <t>, 0.000 to 5.464 us
- **S <t>** - Sets sample time to <t>, 0.000 to 2.732 us
- **A <t>** - Sets averaging sample time to <t>, 0.002 to 2100.897 ms
- **D <d>** - Sets deadband to <d>, 0.0000 to 15.9375 dB
- **C <t>** - Sets time constant to <t>, 0.100 to 1000.000 ms
- **T <d>** - Sets power target to <d>, -100.0 to 13.0 dBm

Examples:

```
AGC L P 0.567  Set AGC loop period to 0.567 µs
Valid range is 0.000 to 5.464 µs
AGC L S 1.987  Set AGC sample time to 0.567 µs
Valid range is 0.000 to 2.732 µs
AGC L A 42.000 Set AGC averaging sample time to 42.000 ms
Valid range is 0.002 to 2100.897 ms
AGC L D 0.0010 Set AGC deadband to 0.0010 dB
Valid range is 0.0000 to 15.9375 dB
AGC L C 25.000 Set AGC time constant to 25.000 ms
Valid range is 0.100 to 1000.000 ms
AGC L T -70.0  Set AGC power target to -70.0
Valid range is -100.0 to 13.0 dBm
```

**4.9.1.4.5 Automatic Gain Control Attenuator Look Up Table – AGC LUT**

The AGC LUT command displays or rebuilds the attenuator look up table.

**AGC LUT [<p>|R]** – AGC attenuator Look Up Table

- **<p>** - Show AGC LUT <p> attenuation
- **R** – Rebuild AGC LUT

Examples:

```
AGC LUT 111.5 Display AGC look up table 111.5 attenuation
Valid range is 0.0 to 255.5 dB
AGC LUT R  Rebuild AGC look up table
```

**4.9.1.4.6 Automatic Gain Control Auto Zero – AGC AZ**

The AGC AZ command enables or disables AGC auto zero and sets hold threshold or time constants.

**AGC [AZ [TR <c>|TL <c>]]**

- **TR <c>** - Sets the AGC DSP auto zero raising time constant to <c>, 0.050 to 100.000 seconds
- **TL <c>** - Sets the AGC DSP auto zero lowering time constant to <c>, 0.050 to 100.000 seconds
Examples:
AGC AZ 0 Disable AGC auto zero
AGC AZ 1 Enable AGC auto zero
AGC AZ TR 0.100 Set AGC DSP auto zero raising time constant to 0.100 seconds
Valid range 0.050 seconds to 100.000 seconds

4.9.1.4.7 Automatic Gain Control Zero – AGC Z
The AGC Z command sets the AGC Zero operating mode and the value at which zero can be set.

AGC [Z [M <m>]] – Sets the AGC zero mode to <m>

where: <m> - AGC zero mode

A – Auto: Automatically set AGC zero level
M – Manual: Manually set AGC zero level, reset on frequency or IF bandwidth change, reset on power cycle
H – Hold: Manually set AGC zero level, NO reset on frequency or IF bandwidth change, reset on power cycle
S – Hold and Save: Manually set AGC zero level, NO reset on frequency or IF bandwidth change, NO reset on power cycle

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

AGC [Z [<p>|Z|R]]

<p> - Sets the AGC output zero to <p> in dBm
Z – Sets the AGC output zero to current
R – Resets the AGC output zero to nominal

Examples:
AGC Z A Automatically set AGC zero level
AGC Z M m Manually set AGC zero level, reset on frequency, or IF bandwidth change; reset on power cycle
AGC Z H Manually set AGC zero level, NO reset on frequency or IF bandwidth change; reset on power cycle
AGC Z S Manually set AGC zero level, NO reset on frequency or IF bandwidth change; NO reset on power cycle
AGC Z 2 Set AGC output zero to 2 dBm
AGC Z R Reset AGC output zero to nominal
AGC Z Z Set AGC output zero to current

4.9.1.5 High Speed Output Mixer Settings – AHM
The AHM command displays and controls high speed (video) output mixer settings.

AHM [<f>]<c> []<e>]] – Sets high speed (video) mixer parameters
<f> - Sets mixer frequency for ALL channels to <f>, -46.6667 to 46.6667 MHz

<c> <e> - Sets channel <c> mixer enable to <e>

where:

<c> - Channel to set enable

A – Channel DAC A
B – Channel DAC B
C – Channel DAC C
D – Channel DAC D

<e> - Enable

0 – Disabled
1 – Enabled

Examples:

AHM

high speed (video) mixer at 0.0000 MHz
Channel DAC A mixer disabled
Channel DAC B mixer disabled
Channel DAC C mixer disabled
Channel DAC D mixer disabled

AHM x

Sets mixer frequency for all channels in MHz
Valid range is -46.6667 to 46.6667 MHz

AHM c x

Sets a specific channel (c) mixer to enabled or disabled
Valid channel mixer values are A, B, C, or D

For example: AHM B 1 sets channel DAC B to Enabled
AHM D 0 sets channel DAC D to Disabled.

4.9.1.6 High/Low Speed Outputs

The receiver has four generic high speed (video) analog outputs, four generic low speed analog outputs, and four generic clock/data paired digital outputs. While there are signals that are normally found on these outputs, there is also a list of other sources that can be connected.

A receiver channel is conceptually divided into two basic parts. One is the common ‘platform’ and the other is the ‘demodulator’. The ‘platform’ is common to all telemetry modulations schemes. The demodulator is specific to the telemetry modulations scheme.

Some commands operate at the platform level, some at the demodulator level, and some at specific configurations of the demodulator. This is why the Help displays in this manner:

System Commands
Some of these sources are part of the ‘platform’ and some of these sources are specific to the demodulator in use.

The commands AHO, ALO, DHO, and DLO are the source control commands for the platform.

These commands control source, (for analog outputs, scale, offset,) and polarity.

- **AHO** – Analog High-Speed Outputs
- **ALO** – Analog Low-Speed Outputs
- **DHO** – Digital High Speed Outputs
- **DLO** – Digital Low Speed Outputs

### 4.9.1.6.1 Analog High Speed Output – AHO

The AHO command displays and controls the high speed (video) output settings. Refer to section 13 (Appendix E) for tape output configuration instructions.

Parameter values are explained below.

\[
\text{AHO} \ [\langle c \rangle \ [\langle s \rangle|\langle p \rangle|S \langle s \rangle|O \langle o \rangle] \ |E \ \langle e \rangle]
\]

where:

- \(<c>\) is the channel to set; Valid entries are:
  - A – Channel DAC A
  - B – Channel DAC B
  - C – Channel DAC C
  - D – Channel DAC D
- \(<s>\) sets the channel source to one of the options below (if desired):
  - IF0 – Physical channel 0 IF input
  - IF1 – Physical channel 1 IF input
  - POI – Physical channel 0 downconverted baseband I only
  - POQ – Physical channel 0 downconverted baseband Q only
  - POT – Physical channel 0 tape output source (needs mixer)
- P1I – Physical channel 1 downconverted baseband I only
- P1Q – Physical channel 1 downconverted baseband Q only
- P1T – Physical channel 1 tape output source (needs mixer)
- CMBI – Combiner baseband I only
- CMBQ – Combiner baseband Q only
- CMBT – Combiner tape output source (needs mixer)
- DP0 – Data path high-speed signal 0
- DP1 – Data path high-speed signal 1
- DP2 – Data path high-speed signal 2
- DP3 – Data path high-speed signal 3
- F0 – Fixed value 0
- F1 – Fixed value 1

OR

<p> sets the channel polarity to one of the values below:

{0|+} – Active high (normal)
{1|-} – Active low (inverted)

OR

S <s> sets the channel scale to a value between -128.0000 and 127.9961

OR

O <o> sets the channel offset to a value between -1.0000 and 0.9995

E <e> sets the channel enable to enabled or disabled

- 0 – Disabled
- 1 – Enabled

Example:

AHO  Displays current high speed (video) output status settings (enabled/disabled and output frequency)

   high speed (video) Channel DAC A
   Source Data path high-speed signal 0
   Scale  - 1.0000
   Offset  - 0.0000
   Polarity – High (+)
high speed (video) Channel DAC B
- Source Data path high-speed signal 1
- Scale: 1.0000
- Offset: 0.0000
- Polarity: High (+)

high speed (video) Channel DAC C
- Source Physical channel 0 downconverted baseband I only
- Scale: 1.0000
- Offset: 0.0000
- Polarity: High (+)

high speed (video) Channel DAC D
- Source Physical channel 0 downconverted baseband Q only
- Scale: 1.0000
- Offset: 0.0000
- Polarity: High (+)

70 MHz modulator disabled

AHO B P1T
- Sets the channel to Channel DAC B with Physical channel 1 tape output source;
  (Needs mixer)

AHO D S -42.0000
- Sets the channel to Channel DAC D with a channel scale of -42.0000

AHO C O 0.1234
- Sets the channel to Channel DAC C with a channel offset of 0.1234

AHO A E 1
- Sets the channel to Channel DAC A and enables the channel

AHO M
- Sets the 70 MHz modulator output to enable or disable

Examples:
AHO M 0  Disabled
AHO M 1  Enabled

AHO –V ?
- Shows extended Help for the AHO command

4.9.1.6.2 Analog Low Speed Output – ALO
The ALO command displays and controls the low speed (ACU) output settings.

Parameter values are explained below.

ALO  [<c>  [<s>|<p>|S <s>|O <o>]  |E  <e>]

where:

- <c> is the channel to set; Valid entries are:
  - A – Channel A (AM)
  - B – Channel B (Aux Analog A Out)
  - C – Channel C (AGC)
• D – Channel D (Aux Analog B Out)
  \(<s>\) sets the channel source to one of the options below (if desired):
    • AM – Demodulated AM
    • AGC – AGC output
    • CMBW – Combiner weight
    • DP0 – Data path low-speed source 0
    • DP1 – Data path low-speed source 1
    • DP2 – Data path low-speed source 2
    • DP3 – Data path low-speed source 3
    • DQDEC – DQ decode
    • DQDP – DQ datapath
    • DQOUT – DQ output
    • DS0 – DSP SNR 0
    • DS1 – DSP SNR 1
    • EA0 – External AGC 0
    • EA1 – External AGC 1
    • F0 – Fixed value 0
    • F1 – Fixed value 1
    • IA0 – Internal AGC 0
    • IA1 – Internal AGC 1

OR

\(<p>\) sets the channel polarity to one of the values below:
  \{0|+\} – Active high (normal)
  \{1|-\} – Active low (inverted)

OR

\(<s>\) sets the channel scale to a value between -128.0000 and 127.9961

OR

\(<o>\) sets the channel offset to a value between -1.0000 and 0.9995

E \(<e>\) sets the channel enable to enabled or disabled
  • 0 – Disabled
  • 1 – Enabled
Examples:
ALO C AGC Sets the channel to Channel C (AGC) with AGC output
ALO D 1 Sets the channel to Channel D (Aux Analog B Out) with polarity active low (inverted)
ALO A S 98.6543 Sets the channel to Channel A (Demodulated AM) with channel scale set to 98.6543
ALO B E 0 Sets the channel to Channel B and disables the channel

ALO –V ? – Shows extended Help for the AHO command

Example:
ALO Displays current low speed (ACU) output status settings (enabled/disabled and output frequency)
   low speed (ACU) Channel A (AM)
       Source Demodulated AM
       Scale - 1.0000
       Offset - 0.0000
       Polarity – High (+)
   low speed (ACU) Channel B (Aux Analog A Out)
       Source Fixed value 0
       Scale - 1.0000
       Offset - 0.0000
       Polarity – High (+)
   low speed (ACU) Channel C (AGC)
       Source AGC output
       Scale - 1.0000
       Offset - 0.0000
       Polarity – High (+)
   low speed (ACU) Channel D (Aux Analog B Out)
       Source Fixed value 0
       Scale - 1.0000
       Offset - 0.0000
       Polarity – High (+)

4.9.1.6.3 Digital High Speed Input – DHI
DHI displays and controls high speed digital input settings.

DHI [<c> <s>] – Sets channel <c> to source <s>
   where:

       <c> - Input channel
       NC – Not Connected
3rd Generation Rack-Mount RDMS™

<s> - Signal source
  
  F0 – Fixed 0
  F1 – Fixed 1
  GC – Generator Clock
  GD – Generator Data
  TH5 – Top Hat 5
  TH7 – Top Hat 7

DHI [<s> <p>] – Sets source <s> polarity to <p>

where:

<s> - Input source
  
  TH5 – Top Hat 5
  TH7 – Top Hat 7

<p> - Input polarity
  
  {0|+} – Active high (normal)
  {1|-} – Active low (inverted)

4.9.1.6.4 High Speed Digital Output - DHO

DHO displays and controls high speed digital output settings.

DHO [<c> <s>] - Sets channel <c> to source <s>

where:

<c> - Output channel
  
  AC - Channel A Clock
  AD - Channel A Data
  BC - Channel B Clock
  BD - Channel B Data
  CC - Channel C Clock
  CD - Channel C Data
  DC - Channel D Clock
  DD - Channel D Data
  TH1 - Top Hat 1
  TH2 - Top Hat 2
<s> - Signal source
  F0 - Fixed 0
  F1 - Fixed 1
  GC - Generator Clock
  GD - Generator Data
  AC - Clock A
  AD - Data A
  BC - Clock B
  BD - Data B
  DP0 - Datapath 0
  DP1 - Datapath 1
  DP2 - Datapath 2
  DP3 - Datapath 3
  DP4 - Datapath 4
  DP5 - Datapath 5
  DP6 - Datapath 6
  DP7 - Datapath 7

DHO [<c> <p>] - Sets channel <c> polarity to <p>
  where:

  <c> - Output channel
  AC - Channel A Clock
  AD - Channel A Data
  BC - Channel B Clock
  BD - Channel B Data
  CC - Channel C Clock
  CD - Channel C Data
  DC - Channel D Clock
  DD - Channel D Data
  TH1 - Top Hat 1
TH2 - Top Hat 2

<p> - Output polarity

{0[+] - Active high (normal)
{1[ ] - Active low (inverted)

4.9.1.6.5 Low Speed Digital Input – DLI
DLI displays and controls low speed digital input settings.

DLI [<c> <s>] – Sets channel <c> to source <s>

where:

<c> - Input channel

UR0 – UART Rx 0
UR1 – UART Rx 1

<s> - Signal source

F0 – Fixed 0
F1 – Fixed 1
URX – UART Rx
TH8 – Top Hat 8
TH9 – Top Hat 9
TH10 – Top Hat 10
TH11 – Top Hat 11
TH12 – Top Hat 12
TH14 – Top Hat 14
TH18 – Top Hat 18
TH20 – Top Hat 20
TH21 – Top Hat 21

DLI [<s> <p>] – Sets source <s> polarity to <p>

where:

<s> - Input source

URX – UART Rx
TH8 – Top Hat 8
TH9 – Top Hat 9
TH10 – Top Hat 10
TH11 – Top Hat 11
TH12 – Top Hat 12
TH14 – Top Hat 14
TH18 – Top Hat 18
TH20 – Top Hat 20
TH21 – Top Hat 21

<p> - Input polarity

{0|+} – Active high (normal)
{1|-} – Active low (inverted)

4.9.1.6.6 Low Speed Digital Output – DLO
DLO displays and controls low speed digital output settings.

DLO [<c> <s>] - Sets channel <c> to source <s>

where:

<c> - Output channel

UTX - UART Tx
TH3 - Top Hat 3
TH4 - Top Hat 4
TH6 - Top Hat 6
TH13 - Top Hat 13
TH15 - Top Hat 15
TH16 - Top Hat 16
TH17 - Top Hat 17
TH19 - Top Hat 19
TH22 - Top Hat 22

<s> - Signal source

F0 - Fixed 0
F1 - Fixed 1
UT0 - UART Tx 0
UT1 - UART Tx 1
DP0 - Datapath 0
DP1 - Datapath 1
DP2 - Datapath 2
DP3 - Datapath 3
DP4 - Datapath 4
DP5 - Datapath 5
DP6 - Datapath 6
DP7 - Datapath 7

DLO [<c> <p>] - Sets channel <c> polarity to <p>

where:

- **<c>** - Output channel
  - UTX - UART Tx
  - TH3 - Top Hat 3
  - TH4 - Top Hat 4
  - TH6 - Top Hat 6
  - TH13 - Top Hat 13
  - TH15 - Top Hat 15
  - TH16 - Top Hat 16
  - TH17 - Top Hat 17
  - TH19 - Top Hat 19
  - TH22 - Top Hat 22

- **<p>** - Output polarity
  - {0|+} - Active high (normal)
  - {1|-} - Active low (inverted)

#### 4.9.1.7 Low Speed Mixer Control – ALM

The ALM command displays and controls low speed (ACU) output mixer settings

**ALM [<f>|<c> [<e>]]** – Sets low speed (ACU) mixer parameters

- **<f>** - Sets mixer frequency for ALL channels to <f>, -100.0000 to 100.0000 kHz
- **<c> <e>** - Sets channel <c> mixer enable to <e>

where:
<c> - Channel to set enable

A – Channel A (AM)
B – Channel B (Aux Analog A Out)
C – Channel C (AGC)
D – Channel D (Aux Analog B Out)

<e> - Enable

0 – Disabled
1 – Enabled

Examples:
ALM x  Sets mixer frequency for all channels in MHz
Valid range is -46.6667 to 46.6667 MHz
ALM c x Sets a specific channel (c) mixer to enabled or disabled
Valid channel mixer values are A, B, C, or D
For example: ALM B 1 sets channel DAC B to Enabled
ALM D 0 sets channel DAC D to Disabled.

ALM
low speed (ACU) mixer at 0.0000 kHz
Channel A (AM) mixer disabled
Channel B (Aux Analog A Out) mixer disabled
Channel C (AGC) mixer disabled
Channel D (Aux Analog B Out) mixer disabled

4.9.1.8 Lock Status Command – AL
The Lock Status command reports the system lock status.
Example:
AL
System Lock is active

4.9.1.9 Best Channel Selector – BCS
The BCS command displays and controls the best channel selector settings.

BCS [<e>] - Enables best channel selection

where: <e> - Enable

0 – Disabled (Off)
1 – Enabled (On)

BCS [T <t>] - Sets best channel selector threshold <t>, 0 to 255
BCS [PH <n>] - Sets best channel selector pin hold delay $2^n$, 0 to 15 cycles

BCS [S <s> <e>] - Sets best channel selector source <s> enable to <e>

where:

<s> - Sources

CH0 - Channel 0
CH1 - Channel 1
INT - Internal

<e> - Enable

0 - Disabled
1 – Enabled

Example:
PCMFM$bcs
BCS enabled
BCS threshold 192
BCS pin hold delay $2^2$ cycles

System status display elements:

BCS - Best channel selector

4.9.1.10 Bit Rate – BR

The Bit Rate command sets or reports the baseband bit rate. The value reported by this command is shown on the front panel Advanced Menu, Sync Bit Rate option and on the Browser Interface in the Advanced Settings, Sync Bit Rate field.

BR [<r>]M[SM]

<r> - Set bit rate to <r>, 0.0240 to 23.0000 Mbps

M – Show measured bit rate

SM – Set bit rate to measured bit rate

BR M – Show the current measured bit rate

BR M Display measured bit rate in Mbps

BR SM – Set the bit rate to the measured bit rate

BR SM Set the bit rate to the measured bit rate in Mbps

Examples:
BR Report the bit rate setting
Bit rate: 1.000000 Mb/s
BR 5  Set bit rate to 5 Mbps
BR 0.6 Set bit rate to 600 Kbps
   Valid range is 0.0080 to 23.0000 Mbps

4.9.1.11 Combiner Control – CMB
The Combiner Control command displays and controls combiner settings.

CMB [<e>|M <m>|W <s>[]]
   <e> - Sets combiner enable to <e>
      where: <e> - Enable
      0 – Disabled
      1 – Enabled
   M <m> - Sets combiner operation mode to <m>
      where: <m> - Operation Mode
      M – Maximal Ratio
      B – Best Source
   W <w> - Sets combiner weighting source to <s>
      where: <s> - Weighting Source
      SNR – Ultra-Dynamic – Signal to Noise Ratio
      DQ – Ultra-Precision – Data Quality

CMB [A <e>|H <t>|B <b>]
   A <e> - Sets combiner time aligner enable to <e>
      where: <e> - Enable
      0 – Disabled
      1 – Enabled
   A H <t> - Sets aligner hold below Eb/N0 <t>, -20.000 to 30.000 dB or -100.000 is off
   A B <b> - Sets aligner with timing offset above <b>, 0.010 to 1.000 bits

CMB A P <p> – Sets the aligner hold period to <p>

Example:
CMB A P 5007 Set CMB aligner hold period to 5007 µs
   Valid range is 0.000 to 4294967296.000 µs; initialized value is 5000 µs
CMB [BSS <h>] – Sets combiner BSS mode hysteresis <h>, 0.000 to 48.131

CMB [B <s>][MB <b>][L <f>][Z <v>]
- B <s> - Sets combiner bit rate to bandwidth scale to <s>, 0.001000 to 10.000000
- MB <b> - Sets combiner maximum bandwidth to <b>, 0.000001 to 10.000000
- L <f> - Sets combiner frequency error limit to <f>, .00000002173 to 23.3333 of bit rate
- Z <v> - Sets combiner loop zeta to <v>, 0.001 to 10.00

CMB [BI <t>][BO <t>] – Sets combiner maximal ratio to BSS in/out thresholds
- BI <t> - Sets combiner maximal ratio mode to BSS hold mode threshold to <t>
- BO <t> - Sets combiner maximum BSS hold mode to ratio mode threshold to <t>

Examples:
CMB BI x Set combiner BSS in to value
CMB BO x Set combiner BSS out to value
Value range -24.065 to 24.065

CMB [HI <t>][HO <t>] - Set combiner hold in/out thresholds
- HI <t> - Sets combiner hold in to <t>, -24.065 to 24.065
- HO <t> - Sets combiner hold out to <t>, -24.065 to 24.065

Examples:
CMB HI x Set combiner hold in to value
CMB HO x Set combiner hold out to value
Value range -24.065 to 24.065

Examples:
CMB
System configured for Physical input 0
Combiner frequency error -0.024177 MHz
Combiner error limit 0.06250 of bitrate
Combiner zeta 1.000
Hold in threshold 5.936 dB
Hold out threshold 0.000 dB
BSS in threshold 11.761 dB
BSS out threshold 8.936 dB
Aligner off
Average aligner time shift 0.00 ns (0.000 bits)
Aligner hold threshold 0.000 dB
Aligner max offset 0.333 bits

CMB 0  Set combiner Disabled
CMB 1  Set combiner Enabled

4.9.1.12  Clock Polarity – CP
The Clock Polarity command displays and controls clock output polarity.

CP [<p>] – Sets clock component output polarity

<p> - Set clock polarity to <p>

where:

<p> - Polarity

{0|+} – Active high (normal)
{1|-} – Active low (inverted)

Examples:
CP  Report the clock source state
Clock polarity active High (+)

CP 0  Set clock inversion Off
CP 1  Set clock inversion On

4.9.1.13  Downconverting Antenna – DA
The Downconverting Antenna command displays and controls receiver C band to P band downconverting antenna

DA [<e>] – Sets the C band downconverting antenna enable to <e>

where: <e> - Enable

0 – Disabled (C band tunes directly)
1 – Enabled (C band tunes to downconverted P band)

Examples:
DA
Downconverting antenna is disabled

DA 0  Set downconvert antenna state to Off (Disabled); C band tunes directly
DA 1  Set downconvert antenna state to On (Enabled); C band tunes to downconverted P band
**Downconverting antenna control only available when using a 5-band downconverter AND P and C bands are enabled.

4.9.1.14 Differential Decoding – DD

The Differential Decoding command displays and controls differential decoder settings (SOQPSK mode only). Differential Decoding for DPM defaults to Disabled (Off).

DD <e> - Sets the differential decoder enable to <e>

where: <e> - Enable

0 – Disabled

1 – Enabled

Example:

DD
differential decoder disabled

4.9.1.15 Digital Output Muting – DOM

The Digital Output Muting command displays and controls lock detect controlled output settings.

DOM [<e>|T <t>|C <e>|D <e>]

where: <e> - Enable

0 – Disabled

1 – Enabled

T <t> - Sets the output muting unlock timeout to <t>, 0 to 46016 ms

C <e> - Sets clock output muting on unlock to <e>

where: <e> - Enable

0 – Disabled

1 – Enabled

D <e> - Sets data output muting on unlock to <e>

where: <e> - Enable

0 – Disabled

1 – Enabled

Example:

DOM

Output muting timeout 1000

Output muting clock enable 0
Output muting data enable 0

4.9.1.16 Data Polarity – DP
The DP command displays and controls data output polarity.

DP [<p>] – Sets data component output polarity
  
  <p> - Set data polarity to <p>
  
  where: <p> - Polarity

  {0|+} – Active high (normal)
  
  {1|-} – Active low (inverted)

Examples:
  
  DP
  
  Data polarity active High (+)
  
  DP 0  Set data polarity to NOT inverted (Off)
  
  DP 1  Set data polarity to inverted (On)

4.9.1.17 Data Quality Encapsulation – DQ
The Data Quality command displays and controls data quality settings.

DQ [<e>|B <b>]
  
  [<e>] - Enables data quality encapsulation
  
  where: <e> - Enable

  0 - Disabled
  
  1 - Enabled
  
  [B <b>] - Sets data quality encapsulation block size to <b>, 1 to 16384

DQ [RAW <t> <e>] - Sets data quality raw metric enable for table <t> to <e>
  
  where: <t> - Table

  DP - datapath LUT
  
  DEC - decode LUT
  
  OUT - output LUT
  
  where: <e> - Enable

  0 - Disabled
  
  1 - Enabled
DQ LUT \(<t>\ [<p>[ = <v>]]\) - Show/set data quality LUT value(s) for table \(<t>\)

where: \(<t>\) - Table

DP - datapath LUT
DEC - decode LUT
OUT - output LUT

where:

\(<p>\) - Data quality LUT index \(<p>\), 0 to 255
\(<v>\) - Data quality LUT value \(<v>\), 0.0000 to 0.999985

DQ \([M \ <e> \ [<r>]]\) - Sets data quality encapsulation dump enable to \(<e>\) at rate \(<r>\)

where: \(<e>\) - Enable

0 - Disabled
1 - Enabled

\(<r>\) - Display rate \(<r>\), 1 to 60000 ms

Example:
PCMFMS\$dq
Data quality encapsulation disabled
Data quality encapsulation block size 4096 bits
Average datapath BEP 1.005e-12
Average decode BEP 1.005e-12
Average output BEP 1.140e-12
DQ datapath bit count: 3253769216  error count: 2.70774440e+07  BEP: 8.322e-03
DQ decode bit count: 1725284352  error count: 2.58360140e+07  BEP: 1.497e-02
DQ output bit count: 1725284352  error count: 2.09354580e+07  BEP: 1.213e-02
DQ decode raw disabled
DQ datapath raw disabled

System status display elements:
DQ DP  -  - Average datapath DQ
DQ DEC -  - Average decode DQ
DQ OUT - Normal Wide CSV - Average output DQ
DQ DPC -  - DQ datapath counts
DQ DECC -  - DQ decode counts
DQ OUTC -  - DQ output counts
4.9.1.18 Derandomizer State – DR
The DR command displays and controls derandomizer settings.

DR [M <m>] – Sets the derandomizer mode to <m>

where: <m> - Derandomizer mode

N – None
I – IRIG
C – CCSDS (Only valid with LDPC)

Examples:
DR
Derandomizer none
DR M I
Derandomizer IRIG

4.9.1.19 Digital Status Output – DSO
There are two generic discrete digital outputs that are normally lock status and sync detect (used for synchronization time testing) but also have other potential sources. The Digital Status Output command controls the source, polarity, and override states.

DSO [<c> [<s>|<p>|M <m>]]

where:

<c> - Channel
L – Lock detect output
S – Sync detect output
<s> - Signal source
LD – Lock detect
SD – Sync detect
PL – PCM frame lock
PS – PCM sub-frame valid

<p> - Sets channel <c> polarity to <p>

where: <p> - Output polarity
{0,+} – Active high (normal)
{1,-} – Active low (inverted)
M <m> - Sets channel <c> output mode to <m>
where: <m> - Output mode

0 – Allows normal output
1 – Forces output to 1 (active)
-1 – Forces output to 0 (inactive)

Example:
DSO
  Lock detect output = Lock detect active High (+) normal operation
  Sync detect output = Sync detect active High (+) normal operation

4.9.1.20 Forward Error Correction – FEC

Forward Error Correction requires the K7 option in the serial number.

The FEC command displays and controls Forward Error Correction settings.

FEC [M <m>|S <m> <s>]

M <m> - Sets FEC mode to <m>

where: <m> - Mode
N – None
L – LDPC Block decode
V – Viterbi K = 7 Rate

S <m> <s> - Sets soft decision scale for mode <m> to <s>

where: <m> - Mode
N – None
L – LDPC Block decode
V – Viterbi K = 7 Rate

where: <s> is a value between -32.000 and 31.984

FEC M – Sets the FEC mode for all enabled modes

Examples:
FEC M N Set FEC mode to None
FEC M V Set FEC mode to Viterbi K=7 Rate=1/2

Examples:
FEC
  FEC mode None
4.9.1.21 Force Lock Indication – FL

The FL command displays and controls lock forcing settings.

FL [<l>] – Sets lock state to <l>

where: <l> - Lock state

0 – Normal operation
1 – Forced active
-1 – Forced inactive

Examples:
FL
Lock is normal
System lock is active
Datapath lock is active
FL 0 Force lock to Normal
FL 1 Force lock to On
FL -1 Force lock to Off

4.9.1.22 FM Demodulator Settings – FM

The FM command displays and controls FM demodulator settings.

Parameter values are explained below.

\[ \text{FM} \ [\text{p}|S \text{s}|B \text{b}|D \text{m}] \]

where:

\(<p>\) sets the channel polarity to one of the values below:

- \{0\|+\} – Active high (normal)
- \{1\|-\} – Active low (inverted)

OR

\(S \text{s}\) sets the FM output scale to a value between -128.0 and 128.0

OR

\(B \text{b}\) sets the FM detector bandwidth to a value between 0.02 MHz and 46.00 MHz

The FM detector bandwidth cannot be less than current bit rate bandwidth. Refer to section 4.9.1.22.1 for additional details about the FM B x command.

OR

\(D \text{m}\) sets the NTSC Video deemphasis filter mode to one of three values
3rd Generation Rack-Mount RDMS™

- 0 – Off
- N – NTSC
- P – PAL

Example:
FM
  FM output polarity +
  FM demodulator bandwidth 1.4 MHz
  FM output scale 1.0
  Video de-emphasis filter Off

4.9.1.22.1 FM Video Bandwidth Control – FM B
The FM B x command adjusts the I/Q (video) output bandwidth with PCM/FM in mind. Setting the FM (video) bandwidth wider than it would normally be set by the bit rate (this would be 1.1 to 1.4 wider than the bit rate) configures the system to allow a higher bandwidth on the output while allowing normal PCM/FM demodulation on the lower frequency PCM/FM.

- The video bandwidth can never be set narrower than the required bandwidth for the specified bit rate. (The FM bandwidth cannot be less than the bandwidth required to process the bit rate being used.)
- The IF filter selection, if set to FS A, is wide enough to accommodate the wider FM (video) bandwidth.
- This configuration only operates properly in Phase Noise Compensation mode (PN 1).
- Modulation Index tracking must be turned OFF as it is incompatible with modulations like PCM/FM/FM.
- The video bandwidth must be set AFTER the bit rate has been set.
- Setting the bit rate sets the video bandwidth compatible with the bit rate.

4.9.1.23 Front Panel Display Status – FPD
The Front Panel Display status command displays the data that is sent to the rack used to keep the front panel displays updated.

FPD [<e>]

  <e> - Sets front panel data update enable to <e>

  where: <e> - Enable
           0 – Disabled
           1 – Enabled

Example:
FPD

  Front panel data update enabled at 50 ms update rate
  Version 4
  Signal strength -60.547 dB
  Signal quality 27.235 db Eb/N0
  System lock active
  AGC is zeroed
AGC zeroed at -60.109 dBm
Gain calibration is valid
Demod temperature 43 C
DQE BEP 0.999985 (1.000e-12)
Privilege dictionary is invalid
PCMFM
   Version 1
   MI scaling mode acquire
   MI scaling state triggered
   MI scaling acquire trigger 27.573 Eb/N0 dBm
   Modulation H 0.701

4.9.1.24 Frequency – FR
The FR command displays and controls receiver frequency.
FR [<f>] – Sets receiver to <f> in MHz
where: <f> - Receiver frequency
   P band: 200.0 to 1150.0 MHz
   CT band: 1150.0 to 2500.0 MHz
   C band: 4400.0 to 5250.0 MHz
   70 MHz band: 70.0 to 70.0 MHz
   Playback band: 0.1 to 20.0 MHz

Examples:
FR          Rx frequency 2200.500000 MHz
FR 2200.5   Set modulation to 2200.5 MHz

4.9.1.25 Help Command – H
H – Displays a list of basic Help commands
H ? – Displays “Help on Help”
Commas ’,’ indicate one or more of the following parameters are allowed:
   If multiple parameters are specified they must be in the order in the list.
For example, BER [M [<s>,?[] - BER command followed by optional command control parameter 'M'. If the 'M' command control parameter is used, it is optionally followed by one or more parameters from the list <s>, ‘?’.

4.9.1.26 Advanced Help Command – HA
HA [-v] – Displays extended help for each command, if available
HA [<s>] – Searches help for <s> and displays it
Help on Help...

- Commands are tiered according to their degree of complexity/frequency of use into basic, advanced, or extended
- Basic command help can be accessed by ‘H’ or ‘?’
- Detailed help on any command is accessed by following the command with ‘?’ such as <command> ?

Help/Command conventions:

- All commands are entered followed by 0 or more parameters.
- Each parameter is separated by one or more spaces.
- Each parameter may be either a value parameter to the command or a command control parameter that specifies the operation of the command.

  <command> <parameter 1> <parameter 2> ...

- In general, a command with no parameters will display the commands associated status.

Detailed help displays follow a common convention:

- Upper case parameters indicate command control parameters that must be entered as specified:
  
  **BR M** – BR command followed by the command control parameter ‘M’

- Angle brackets ‘<’ and ‘>’ indicate value parameters. A value parameter is a variable parameter to a command. A value parameter may be either a numeric or text value, or an additional command control parameter:

  **FR <f>** - FR command followed by the value parameter <f>

- Square brackets ‘[‘ and ‘]’ indicate optional parameters:

  **MO [<m>]** – MO command followed by optional value parameter <m>

- Vertical bars ‘|’ indicate a choice of parameters:

  **AGC [M <m>|<e>]**

  AGC command followed by optional M control parameter followed by the <m> value parameter OR AGC command followed by just the <e> value parameter.

- Braces '{' and '}' indicate a required value:

  **DDT [P {<s>|<p>}]**

  DDT command followed by optional command control parameter ‘P’. If the ‘P’ command control parameter is used it is followed by a required <s> OR <p> value parameter.

A complex example:

**AGC BA [<e>|V <a>|I|O <t> [A]]**
The AGC command followed by the BA command control parameter, followed by one of:

- `<e>` value parameter
  OR
- the V command parameter followed by the `<a>` value parameter
  OR
- the I or O command parameter followed by the `<t>` value parameter followed by an optional A command parameter

### 4.9.1.27 HyperTrack – HT
Displays and controls HyperTrack settings

**HT [<e>|DR <r>|RSSI <d>|DQM <d>]**

- `<e>` - Sets adaptive equalizer enable to `<e>`
  where: `<e>` - Enable
    - 0 - Disabled
    - 1 - Enabled
- `[DR <r>]` - Sets data rate to `<r>`, 0.1152 to 40.0000 MHz
- `[RSSI <d>]` - Sets RSSI decimation rate to 2^<d>, 0 to 15
- `[DQM <d>]` - Sets DQM decimation rate to 2^<d>, 0 to 15

### 4.9.1.28 IF Filter Control – IF
The IF filter control command displays and controls the filter selections.

IF filters may be set to automatic based on the bit rate or the second IF filter may be set to a value based on a filter index.

**IF [A|<s>|F <f>] – Sets IF filter control**

- A – Sets IF filter selections to automatic based on bit-rate
- `<s>` - Sets second IF filter to `<s>`
  where: `<s>` - Filter index

The IF A command sets the IF filter selections to automatic based on bit rate.

IF x sets the second IF filter to one of the filter index values listed below:

- 0 – 70 kHz
- 1 – 250 kHz
- 2 – 500 kHz
- 5 – 2.0 MHz
- 6 – 3.0 MHz
- 7 – 4.5 MHz
- 10 – 14.0 MHz
- 11 – 20.0 MHz
- 12 – 28.0 MHz
IF F x sets the first IF filter to one of the filter index values below:

- 0 – 12.0 MHz
- 1 – bypassed

Examples:

IF

Auto IF filter select enabled
First IF filter (0) 12.0 MHz
Second IF filter (5) 2.0 MHz
IF F 0  Sets the first IF filter to 12.0 MHz
IF F 9  Sets the second IF filter to 10.0 MHz

4.9.1.29 Low Density Parity Check – LDPC

The LDPC command displays and controls Forward Error Correction settings.

LDPC [M <m>|A <t>|I <s>]

M <m> - Sets LDPC mode to <m>. LDPC mode is stored and transferred if the (waveform) Mode changes.

where: <m> - LDPC Mode

4k1 – 4k Rate 1/2
1k1 – 1k Rate 1/2
4k2 – 4k Rate 2/3
1k2 – 1k Rate 2/3
4k4 – 4k Rate 4/5
1k4 – 1k Rate 4/5

A <t> - Sets ASM threshold to <t>, 0 to 65535. This is not a stored parameter.

I <s> - Sets half iteration scale to <s>, 0.100 to 1.000

Examples:

LDPC

LDPC mode 4k Rate 2/3
LDPC decode ASM threshold 192
LDPC decode half iteration scale 0.900
LDPC A 42  LDPC decode ASM threshold 42
LDPC I .567  LDPC decode half iteration scale 0.567
4.9.1.30 Modulation Index – MI

The MI command displays and controls modulation index scale settings.

**MI [<s>|M <m>|TH <h>|THE <e>|AD <d>|AS <s>|P <e>]**

- `<s>` - Sets modulation index scale to `<s>`, 0.350 to 8.000, this forces the mode to hold at the specified value
- `M <m>` - Sets modulation index scale mode to `<m>`
  - where: `<m>` - Mode
    - O – Off (sets scale 1.0 for nominal deviation of 0.70)
    - H – Hold
    - A – Acquire
    - T – Tracking
- `TH <h>` - Sets tracking-mode hold below Eb/N0 of `<h>`, -20.000 to 30.000
- `THE <e>` - Sets tracking-mode hold below Eb/N0 enable to `<e>`
  - where: `<e>` - Enable
    - 0 – Disabled
    - 1 – Enabled
- `AD <d>` - Sets acquire mode minimum delta H to `<d>`, 0.000 to 8.000
- `AS <s>` - Sets acquire mode settling time to `<s>`, 20 to 10000 ms with a 10 ms resolution
- `P <e>` - Sets the modulation index scale parameter (mode and H value) persistence to `<e>`
  - where: `<e>` - Enable
    - 0 – Disabled
    - 1 – Enabled

**MI [TS {M <i>|T <i>|H <i>}]**

- `M <i>` - Sets modulation index trellis maximum index to `<i>`, 0.000 to 8.000
- `T <i>` - Sets modulation index trellis target index to `<i>`, 0.000 to 8.000
- `H <i>` - Sets modulation index trellis hysteresis to `<i>`, 0.000 to 8.000

**Examples:**
- **MI**
  - Modulation index scaling mode acquire (Triggered at 27.57 Eb/N0)
  - Modulation index 0.701, estimated index 0.701
  - Tracking mode hold threshold 10.000 Eb/N0
Tracking mode hold enabled
Acquire mode delta H 0.005
Acquire mode settle time 500 ms
Operation persistence disabled

MI x  Sets mod index scale to a value between 0.350 and 4.000 and forces mode to hold at specified value
MI O  Disable Mod Index Tracking (Set to h=0.7)
MI A  Acquire mode enable
MI A D  Sets the maximum delta h (indicates a change in h defaults to 0.005)
MI A S  Sets the delta h settling time defaults to 500 ms
MI H  Hold Mod Index Tracking at current position
MI I  Sets Trellis Index
MI T  Tracking mode enable
MI T H x  Sets the Tracking Hold threshold below Eb/N0 (x)
          Valid range is -20.000 to 30.000

4.9.1.31 Modulation – MO

The MO command displays and controls mode settings.

MO [<m>] – Sets the demodulation mode to <m>

  where: <m> - Mode

  {0|PCMFM} – Pulse Code Modulation/Frequency Modulation
  {1|SOQPSK} – Shaped Offset Quadrature Phase Shift Keying
  {2|MhCPM} – Multi-h Continuous Phase Modulation
  {3|BPSK} – Bi-Phase Phase Shift Keying
  {4|QPSK} – Quadrature Phase Shift Keying
  {5|AQPSK} – Asymmetrical Quadrature Phase Shift Keying
  {6|AUQPSK} – Asymmetrical/Unbalanced Quadrature Phase Shift Keying
  {7|OQPSK} – Offset Quadrature Phase Shift Keying
  {8|UQPSK} – Unbalanced Quadrature Phase Shift Keying
  {9|DPM} – Digital Phase Modulation
  {11|STC} – Space Time Coding
  {12|SOQPSK/LDPC} – Shaped Offset Quadrature Phase Shift Keying With LDPC
  {13|STC/LDPC} – Space Time Coding With LDPC
Examples:

MO

Mode PCMFM – Pulse Code Modulation/Frequency Modulation
MO 0  Set modulation to PCM/FM
MO 1  Set modulation to SOQPSK-TG
MO 2  Set modulation to Multi-h CPM
MO 3  Set modulation to BPSK
MO 4  Set modulation to QPSK
MO 5  Set modulation to AQPSK
MO 6  Set modulation to AUQPSK
MO 7  Set modulation to OQPSK
MO 8  Set modulation to UQPSK
MO 9  Set modulation to Digital PM (DPM)
MO 10 Set modulation to Analog FM
MO 11 Set modulation to Space Time Coding (STC)
MO 12 Set modulation to SOQPSK/LDPC
MO 13 Set modulation to STC/LDPC

4.9.1.32 Output Clock Measurement – OCM

The Output Clock Measurement command displays measured output clock frequency. Most of the time this is the same as the commanded bit rate but, depending on encoding/decoding and other factors, this may or may not be the commanded bit rate.

OCM – Shows measured clock rate

Example:

OCM

Component A measured datapath rate 0.999998 – commanded 0.999998
Component B measured datapath rate 0.000000 – commanded 0.000000

4.9.1.33 PCM Decoding – PDC

The PCM Decoding command displays and controls PCM digital decoder settings.

PDC [<t>] – Sets the PCM decoding to <t>

where: <t> - Decoding

NRZL – Non-return-to-zero, level
NRZM – Non-return-to-zero, mark
NRZS – Non-return-to-zero, space
RZ – Return-to-zero
BIPL – Bi-phase, level
BIPM – Bi-phase, mark
BIPS – Bi-phase, space
DMM – Delay modulation (Miller code), mark
DMS – Delay modulation (Miller code), space
M2M – Modified delay modulation (Miller squared code), mark
M2S – Delay modified modulation (Miller squared code), space

Example:
PDC
   PCM decode NRZL – Non-return-to-zero, level

4.9.1.34 Receiver Channel Parameters
Six of the listed commands, PER, PERA, PLD, PRS, PSV, and RFD operate within the following constraints.

There are two forms the receiver channel parameters take. One is the current operating parameter set that controls the operation of the receiver brick and the other is the stored parameter set.

The current operating parameters are volatile in nature in that when the power is removed, the parameters are lost. The stored parameters are saved in FLASH memory in the receiver brick. When the receiver brick is turned on, the stored parameters are loaded into the current operating parameter set.

Parameters in the current operating parameter set can be changed without affecting the stored parameter set. When the receiver brick is powered down, current operating parameters go away and when powered on, the stored parameter set becomes the current operating parameter set.

4.9.1.34.1 Parameters Erase – PER
The Parameters Erase command erases the stored parameter set for the current mode. It has no impact on the current operating parameter set. If the receiver brick is power cycled, the current operating parameter set is set to defaults.

Example:
PER
   Erasing parameter data... ok

4.9.1.34.2 All Parameters Erase – PERA
The Parameters Erase command erases the stored parameter set for all modes. It has no impact on the current operating parameter set. When the receiver brick is power cycled, all operating parameters set are set to defaults.

Example:
PERA
   Erasing parameter data... ok

4.9.1.34.3 Parameter Load – PLD
The Parameter Load command loads the stored parameter set into the current operating parameter set.

Example:
PLD
   Loading parameter data... ok
4.9.1.34.4 Parameter Reset – PRS
The Parameter Reset command resets the current operating parameter set to the defaults. This does not affect the stored parameter set.

Example:
PRS
   Initializing parameter data... ok

4.9.1.34.5 Parameters Save – PSV
The Parameters Save command writes the current operating parameter set into a (previously erased) stored parameter set.

Example:
PSV
   Saving parameter data... ok

4.9.1.34.6 RF Path Attenuation – RFA
RFA [<p>] – Sets RF path attenuation to <p>
   where: <p>
      MIN
      MAX
      0.0 to 126.0 dB using AGC table

4.9.1.34.7 Reset to Factory Defaults – RFD
The Reset to Factory Defaults command erases the stored parameter set for ALL modes then resets the current operating parameter set to the defaults including mode (it changes to the default mode).

Example:
RFD
   WARNING: ALL CONFIGURATION PARAMETER DATA IS ABOUT TO BE ERASED!!
   THIS CANNOT BE UNDONE!!
   Enter “YES” to continue!$
   Aborted

4.9.1.35 Power Level – PL
The PL command reports or sets the current input power level setting.

PL [<e>[-h][<f>][<r>]] - Sets power level tracking display enable to <e> in format <f> at rate <r>
   where:
      <e> - Enable
         0 – Disabled
         1 – Enabled
      <f> - Format (last used, if not specified)
N – Normal
C – CSV

<\r> - Sets display rate to \r>
Valid range is 100 to 60000 ms (500 ms if not specified)

Options:
- \-h – Do not display header

PL [HEAD \<f\>] – Shows system status header in format \f\>

where:

<\f> - Format (last used, if not specified)
N – Normal
C – CSV

Examples:
PL
Input dBm  Atten dB  Signal dBm  Adj dBm  Eb/N0 dB Saturation
60.48     59.750      -3.43      13.03      27.30          0
Power leveling automatic
Power leveling active
Power level target power  13.00 dB
Power level scale  0.00 dB
Power level measurement signal + noise
Power level filtering enabled

PL 0  Set the current power level information tracking display to Off
PL 1  Set the current power level information tracking display to On

PL C A – Sets power level automatic control mode

Examples:
PL C A 0  Set the power level automatic control mode to Software
PL C A 1  Set the power level automatic control mode to Hardware

PL F – Sets the average and adjusted power level filter coefficient

Example:
PL F 5  Set the power level filter coefficient to 5
Valid range is 1 to 16

PL M – Sets the power level measurement type
Examples:
PL M 0  Set the power level measurement type to Total Power
PL M 1  Set the power level measurement type to Signal Power

PL S – Sets the power level scale value
Example:
PL S 2.517  Set the power level scale value to 2.517
Valid range is 0.000 to 7.996

4.9.1.36  Phase Noise Compensation – PNC
The PNC command reports or sets the phase noise compensation state.
Examples:
PNC
  Phase noise compensation off
PNC 0  Set phase noise compensation to Off
PNC 1  Set phase noise compensation to On

4.9.1.37  Query Temperature – QT
The Query Temperature command reports the temperature in degrees Celsius.
Example:
QT
  FPGA temperature: 41.0 C (85 C Max)
  Demod temperature: 43.0 C (85 C Max)

4.9.1.38  Signal Degradation Information – SDI
The Signal Degradation Information command sets and displays a variety of signal degradation information settings.

SDI [<e>|T <e>|S <s>|P <p>|L <b>|IT <t>|ET <t>]
  <e> - Sets the SDI enable to <e>
    where: <e> - Enable
         0 – Disabled
         1 – Enabled
  T <e> - Sets the SDI tracking display enable to <e>
    where: <e> - Enable
         0 – Disabled
         1 – Enabled
  S <s> - Sets the SDI data source to <s>
where: <s> - Data source
   P0 – Physical input 0
   P1 – Physical input 1
   CMB – Combiner

P <p> - Sets source polarity to <p>
   where: <p> - Polarity
   {0+[} – Active high (normal)
   {1[-} – Active low (inverted)

L <l> - Sets lock state to <l>
   where: <l> - Lock state
   0 – Normal operation
   1 – Forced active
   -1 – Forced inactive

I <t> - Sets internal threshold to <t>, 0 to 65535, or A for automatic

E <t> - Sets external threshold to <t>, 0 to 65535, or A for automatic

Examples:
SDI
   SDI enabled
   SDI datasource Physical input 0
   Lock is normal
   SDI lock is inactive
   Polarity – High (+)
   SDI internal threshold automatically set to 32768
   SDI external threshold automatically set to 403

SDI 0  Disable SDI
SDI 1  Enable SDI

SDI E – Sets signal degradation information external threshold

Examples:
SDI E A  Set SDI external threshold to automatic
SDI I 1943 Set SDI external threshold to 1943
   Valid range 0 to 65535

SDI I – Sets signal degradation information internal threshold
Examples:
SDI I A  Set SDI internal threshold to automatic
SDI I 4242 Set SDI internal threshold to 4242
Valid range 0 to 65535

SDI L – Sets signal degradation information lock state
Examples:
SDI L 0  Set SDI lock state to normal operation
SDI L 1  Set SDI lock state to forced active
SDI L -1 Set SDI lock state to forced inactive

SDI P – Sets signal degradation information source polarity
Examples:
SDI P 0  Set SDI source polarity to active high (normal)
Valid active high 0 or +
SDI P 1  Set SDI source polarity to active low (inverted)
Valid active low 1 or –

SDI S – Sets signal degradation information source
Examples:
SDI S P0  Set SDI data source to Physical Input 0
SDI S P1  Set SDI data source to Physical Input 1
SDI S CMB Set SDI data source to Combiner

SDI T – Sets signal degradation information tracking display enable or disable parameters
Examples:
SDI T 0  Disable SDI tracking display
SDI T 1  Enable SDI tracking display

4.9.1.39 Spectrum Inversion – SI
The SI command displays and controls receiver spectrum inversion.

SI [<e>]
where: <e> - Enable

0 – Disabled
1 – Enabled

Example:
SI
Spectrum inversion is disabled
4.9.1.40 Show Serial Number – SN

The SN command displays the part number and serial number for the connected RDMS™.

Example:

SN

Part Number: QSX-RDMS-3R1D-A1-1311-00-14-K7-EQ
Customer Model: CHANNEL 1
Serial Number: 2091
Hardware Rev:

4.9.1.41 Save Parameters – SV

The Save Parameters command erases the stored parameter set and writes the current operating parameter set into the stored parameter set in a single command.

Example:

SV

Saving parameter data... ok

4.9.1.42 System Status Tracking – SYS

The SYS command displays system status and allows specification of the format: Normal (narrow), Wide (verbose), and CSV (Comma Separated Values). If “-h” is added to the command string, the header will not be displayed.

SYS [<e> [-h] [<f>] [<r>]] – Sets system status tracking display enable to <e> in format <f> at rate <r>. If not specified, Format and Rate will be the last one used, or the default if it was never specified.

where:

<e> - Enable
0 – Disabled
1 – Enabled

<f> - Format (last used, if not specified) Each item/parameter in the SYS display is optional within each display format.

N – Normal
W – Wide
C – CSV

<r> - Display rate <r>, 100 to 60000 ms (500 ms if not specified)

Options:

-h – Do not display header (This command suppresses header emission. This has to be specified with each command.)

SYS [HEAD [<f>]|ELE [<f>]]

[HEAD <f>] – Shows the system status header in format <f>
[ELE [<f>]] – Shows the system status elements (items/parameters) for format <f>

where:

- <f> - Format
  - N – Normal
  - W – Wide
  - C – CSV

SYS [<c> [<s>]] <f> <e>] – Sets the system status element (item/parameter) <c> [<s>] display in format <f> to <e>

where:

- <c> [<s>] - (Command <c> and subcommand <s>)
- BEOL – Beginning/End of line marker

List of optional items/parameters that can be displayed.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOD ST</td>
<td>System time</td>
</tr>
<tr>
<td>TOD DT</td>
<td>Date/Time of day (can be set with the TOD Command)</td>
</tr>
<tr>
<td>PL INP</td>
<td>Receiver input power</td>
</tr>
<tr>
<td>PL ATT</td>
<td>Input attenuation</td>
</tr>
<tr>
<td>PL SL</td>
<td>Demod signal level</td>
</tr>
<tr>
<td>PL ADJ</td>
<td>Adjusted signal level</td>
</tr>
<tr>
<td>PL EB</td>
<td>Signal Eb/N0</td>
</tr>
<tr>
<td>AFC DET</td>
<td>Detected AFC offset</td>
</tr>
<tr>
<td>AFC CMP</td>
<td>Compensated AFC offset</td>
</tr>
<tr>
<td>AFC S</td>
<td>AFC state</td>
</tr>
<tr>
<td>AGC EXT</td>
<td>External AGC zero</td>
</tr>
<tr>
<td>BR</td>
<td>Current bitrate</td>
</tr>
<tr>
<td>AL</td>
<td>Demod locked</td>
</tr>
<tr>
<td>DQ OUT</td>
<td>Average DQM in DQE</td>
</tr>
<tr>
<td>DQ DP</td>
<td>Average datapath DQM</td>
</tr>
<tr>
<td>PDF</td>
<td>PCM deframe</td>
</tr>
<tr>
<td>MI</td>
<td>Modulation index and mode</td>
</tr>
</tbody>
</table>
where:

\(<f>\) - Format (last used, if not specified)

N - Normal
W - Wide
C - CSV
A - All above

\(<e>\) - Enable

0 - Disabled
1 - Enabled

SYS [ALL \(<f>\) \(<e>\)] – Sets all system status elements (items/parameters) in style \(<f>\) to \(<e>\)

where:

\(<f>\) - Format (last used, if not specified)

N - Normal
W - Wide
C - CSV
A - All above

\(<e>\) - Enabled in

DEF - Default

0 - Disabled
1 - Enabled

Examples:
SYS 1
STC$sys 1

<table>
<thead>
<tr>
<th>Input dBm</th>
<th>Eb/N0 dB</th>
<th>AFC DET kHz</th>
<th>BR Mb/s</th>
<th>L</th>
<th>Avg DQE</th>
</tr>
</thead>
<tbody>
<tr>
<td>-61.13</td>
<td>4.42</td>
<td>-10.959~</td>
<td>4.999991</td>
<td>1.023e-12</td>
<td></td>
</tr>
<tr>
<td>-61.07</td>
<td>4.43</td>
<td>-11.015~</td>
<td>4.999991</td>
<td>1.016e-12</td>
<td></td>
</tr>
<tr>
<td>-61.13</td>
<td>4.43</td>
<td>-11.032~</td>
<td>4.999991</td>
<td>1.013e-12</td>
<td></td>
</tr>
</tbody>
</table>
4.9.1.43 Tape Out – TO

The Tape Out command displays and controls tape output settings. It can be enabled on video A or B outputs only. (C and D video outputs are used to drive the 70 MHz IF modulator on the combiner.)

The Tape Out carrier frequency can be specified in three ways:

- Any frequency from 0 to 46 MHz
- A standard IRIG channel
- Any frequency from 0 to 46 MHz snapped to a standard IRIG channel

Tape Out enable, output channel select, and frequency save/restore propagate between mode changes.

TO [O <c> <m>|F<f>|I <f>|C <c>]

O <c> <m> - Sets tape output channel <c> mode to <m>

where:

- <c> - Analog output channel
  - A - Channel A
  - B - Channel B

F <f> - Sets the tape output frequency to <f>, -46.6667 to +46.6667 MHz

I <f> - Sets tape output frequency <f> to the nearest IRIG standard channel

C <c> - Sets tape output frequency to IRIG standard channel <c>

where:

- <c> - IRIG channel
  - 0 – 112.5 kHz
  - 1 – 150 kHz
  - 2 – 225 kHz
  - 3 – 300 kHz
  - 4 – 450 kHz
  - 5 – 600 kHz
  - 6 – 900 kHz
4.9.1.44 Time of Day – TOD

The Time of Day command displays and sets the current calendar date and time of day values. This is primarily used to add a hard reference to the BERT (BER command) output. It is volatile and must be reset after every power cycle or mode change.

**TOD [[mm/dd/yyyy] [hh:mm[:ss]]]

where:

- **mm** – Month 1 – 12
- **dd** – Day of month 1 – 31
- **yyyy** – Year
- **hh** – Hour 0 – 23
- **mm** – Minutes 0 – 59
- **ss** – Seconds 0 = 59

**Examples:**

TOD

10/16/2015  14:34:06
Friday, October 16, 2015  02:34:06 PM

TOD 10/16/2015 14:34:00

4.9.1.45 Show Options – UP

The Show Options command displays unit parameter settings.

**Example:**

UP

Part Number:    QSX-RDMS-3R1D-A1-1311-00-14-K7-EQ
Customer Model: CHANNEL 1
Serial Number:  2091
Hardware Rev:
Revisions options: None
Configured as receiver with IF SAW filters
1 channel
Housing is rack mount, IF input, TTL output
Enabled extended bands:
- P band: 200.0 to 1150.0 MHz
- CT band: 1150.0 to 2500.0 MHz
- C band: 4400.0 to 5250.0 MHz
- 70 MHz band: 70.0 to 70.0 MHz
- Playback band: 0.1 to 20.0 MHz

Enabled modes:
- PSK
- MHCPM
- SOQPSK
- STC
- PCMFM

Pin out:
- 00 – Standard

Options:
- EQ – Adaptive Equalizer
- 14 – 14 SAW Filters
- K7 – Viterbi decode (k = 7 rate = 1/2)

**4.9.1.46 Version – VE**
The Version command displays the current application, FPGA, and adaptive equalizer versions.

**Example:**
VE
```
PCMFM FPGA Rev: 0000102A   Sep  9 2015 19:19:51
AEQ Rev: 1.0.5      Sep  9 2015 19:13:52
```

**4.9.1.47 Viterbi Forget Factor – VFF**
The Viterbi Forget Factor command reports or sets the Viterbi forget factor, on a scale from 0.01 – 0.99.

**VFF [F <f>]**
- F <f> - Sets trellis forget factor to <f>, 0.000 to 1.000

**Examples:**
VFF
```
Trellis run length 241.078, increment 14.952
Trellis forget factor 0.800
```
VF 0.04 Set the Viterbi forget factor to 0.04
VF 0.62 Set the Viterbi forget factor to 0.62
VF V Show current trellis index (where applicable)
5 Performance Specifications

5.1 Power
The rack-mount receiver requires 100 to 240 VAC, 50/60 Hz power.

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

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

<table>
<thead>
<tr>
<th>BER</th>
<th>Maximum $E_b/N_0$ (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PCM/FM, Tier 0</td>
</tr>
<tr>
<td>$10^{-3}$</td>
<td>7.5</td>
</tr>
<tr>
<td>$10^{-4}$</td>
<td>9.0</td>
</tr>
<tr>
<td>$10^{-5}$</td>
<td>10.0</td>
</tr>
<tr>
<td>$10^{-6}$</td>
<td>11.0</td>
</tr>
</tbody>
</table>

Typical BER performance, plotted in Figure 48, is significantly superior to that tabulated above.
5.4 Synchronization

The 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 270.
Figure 270: Synchronization Time at Various Signal-to-Noise Ratios
5.5 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 13: Band Configuration Codes

<table>
<thead>
<tr>
<th>Freq. Code</th>
<th>200.0</th>
<th>1415.0</th>
<th>1585.0</th>
<th>1650.0</th>
<th>1855.0</th>
<th>2185.0</th>
<th>2500.0</th>
<th>Extended $\geq 250.0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>Base</td>
<td>1150.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower L</td>
<td>400.0</td>
<td>1435.5</td>
<td>1534.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper L</td>
<td></td>
<td></td>
<td>1750.0</td>
<td>1850.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2200.0</td>
<td>2394.5</td>
<td></td>
<td>Extended $\geq 2300.0$</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4400.0</td>
<td>$\geq 5150.0$</td>
</tr>
</tbody>
</table>

Legend:
- Frequency Gap
- Standard (Base) Frequency Range
- Extended Frequency Range (available by selecting Extended Tuning = 1 in part number)
5.5.1 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
6 Maintenance Instructions

The Rack-Mount receiver requires no regular maintenance, and there are no user-serviceable parts inside.
7 Product Warranty

The Rack-Mount receiver carries a standard parts and labor warranty of one (1) year from the date of delivery.

7.1 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.

7.1.1 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.
8 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.
9 Appendix A – Bit Error Rate Testing

There is a separate BERT for each data path in the receiver (0 main channel, 1 combiner channel). By default all commands are targeted to the current “tracking channel”, 0 or 1.

The results of the test can be displayed using the BER command with no parameters or a continuous display can be produced using BER D 1. BER D 0 turns off the continuous display.

Table 14: Bit Error Rate Serial Commands

<table>
<thead>
<tr>
<th>Mnemonic</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BER ?</td>
<td>Bit Error Rate Help</td>
<td>Provides help for using the bit error rate commands</td>
</tr>
<tr>
<td>BER</td>
<td>Bit Error Rate Status</td>
<td>Report bit error rate status</td>
</tr>
<tr>
<td></td>
<td>Examples:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BER</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Measurement disabled</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sequence is PN15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Continuous measurement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gating repeat</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Error interval seconds</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BERT display tracking</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Normal at 0 ms</td>
<td></td>
</tr>
<tr>
<td>BER (was D)</td>
<td>Bit Error Rate Output Display</td>
<td>Set the bit error output display to a specific style and display rate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BER [&lt;e&gt;[-h] [&lt;f&gt;] [&lt;r&gt;]] – Sets bit error tracking display enable to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;e&gt; in format &lt;f&gt; at rate &lt;r&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>where:</td>
</tr>
<tr>
<td></td>
<td>&lt;e&gt; - Enable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0 – Disabled</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 – Enabled</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;f&gt; - Format (last used, if not specified)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N – Normal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>W – Wide</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C – CSV (Comma Separated Values)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;r&gt; - Display rate &lt;r&gt;, 100 to 60000 ms (500 ms if not specified)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-h – Do not display header</td>
<td></td>
</tr>
<tr>
<td>Mnemonic</td>
<td>Name</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>BER DQ</td>
<td>Set AGV DQ</td>
<td>Sets average DQ for output (OUT) or datapath (DP) display enable to &lt;e&gt; &lt;br&gt;BER [DQ {OUT</td>
</tr>
<tr>
<td>BER G n</td>
<td>Set Bit Error Measurement Gating</td>
<td>Sets bit error measurement gating &lt;br&gt;The test can be configured to make a single measurement or, when a time limit, bit count, or error count is set, automatically repeat the test. &lt;br&gt;BER [G &lt;n&gt;] &lt;br&gt;Sets bit error measurement gating to &lt;n&gt; &lt;br&gt;where &lt;n&gt; - Measurement gating &lt;br&gt;S – Single &lt;br&gt;R – Repeat &lt;br&gt;Examples: &lt;br&gt;Ber G S Set gating to Single &lt;br&gt;Ber G R Set gating to Repeat</td>
</tr>
<tr>
<td>BER HEAD &lt;f&gt;</td>
<td>BER Header</td>
<td>BER [HEAD &lt;f&gt;] &lt;br&gt;Shows system status header in format &lt;f&gt; &lt;br&gt;where &lt;br&gt;&lt;f&gt; - Format &lt;br&gt;N – Normal &lt;br&gt;W – Wide &lt;br&gt;C – CSV</td>
</tr>
<tr>
<td>BER I</td>
<td>BER Interval</td>
<td>BER [I &lt;i&gt;] &lt;br&gt;Sets bit error interval to &lt;i&gt; &lt;br&gt;where &lt;br&gt;&lt;i&gt; - Error Interval &lt;br&gt;S – Seconds &lt;br&gt;D – Desciseconds</td>
</tr>
<tr>
<td>Mnemonic</td>
<td>Name</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>BER M</td>
<td>BERT Measurement Status</td>
<td>Display current BERT measurement status in a specific style</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BER [M &lt;s&gt;[-h]?]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>where</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;s&gt; - Style</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N - Normal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>W - Wide</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C - CSV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Options:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-h - Do not display header</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Examples:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BER M ? Display style help</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BER M N N indicates Normal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BER M W W indicates Wide</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BER M CSV CSV indicates Comma Separated Values</td>
</tr>
<tr>
<td>BER P n</td>
<td>Set Bit Error Test Pattern</td>
<td>Set bit error test pattern</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BER [P {&lt;n&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P indicates a preset or fixed pattern length</td>
</tr>
<tr>
<td></td>
<td></td>
<td>where ‘n’ is one of:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PN6, PN9, PN11, PN15, PN20, PN23, PN31</td>
</tr>
<tr>
<td></td>
<td></td>
<td>or ‘p’ is a fixed pattern length of 2 to 32 bits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(fixed pattern lengths are automatically determined and leading zeros are significant)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Examples:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BER P PN9 Set test pattern to preset PN9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BER P 13 Set test pattern to a fixed pattern length of 13 bits</td>
</tr>
<tr>
<td>BER RR n</td>
<td>Set Restart Measurement</td>
<td>Set restart measurements on resync enable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BER [RR &lt;e&gt;]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>where ‘e’ is Enable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 = Disable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 = Enable</td>
</tr>
</tbody>
</table>
### Mnemonic | Name | Description
--- | --- | ---
BER T n | Set Bit Error Measurement Type | Sets bit error measurement type
The test type can be configured to run continuously or stop when either a time limit, bit count, or error count has been reached. The error count limit guarantees a minimum number of errors.
BER [T <t>]
T indicates type
where ‘n’ is one of the following:
C = Sets to Continuous (clears limits)
T x = Sets BERT time limit
where ‘x’ is between 0.000 and 4294967.500 seconds
B x = Sets bit limit
where ‘x’ is between 1 and 2.81475E+14 bits
E x = Sets error limit
where ‘x’ is between 1 to 2.81475E+14 errors
Bit count and error count limits are mutually exclusive—either parameter may be combined with time limit
Examples:
BER T C Set bit error measurement type to Continuous
BER T 2.333 Set BERT time limit to 2.333 seconds
BER T B 1 Set bit limit to 1 bit
BER T E 0.5 Set error limit to 0.5 errors

BER R | Measurement Enable | Starts or Restarts bit error measurement
If a time limit, bit count, or error count limit is set and the limit has been reached (enabled but not running) the BERT is restarted.
Example:
BER R Enter command to Start or Restart bit error measurement, current tracking channel

BER S | Measurement Disable | Stops bit error measurement
Example:
BER S Enter command to Stop bit error measurement, current tracking channel

The following example illustrates how to display a bit error register. Note the details below.

- A column header is displayed every ten rows.
- The 'E' column indicates the BERT is enabled by displaying a pound sign '#'. If the BERT is not enabled, this column is blank.
- The 'R' column indicates the BERT is actually running and making a measurement by displaying a '!'. If the BERT is not running, this column is blank.
- The BERT can be enabled, but not running, in the case of a time, bit, or error count limit.
- An asterisk '*' after the error rate column indicates that the data is inverted. If the display is continuous and a time, bit, or error limit is set with repeating gating, the display shows the end of the test by displaying '>>>' in the first three columns.

The following shows an example display with a five (5) second repeating test.

```
PCMFMS$ber t 5
Time limit 5 seconds
PCMFMS$ber r
Measurement enabled, running
PCMFMS$ber d n
Measurement enabled, running
Sequence is PN15
Time limit 5 seconds
Gating repeat
Error interval seconds
BERT display tracking Normal at 0 ms
PCMFMS
```

<table>
<thead>
<tr>
<th>E</th>
<th>R</th>
<th>Time</th>
<th>Bits</th>
<th>Errors</th>
<th>Delta Err</th>
<th>Error Rate</th>
<th>Seconds</th>
<th>Eb/N0</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>!</td>
<td>*</td>
<td>00:00:02.600</td>
<td>2.5933e+07</td>
<td>1.2836e+07</td>
<td>1.2836e+07*</td>
<td>4.950e-01</td>
<td>2</td>
<td>-45.15</td>
<td></td>
</tr>
<tr>
<td>!</td>
<td>!</td>
<td>00:00:03.100</td>
<td>3.0919e+07</td>
<td>1.5516e+07</td>
<td>2.6804e+06*</td>
<td>5.018e-01</td>
<td>3</td>
<td>-43.43</td>
<td></td>
</tr>
<tr>
<td>!</td>
<td>!</td>
<td>00:00:03.600</td>
<td>3.5904e+07</td>
<td>1.8197e+07</td>
<td>2.6813e+06*</td>
<td>5.068e-01</td>
<td>3</td>
<td>-44.11</td>
<td></td>
</tr>
<tr>
<td>!</td>
<td>!</td>
<td>00:00:04.100</td>
<td>4.0889e+07</td>
<td>2.0737e+07</td>
<td>2.5398e+06*</td>
<td>5.072e-01</td>
<td>4</td>
<td>-44.64</td>
<td></td>
</tr>
<tr>
<td>!</td>
<td>!</td>
<td>00:00:04.600</td>
<td>4.5875e+07</td>
<td>2.3443e+07</td>
<td>2.7062e+06*</td>
<td>5.110e-01</td>
<td>4</td>
<td>-31.84</td>
<td></td>
</tr>
</tbody>
</table>

### 9.1 Test Noise Commands

Digitally generated Additive White Gaussian Noise (AWGN) can be injected in the demodulator for test purposes. This noise can exhaust most or all of the demodulator's error-free signal processing margin so that small imperfections in the received signal will be visible as an increase in the bit error rate.

The noise level is calibrated relative to an extremely accurate measurement of the input signal level. This measurement will be most accurate when the received signal has a high signal-to-noise ratio. Therefore, input signal levels above -70 dBm are generally recommended. Due to the available dynamic range of the demodulator signal processing path and the faithful representation of the AWGN, noise samples may be clipped, especially at or below 0 dB Eb/N0.

Note that the noise is injected following downconversion to baseband but before demodulation. Therefore, the noise will affect demodulator output signals, including video outputs and the front panel display (eye diagram or constellation), but it will not change measurements of the input signal (signal strength and signal quality).
The AWGN command, described in Table 15, displays and controls Additive White Gaussian Noise settings.

Table 15: Test Noise Commands

<table>
<thead>
<tr>
<th>Mnemonic</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWGN ?</td>
<td>Test Noise Help</td>
<td>Provides help for using the test noise commands</td>
</tr>
<tr>
<td>AWGN</td>
<td>Test Noise Status</td>
<td>Report test noise status of current tracking channel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- AWGN disabled</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- AWGN power 50.00 dB E_s/N_0</td>
</tr>
<tr>
<td>AWGN &lt;e&gt;</td>
<td>Enable/Disable Test Noise</td>
<td>Turns the test noise output Enabled or Disabled</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;e&gt; - Sets AWGN enable to &lt;e&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- If ‘e’ is 0, test noise is Off/Disabled</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- If ‘e’ is 1, test noise is On/Enabled</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- AWGN 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- AWGN enabled</td>
</tr>
<tr>
<td>AWGN [P &lt;p&gt;]</td>
<td>Set Test Noise Level</td>
<td>Sets the test noise power level in dB E_s/N_0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Range for p is -10.00 dB E_s/N_0 to +50.00 dB E_s/N_0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- AWGN P 42.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- AWGN power 42.00 dB E_s/N_0</td>
</tr>
</tbody>
</table>
10 Appendix B – Recommended AM and AGC Settings for ACU Interfaces

10.1 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.

10.2 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

10.3 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 10.2). Table 16 describes recommended settings based on these parameters:

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

In Table 16, 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 \( \frac{1000}{30} = 33.3 \) ms, and an AM Bandwidth of \( 5 \times 30 = 150 \) Hz, with AGC Compensation OFF.

The AGC Time Constant should \textit{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 16.
11 Appendix C – Phase Noise Compensation

11.1 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 271, shows all of the possible paths the phase trajectory can take over a period of seven bits. Figure 272 shows the two unique paths, based on whether the second bit is a 1 or 0.

![Figure 271: Ideal PCM/FM Phase Tree (h = 0.7)](image-url)
11.1.1 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.
11.2 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.

11.3 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.

11.4 When to Use PNC

There is no bullet-proof test for whether PNC is needed, but there are good indicators. Turn on PNC if:

- The demodulator is struggling to lock, even with good Signal to Noise Ratio (SNR). ("Good" SNR means the Quality bar is above one-quarter height.)
- The eye pattern NEVER looks “clean,” as in Figure 275
- Symptoms get worse when the transmitter is under vibration
- Symptoms get worse at low bit rates

Figure 274: Trellis Detection Gain with Significant to Severe Phase Noise
11.5 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)
12 Appendix D - 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.

12.1 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:

![Minor Frame Maximum Length, N Words or B Bits](image)

*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.

12.2 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 detect
- LOCK_THRESH – Number of valid sync detects required to declare PCM frame lock
- SEARCH_THRESH – Number of invalid sync 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 276, 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 ONES_DETECT back-panel outputs. Refer to the RDMS™ data sheet for more information about these outputs.
13 Appendix E – How to Configure Tape Output

The method for configuring Tape Output has been updated. Refer to section 4.6.2.21 Video Output Menu for front panel control and section 4.7.3.7 Channel A Output, etc., for Browser Interface control.

This appendix is also available on the Quasonix web site as a stand alone document: How to Configure the Tape Output on a 3rd Generation Rack-Mount RDMS Telemetry Receiver.

This appendix assumes the use of Windows 7 with access via Telnet.

Access via Telnet is described in section 4.8 of this manual.

Contact your local administrator when using other versions of Windows or non-Windows platforms.

13.1 Overview

The Tape Output feature uses the I/Video A or the Q/Video B outputs on the 1U rack mount receiver (refer to section 13.3 for 3U connectors). Connectors are listed in Table 17 and locations are illustrated in Figure 6.

<table>
<thead>
<tr>
<th>Output</th>
<th>Connector</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/Video A Channel 1</td>
<td>J5</td>
</tr>
<tr>
<td>Q/Video B Channel 1</td>
<td>J6</td>
</tr>
<tr>
<td>I/Video A Channel 2</td>
<td>J19</td>
</tr>
<tr>
<td>Q/Video B Channel 2</td>
<td>J20</td>
</tr>
<tr>
<td>I/Video A Channel Combiner</td>
<td>J29</td>
</tr>
<tr>
<td>Q/Video B Channel Combiner</td>
<td>J30</td>
</tr>
</tbody>
</table>

These connectors ordinarily provide the baseband video outputs. If they are used to drive a bit-sync, that functionality may not be available when using Tape Out.

For PCM/FM, only I/Video A is used for baseband video, leaving Q/Video B available for Tape Out. In any QPSK mode (that requires both I and Q baseband outputs), using Tape Out is mutually exclusive.

This is not a persistent configuration. Changing modes or power cycling the unit causes the Video outputs to revert to their normal, baseband outputs.
13.2 Commands

After connecting to Channel 1, Channel 2, or Channel 3 (the combiner), the command prompt displays. The following commands configure the Tape Out on Q/Video B. Anything past the ‘#’ is a comment, and can be discarded.

```
aho b p0t;  # Routes Physical channel 0 tape output source to Q/Video B
ahm x.x;    # Sets the tape out mixer to x.x MHz
ahm b 1;    # Enables the tape out mixer on Q/Video B output
```

The following commands configure the Tape Out on I/Video A.

```
aho a p0t;  # Routes Physical channel 0 tape output source to I/Video A
ahm x.x;    # Sets the tape out mixer to x.x MHz
ahm a 1;    # Enables the tape out mixer on I/Video A output
```

In both cases, the x.x MHz is in the range of 0.075 to 20.0 MHz. Frequencies outside of that range result in unpredictable behavior.

Example:

To configure Q/Video B out for 5.1 MHz center frequency:

```
aho b p0t
ahm 5.1
ahm b 1
```

To configure I/Video A out for 2.8 MHz center frequency:

```
aho a p0t
ahm 2.8
ahm a 1
```

13.2.1 Notes

This is not a persistent configuration. Changing modes or power cycling the unit cause the Video outputs to revert to their normal, baseband outputs.

While the Tape Out can be configured simultaneously on I/Video A and Q/Video B, they cannot have independent frequencies. The frequency specified by ‘ahm x.x’ will be used for BOTH.

13.3 3U Connectors

The Tape Output feature on the 3U Receiver uses the I/Video A, Q/Video B, Video C, and Video D outputs. The 3U connectors are listed in Table 18 and locations are illustrated in Figure 278.
### Table 18: 3U Tape Output Connectors

<table>
<thead>
<tr>
<th>Output</th>
<th>Connector</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/Video A Channel 1</td>
<td>J3</td>
</tr>
<tr>
<td>Q/Video B Channel 1</td>
<td>J8</td>
</tr>
<tr>
<td>Video C Channel 1</td>
<td>J13</td>
</tr>
<tr>
<td>Video D Channel 1</td>
<td>J18</td>
</tr>
<tr>
<td>I/Video A Channel 2</td>
<td>J28</td>
</tr>
<tr>
<td>Q/Video B Channel 2</td>
<td>J33</td>
</tr>
<tr>
<td>Video C Channel 2</td>
<td>J38</td>
</tr>
<tr>
<td>Video D Channel 2</td>
<td>J43</td>
</tr>
<tr>
<td>I/Video A Channel Combiner</td>
<td>J53</td>
</tr>
<tr>
<td>Q/Video B Channel Combiner</td>
<td>J58</td>
</tr>
<tr>
<td>Video C Combiner</td>
<td>J63</td>
</tr>
<tr>
<td>Video D Combiner</td>
<td>J68</td>
</tr>
</tbody>
</table>

![Figure 278: 3U Rear Panel](image-url)
13.4 Troubleshooting

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

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

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

- Model number ***Note that this is different from the customer part number.***
- Serial number
- Software Version

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

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

The default Frequency is 2200.000 MHz.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Reset State</th>
<th>Parameter</th>
<th>Reset State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit Rate</td>
<td>1</td>
<td>Phase Noise Compensation</td>
<td>Off</td>
</tr>
<tr>
<td>Combiner (if available)</td>
<td>Off</td>
<td>Muting Timeout</td>
<td>1000</td>
</tr>
<tr>
<td>Clock Polarity</td>
<td>Normal</td>
<td>Output Muting</td>
<td>Off</td>
</tr>
<tr>
<td>Data Polarity</td>
<td>Normal</td>
<td>Downconvert Antenna</td>
<td>Disabled</td>
</tr>
<tr>
<td>Equalizer (if available)</td>
<td>Off</td>
<td>AGC Polarity</td>
<td>+ (Positive)</td>
</tr>
<tr>
<td>DQ Encapsulation (if available)</td>
<td>Disabled</td>
<td>AGC Scale</td>
<td>10</td>
</tr>
<tr>
<td>Derandomizer</td>
<td>Disabled</td>
<td>AGC Time Constant</td>
<td>100</td>
</tr>
<tr>
<td>Differential Decoder</td>
<td>N/A</td>
<td>AGC Zero Mode</td>
<td>Manual</td>
</tr>
<tr>
<td>Modulation Scaling</td>
<td>Acquire</td>
<td>AM Bandwidth</td>
<td>100</td>
</tr>
<tr>
<td>Modulation Persist</td>
<td>Off</td>
<td>AM Polarity</td>
<td>Normal</td>
</tr>
<tr>
<td>IF Filter</td>
<td>Auto</td>
<td>AM Scale</td>
<td>1</td>
</tr>
<tr>
<td>Video De-emphasis</td>
<td>Off</td>
<td>AGC Compensation</td>
<td>Enabled</td>
</tr>
</tbody>
</table>
Table 20: SOQPSK Factory Reset Values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Reset State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit Rate</td>
<td>1</td>
</tr>
<tr>
<td>Modulation Scaling</td>
<td>N/A</td>
</tr>
<tr>
<td>Clock Polarity</td>
<td>Normal</td>
</tr>
<tr>
<td>Data Polarity</td>
<td>Normal</td>
</tr>
<tr>
<td>Derandomizer</td>
<td>Disabled</td>
</tr>
<tr>
<td>Differential Decoder</td>
<td>Enabled</td>
</tr>
<tr>
<td>IF Filter</td>
<td>Auto</td>
</tr>
<tr>
<td>Downconvert Antenna</td>
<td>Disabled</td>
</tr>
<tr>
<td>AGC Zero Mode</td>
<td>Manual</td>
</tr>
<tr>
<td>Convolutional Decoder</td>
<td>N/A</td>
</tr>
<tr>
<td>Lock Output Polarity</td>
<td>Active High</td>
</tr>
<tr>
<td>NRZ Encoding</td>
<td>N/A</td>
</tr>
<tr>
<td>Output Control</td>
<td>Default</td>
</tr>
<tr>
<td>Output Muting</td>
<td>Disabled</td>
</tr>
<tr>
<td>Phase Noise Compensation</td>
<td>Disabled</td>
</tr>
<tr>
<td>Tape Output</td>
<td>Disabled</td>
</tr>
</tbody>
</table>
Table 21: Multi-h CPM Factory Reset Values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Reset State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit Rate</td>
<td>1</td>
</tr>
<tr>
<td>Modulation Scaling</td>
<td>N/A</td>
</tr>
<tr>
<td>Clock Polarity</td>
<td>Normal</td>
</tr>
<tr>
<td>Data Polarity</td>
<td>Normal</td>
</tr>
<tr>
<td>Derandomizer</td>
<td>Disabled</td>
</tr>
<tr>
<td>Differential Decoder</td>
<td>N/A</td>
</tr>
<tr>
<td>IF Filter</td>
<td>Auto</td>
</tr>
<tr>
<td>Downconvert Antenna</td>
<td>Disabled</td>
</tr>
<tr>
<td>AGC Zero Mode</td>
<td>Manual</td>
</tr>
<tr>
<td>Convolutional Decoder</td>
<td>N/A</td>
</tr>
<tr>
<td>Lock Output Polarity</td>
<td>Active High</td>
</tr>
<tr>
<td>NRZ Encoding</td>
<td>N/A</td>
</tr>
<tr>
<td>Output Control</td>
<td>Default</td>
</tr>
<tr>
<td>Output Muting</td>
<td>Disabled</td>
</tr>
<tr>
<td>Phase Noise Compensation</td>
<td>Disabled</td>
</tr>
<tr>
<td>Tape Output</td>
<td>Disabled</td>
</tr>
</tbody>
</table>
### Table 22: QPSK Factory Reset Values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Reset State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit Rate</td>
<td>1</td>
</tr>
<tr>
<td>Modulation Scaling</td>
<td>N/A</td>
</tr>
<tr>
<td>Clock Polarity</td>
<td>Normal</td>
</tr>
<tr>
<td>Data Polarity</td>
<td>Normal</td>
</tr>
<tr>
<td>Derandomizer</td>
<td>Disabled</td>
</tr>
<tr>
<td>Differential Decoder</td>
<td>N/A</td>
</tr>
<tr>
<td>IF Filter</td>
<td>Auto</td>
</tr>
<tr>
<td>Downconvert Antenna</td>
<td>Disabled</td>
</tr>
<tr>
<td>AGC Zero Mode</td>
<td>Manual</td>
</tr>
<tr>
<td>Convolutional Decoder</td>
<td>Disabled</td>
</tr>
<tr>
<td>Lock Output Polarity</td>
<td>Active High</td>
</tr>
<tr>
<td>NRZ Encoding</td>
<td>NRZ-L</td>
</tr>
<tr>
<td>Output Control</td>
<td>Default</td>
</tr>
<tr>
<td>Output Muting</td>
<td>Disabled</td>
</tr>
<tr>
<td>Phase Noise Compensation</td>
<td>Disabled</td>
</tr>
<tr>
<td>Tape Output</td>
<td>Disabled</td>
</tr>
</tbody>
</table>
15 Appendix G – Special Considerations for International Applications

Because formatting standards may differ by region or country, Windows software may set defaults for your PC to values not expected by the RDMS™ software. Changing these settings, as described in this section, should resolve regional connectivity issues.

15.1 IP Address Separator

An incorrect IP address separator results in the RDMS™ Browser Interface being unable to connect to the PC. Any separator other than a period (.) is unrecognizable by the RDMS™ software. Some regions use a comma (,) instead of a period to separate the fractional part of decimal numbers. For example:

123,456,789

instead of

123.456.789

Typically, changing the Regional Settings option for the list separator on the PC from a comma to a period will resolve the problem.

To change the settings on a Windows 7 machine:

1. Access the Control Panel from the Start Menu. The Start Menu is usually the first icon on the bottom of the PC screen—a circle with four windows in it. Click on Control Panel.
2. When the Computer Settings window displays, click on the Region and Language selection (labeled 2 in Figure 280). This causes the Region and Language window to display (labeled 3 in Figure 280).

3. In the Region and Language window, click on the Additional Settings button. The Customize Format window displays (shown in Figure 281).
4. Use the down arrow in the List Separator column to change the comma to a period. Click on the OK button to complete the change and close the window.

5. Click on the OK button in the Region and Languages window to close the window. The separator in the IP list should now be the period ( . ).
16 Appendix H - RDMS with -IP Option

16.1 Overview
This appendix describes how to operate a 3U Rack-Mount RDMS™ Telemetry Receiver with the -IP (TMoIP) option (Telemetry over IP).

The Browser-based graphical user interface (GUI) provides RDMS and TMoIP configuration, control, and status. PCM serial input channels support automatic bit rate detection and IP packet size auto-configuration.

For detailed operational information refer to the documents in Table 23.

<table>
<thead>
<tr>
<th>Document Name</th>
<th>Document Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quasonix 3rd Generation Rack-Mount RDMS™ Telemetry Receiver Installation and Operation Manual (this document)</td>
<td>N/A</td>
</tr>
<tr>
<td>NetAcquire® Telemetry over IP (TMoIP) Option Users Manual</td>
<td>NA-MAN-021</td>
</tr>
<tr>
<td>NetAcquire® Serial I/O Option Users Manual</td>
<td>NA-MAN-003</td>
</tr>
<tr>
<td>NetAcquire® IRIG Option Users Manual</td>
<td>NA-MAN-023</td>
</tr>
</tbody>
</table>

16.2 Hardware
The 3U Rack-Mount RDMS back panel provides connectors used specifically with the -IP (TMoIP) option. The full back panel is shown in Figure 282. An enlarged view of the right side with TMoIP connectors is shown in Figure 283.
The ports used specifically for TMoIP operation are described in Table 24. EVTM ports are NOT enabled when using TMoIP.

**Table 24: 3U Rack-Mount RDMS TMoIP Ports**

<table>
<thead>
<tr>
<th>Port Name</th>
<th>Purpose</th>
<th>Port Type</th>
<th>Connector</th>
</tr>
</thead>
<tbody>
<tr>
<td>RDMS Control</td>
<td>Browser control network interface</td>
<td>Ethernet (RJ-45)</td>
<td>J80</td>
</tr>
<tr>
<td>TMOIP</td>
<td>Data stream out</td>
<td>Ethernet (RJ-45)</td>
<td>J82</td>
</tr>
<tr>
<td>IRIG-B IN</td>
<td>IRIG-B Time Input</td>
<td>BNC</td>
<td>J77</td>
</tr>
<tr>
<td>IRIG-B OUT</td>
<td>IRIG-B Time Output</td>
<td>BNC</td>
<td>J78</td>
</tr>
<tr>
<td>TMOIP USB</td>
<td>Keyboard or mouse, if desired</td>
<td>USB</td>
<td>J83</td>
</tr>
<tr>
<td>TMOIP VGA</td>
<td>NetAcquire video out to monitor, if desired</td>
<td>SVGA HD-15</td>
<td>J84</td>
</tr>
</tbody>
</table>
16.3 Set Up TMoIP IP Address

The TMoIP enabled receiver must be accessed directly via a web browser. Refer to the front panel Main Menu > System Settings selection to determine the IP address of the RDMS Control Ethernet interface (J80).

1. Open a browser on the connected PC.
2. Type the IP address for the TMoIP enabled receiver into the browser, then press Enter on the keyboard.
   
   If the screen in Figure 284 displays, click on the Set Address button.

3. When the Receiver Addressing window displays (Figure 285), type the correct IP address in the Receiver IP Address field, then click on the OK button. The IP address requested is located on the front panel Main Menu > System Settings screen.

![Figure 284: Browser Window with an Incorrect IP Address](image)

![Figure 285: Receiver Addressing Window](image)

When the correct IP address is entered, the Browser Interface screen displays. *The NetAcquire TMoIP option requires a web browser with Java enabled.*

16.4 Browser Interface

The Browser Interface provides the user with full configuration, control, and monitoring capabilities for one or multiple rack-mount 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 RDMS™ Browser Interface consists of a tool bar at the top of the screen, shown in Figure 162, with six selections that display a variety of parameters for each available channel. The Browser Interface defaults to the Network screen.

![Browser Interface Header Tool Bar with TMoIP Option](image1)

Figure 286: Browser Interface Header Tool Bar for RDMS™ with TMoIP Option

The RDMS Network, Monitor, Configure, Presets, and About screens are described in section 4.7 of this manual. The TMoIP functionality is accessed via the TMoIP tab, as shown in Figure 287. Detailed information about each TMoIP screen is found in the NetAcquire® Telemetry over IP (TMoIP) Option Users Manual.

![Browser Interface Header Tool Bar, TMoIP Tab](image2)

Figure 287: RDMS™ Browser Interface Header Tool Bar, TMoIP Tab

16.4.1 TMoIP Monitor/Configure Screen

The TMoIP Monitor/Configure screen, shown in Figure 163, is the primary operator interface for the TMoIP status and configuration.

![TMoIP Monitor/Configure Screen](image3)

Figure 288: TMoIP Monitor/Configure Screen
In addition to providing status, a key capability of the TMoIP Monitor/Configure screen is selecting the parameters of TMoIP network output packets. Configuration is accomplished by scrolling to the row of the desired Local (TMoIP) Channel, then clicking on the Local Endpoint field, as shown in Figure 289. Associated configuration and control information displays in the right side pane.

16.4.2 TMoIP Network Screen

The TMoIP Network screen, shown in Figure 290, configures the TMoIP network interfaces. The last interface listed in the left pane, Net 2, is not used.
16.4.3 TMoIP Serial I/O Screen

The TMoIP Serial I/O screen, shown in Figure 291, updates status and configures serial input channels for TMoIP.
16.4.4 TMoIP Log Screen

The TMoIP Log screen, shown in Figure 292, displays NetAquire server message log entries.

![Figure 292: TMoIP Log Screen](image)

16.4.5 TMoIP System Screen

The TMoIP System screen is shown in Figure 293. It provides links to a variety of configuration and status screens. The default view contains basic links used by most operators but additional links may be displayed by clicking on the Advanced View check box.

![Figure 293: TMoIP System Screen, Basic](image)
16.4.6 TMoIP About Screen

The TMoIP About screen, shown in Figure 294, provides NetAcquire® server status information, such as host resources, network interface, and server task status.

Figure 294: TMoIP About Window

Detailed information about each TMoIP screen is found in the NetAcquire® Telemetry over IP (TMoIP) Option Users Manual (NA-MAN-021).
Recovery Mode is a new feature added in R15 that serves as a fallback position for system recovery in case of an unforeseen failure that prevents the RDMS from booting or updating.

When the RDMS detects the appropriate boot failure conditions, it automatically boots into Recovery Mode to allow the user an opportunity to restore the unit to normal operation. This system is installed during an SD Card Update, but is not modified by any other type of update, thereby ensuring its reliability in case of unforeseen failure.

When the RDMS enters recovery mode, a Recovery App is displayed on the front panel, as shown in Figure 295, and any accesses via the Browser Interface are forwarded to a Recovery Page, as shown in Figure 296.
In Recovery Mode, the RDMS uses the same addressing method (static or dynamic) that it was last configured with to obtain an IP address. If it was configured with a static address, the RDMS will still be addressable via this static address. If it was configured with DHCP, it is likely, though not guaranteed, that it will have the same IP address that it last had; though this will depend on the DHCP server being utilized on the network. The IP address is not configurable in Recovery Mode, but is displayed on the front panel.

While the system cannot be used operationally in this mode, there are three options for resuming normal operation:

1. Boot Existing Version
2. SD Card Update
3. Network Update

17.1 Option 1 - Boot Existing Version

The first, and most straightforward, method to recover operation is by attempting to boot an existing version that is stored on the RDMS. In order to provide redundancy, the RDMS retains up to two versions of firmware on the device. If one version fails to boot, it is possible to retry booting into that version again, or to fall back to a previous version.

When this option is chosen, the RDMS reboots and boots from the version selected, then it will update the front panel and receivers, in order to match the selected version.

This option is possible through either the front panel or through the browser interface. Only one interface or the other should be utilized.

Front Panel Recovery Boot

The available versions for a recovery boot are displayed on the front panel, as shown in Figure 297.

1. Select a version by pressing the number 1 or 2 on the front panel keypad.
2. Press Enter to confirm and begin the reboot process, as shown in Figure 298.
### Browser Interface Recovery Boot

The available versions for a browser interface recovery boot are shown in Figure 299.

1. Choose an existing version by clicking on one of the selection buttons in front of the version name.
2. Click on the Enter button to confirm and begin the reboot process.

![Figure 299: Browser Interface Recovery Screen, Boot Existing Version](image)

After the RDMS begins to reboot, the recovery process takes about 25 minutes, if no errors are encountered. The browser interface or the front panel may be used to track the progress of the reboot and update. If additional problems occur, the RDMS returns to Recovery Mode after three attempts.

### 17.2 Option 2 - SD Card Update

If the RDMS cannot be recovered through the use of Option 1, the next best option is to use the SD Card Update process. This method uses an update card, provided by Quasonix, to perform a fresh install of the system firmware. Instructions for how to perform this type of update are included with the update card.

### 17.3 Option 3 - Network Update

If the RDMS is not physically accessible, or an update card is not available, the Network Update is the final method available for recovering normal operation.
When the RDMS is accessed via a browser directed to its IP address, the Recovery Mode page displays, as shown previously in Figure 296.

This method uses a firmware update file, provided by Quasonix, in conjunction with the Browser Interface. Instructions for how to perform this type of update are included with the update file. The Update Page can be accessed via the link on the Browser Interface Recovery screen under the Option 3 title, as shown in Figure 300.

![Figure 300: Browser Interface Recovery Screen, Network Update](image-url)
18 Appendix J – 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.

18.1 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 301.
4. Click on the View Certificates… button to view the Certificate Manager, as shown in Figure 302.

![Figure 301: Firefox Options Interface](image)

5. Select the Authorities tab.
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 303.

8. Click on the View button to examine the certificate. It should match the one shown in Figure 304.

9. Check the box for Trust this CA to identify websites, then click on the OK button. The certificate has now been imported.
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 305.
11. Using Firefox, browse to https://RDMS_IP, where RDMS_IP is the IP address of the RDMS.

18.2 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.

1. 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 306.

2. Click on the Content tab.
Figure 306: Internet Properties, Content Tab

3. Click on the Certificates button. The Certificates screen displays. Click on the Trusted Root Certification Authorities tab, as shown in Figure 307.
4. Click on the Import… button to start the Certificate Import Wizard. The Wizard is shown in Figure 308.
5. Click on the Next button. Click on the Browse button under File to Import.
6. Select the Quasonix Root Authority file obtained from Quasonix. Click on the Next button.

![Certificate Import Wizard-Browse](image)

**Figure 309: Windows Certificate Import Wizard-Browse**

7. Select “Place all certificates in the following store.”
8. 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 310.
9. Click on the Finish button. A message displays “The import was successful.” Click on the OK button.

10. View the list of Certificates under Trusted Root Certification Authorities, and verify that Quasonix Root CA is listed, as shown in Figure 311.
11. Using Edge, Internet Explorer, or Chrome, browse to https://RDMS_IP, where RDMS_IP is the IP address of the RDMS.
## 19 Appendix K – Acronym List

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGC</td>
<td>Automatic Gain Control</td>
</tr>
<tr>
<td>AM</td>
<td>Amplitude Modulation</td>
</tr>
<tr>
<td>AQPSK</td>
<td>Variant of Quadrature Phase Shift Keying</td>
</tr>
<tr>
<td>ARTM</td>
<td>Advanced Range Telemetry</td>
</tr>
<tr>
<td>AUQPSK</td>
<td>Variant of Quadrature Phase Shift Keying</td>
</tr>
<tr>
<td>BEP</td>
<td>Bit Error Probability</td>
</tr>
<tr>
<td>BER</td>
<td>Bit Error Rate</td>
</tr>
<tr>
<td>BNC</td>
<td>Bayonet Neill-Concelman Connector (RF Connector)</td>
</tr>
<tr>
<td>BPSK</td>
<td>Binary Phase Shift Keying</td>
</tr>
<tr>
<td>CCSDS</td>
<td>Consultative Committee for Space Data Systems (coding standard)</td>
</tr>
<tr>
<td>CD</td>
<td>Compact Disk</td>
</tr>
<tr>
<td>CPM</td>
<td>Continuous Phase Modulation</td>
</tr>
<tr>
<td>DB-9</td>
<td>D-subminiature 9 pin Serial Connector</td>
</tr>
<tr>
<td>DC</td>
<td>Diversity Combiner</td>
</tr>
<tr>
<td>DHCP</td>
<td>Dynamic Host Configuration Protocol</td>
</tr>
<tr>
<td>DPM</td>
<td>Digital Phase Modulation</td>
</tr>
<tr>
<td>DQE</td>
<td>Data Quality Encapsulation</td>
</tr>
<tr>
<td>DQM</td>
<td>Data Quality Metric</td>
</tr>
<tr>
<td>FPGA</td>
<td>Field Programmable Gate Array</td>
</tr>
<tr>
<td>IF</td>
<td>Intermediate Frequency</td>
</tr>
<tr>
<td>IP</td>
<td>Internet Protocol</td>
</tr>
<tr>
<td>kbps</td>
<td>Kilobits per second</td>
</tr>
<tr>
<td>KHz</td>
<td>Kilohertz</td>
</tr>
<tr>
<td>LCD</td>
<td>Liquid Crystal Display</td>
</tr>
<tr>
<td>LDPC</td>
<td>Low Density Parity Check</td>
</tr>
<tr>
<td>mbps</td>
<td>Megabits per second</td>
</tr>
<tr>
<td>MCX</td>
<td>Snap on subminiature connector</td>
</tr>
<tr>
<td>MHCPM</td>
<td>multi-h Continuous Phase Modulation</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------------------------------------------------------</td>
</tr>
<tr>
<td>MHz</td>
<td>Megahertz</td>
</tr>
<tr>
<td>N</td>
<td>(connector type) Threaded RF connector</td>
</tr>
<tr>
<td>OQPSK</td>
<td>Offset Quadrature Phase Shift Keying</td>
</tr>
<tr>
<td>PCMFM</td>
<td>Pulse Code Modulation/Frequency Modulation</td>
</tr>
<tr>
<td>PM</td>
<td>Phase Modulation</td>
</tr>
<tr>
<td>PSK</td>
<td>Phase Shift Keying</td>
</tr>
<tr>
<td>QPSK</td>
<td>Offset Quadrature Phase Shift Keying</td>
</tr>
<tr>
<td>RDMS</td>
<td>Receiver DeModulator Synchronizer</td>
</tr>
<tr>
<td>RF</td>
<td>Radio Frequency</td>
</tr>
<tr>
<td>RJ-45</td>
<td>Ethernet Connection Jack</td>
</tr>
<tr>
<td>RM</td>
<td>Rack-Mount</td>
</tr>
<tr>
<td>RS-232</td>
<td>Recommended Standard 232 (Serial Communications)</td>
</tr>
<tr>
<td>SAW</td>
<td>Sawtooth Wave</td>
</tr>
<tr>
<td>SDI</td>
<td>System Degradation Indication</td>
</tr>
<tr>
<td>SNR</td>
<td>Signal to Noise Ratio</td>
</tr>
<tr>
<td>SOQPSK</td>
<td>Shaped Offset Quadrature Phase Shift Keying</td>
</tr>
<tr>
<td>SOQPSK-TG</td>
<td>Shaped Offset Quadrature Phase Shift Keying –Telemetry Group</td>
</tr>
<tr>
<td>STC</td>
<td>Space-Time Coding</td>
</tr>
<tr>
<td>TRL</td>
<td>Tracking Loop</td>
</tr>
<tr>
<td>TTL</td>
<td>Transistor Transistor Logic</td>
</tr>
<tr>
<td>UDP</td>
<td>User Datagram Protocol</td>
</tr>
<tr>
<td>UQPSK</td>
<td>Unbalanced Quadrature Phase Shift Keying</td>
</tr>
<tr>
<td>USB</td>
<td>Universal Serial Bus</td>
</tr>
<tr>
<td>VAC</td>
<td>Voltage Alternating Current</td>
</tr>
<tr>
<td>WAN</td>
<td>Wide Area Network</td>
</tr>
</tbody>
</table>