

## Installation and Operation Manual

### Rack-Mount Receiver Analyzer



**Quasonix, Inc.**  
**6025 Schumacher Park Dr.**  
**West Chester, OH 45069**  
**30 March, 2022**

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## 1 Introduction

The Quasonix Rack-Mount Receiver Analyzer supports a wide range of receiver and combiner performance tests, including bit error rate, sync time, sync threshold, and break frequency, and provides 4-ray multipath emulation for static and dynamic multipath testing. The compact 1U chassis contains two complete ARTM signal generators and eight bit error rate testers with calibrated RF levels from -125 dBm to +0 dBm.

The two ARTM signal generators cover P, lower L, upper L, S, and C bands (200 MHz to 2500 MHz and 4.4 GHz to 5.25 GHz contiguously) at power levels from 0 dBm to -125 dBm. It offers eight bit error rate testers with integrated synchronization detection/timing and bit clock frequency counters

A comprehensive telemetry receiver test suite includes bit error rate, noise figure, receiver latency, acquisition time and threshold, combiner/best source selection (BSS) break frequency, and PCM/FM modulation index tests.

The intuitive Graphical User Interface (GUI) interface runs on any Windows PC and is fully remote controlled via a USB interface. All test results may be stored automatically in .CSV files which can be opened in an Excel spreadsheet for flexible data analysis.

The Receiver Analyzer is manufactured by:

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

### 1.1 Description

This document describes the installation and operation of the Quasonix Receiver Analyzer. The Receiver Analyzer is designed to test receivers and demodulators by supplying RF test signal outputs to the unit under test and comparing the clock and data outputs of the unit under test to the known data pattern.

The testers use five key parameters: Frequency (RF) range, modulation, data patterns, data rates, and power level.

The following waveform formats are supported by the Receiver Analyzer:

- PCM/FM (ARTM Tier 0)
- SOQPSK (ARTM Tier I)
- SOQPSK-LDPC
- Multi-h CPM (ARTM Tier II)
- Carrier
- STC
- DPM
- Legacy (PSK) suite, which includes:
  - BPSK
  - QPSK
  - Offset QPSK (OQPSK)

The eight (8) built in bit error rate testers can be used to test any clock and data outputs from *any* receiver or demodulator that operates within these parameters.

## 1.2 Nomenclature

The features and modes installed in each Receiver Analyzer are identified in the part number.

Receiver Analyzer Part Number

**QSX-RXAN-3R1D-A1-1111**

### 1.2.1 Band

Band field codes are listed in Table 1.

**Table 1: Band Field Codes**

Model Number Code	Band	Minimum Frequency	Maximum Frequency	Default Frequency
A	All bands	200.0 MHz	5250.0 MHz	2200.5 MHz

## 1.3 Package Contents

The contents of the box include the following:

- Receiver Analyzer unit
- USB 2.0 AB cable
- Power cord
- Two (2) calibrated RF output cables
- Six (6) 75 ohm clock and data BNC cables
- CD with control software, user manual, data sheets, etc.

Note: The very latest User Manual and Data Sheet are always available on the Quasonix web site.

## 2 Specifications

<b><i>Signal Generator Section</i></b>	
RF Outputs	2, can be slaved
Power Level	0 dBm to –125 dBm, default range (set in 0.1 dB steps)
Output RF Frequency	200.0-2500.0 MHz, tunable in 1 kHz steps 4400.0-5250.0 MHz, tunable in 1 kHz steps
Modulation Formats	PCM/FM, SOQPSK, MHCPM, Carrier, BPSK, QPSK, OQPSK, STC
Bit Rates	0.001 Mbps to 46 Mbps (mode dependent)
Coding Options	Convolutional or LDPC (LDPC IRIG 106-19 Appendix 2-D compliant) IRIG and CCSDS randomization NRZ-L/M/S, BIΦ-L/M/S, RZ, DM-M/S, M2-M/S Basic PCM framing (sync pattern 16 to 33 bits, minor frame up to 16384 bits, major frame up to 256 minor frames, with subframe ID insertion)
Generator Functions	Modulation index scaling Multipath fading (synchronized out-of-phase between RF channels) Multi-ray multipath channel simulation Calibrated additive white Gaussian noise
Clock and Data In/Out	TTL (BNC) Patterns: Mark (all 1s), Space (all 0s), ALT01, PN6, PN9, PN11, PN15, PN17, PN20, PN23, PN31, USER (1 to 32 bits)
<b><i>Receiver Input/Status Output Section</i></b>	
Clock and Data In	TTL (BNC) Supports up to eight (8) clock and data input pairs from receivers, demodulators, etc.
Input Codes	NRZ-L
Lock Detector Out	TTL (HDB-15)
RF On/Off Control Out	TTL (HDB-15)

<b><i>Environmental Section</i></b>	
Operating Temperature	0°C to +50°C
Non-operating Temperature	0°C to +70°C
Operating Humidity	0 to 95% (non-condensing)
Altitude	Up to 30,000 ft.
<b><i>Physical Section</i></b>	
Size	1U rack-mount chassis; 19" wide, 1.75" tall, 14-5/16" rack depth, 15-11/16" overall depth
Weight	12.0 lbs.
Connectors – per RF Channel	RF Out: N female I Clock, Q Clock, I Data, Q Data In: BNC female Combiner/BSS I Clock, Q Clock, I Data, Q Data In: BNC female Status Out: DB-15 High Density female
Connectors – per Chassis	TX Clock/Data In/Out: BNC female USB-B for remote controlled user interface AC power in
Power	25W @ 120 VAC

### 3 Theory of Operation

The Receiver Analyzer derives all internal references from a single TCXO. Each of the dual channels consists of a Synthesizer, I/Q Modulator, Amplifiers, and Step Attenuators. The channel frequencies can either be synchronized (coherent) or different for frequency diversity simulation.

The FPGA orchestrates the entire operation of the analyzer as commanded by the operator through the USB port. The FPGA loads the Synthesizer frequencies, supplies the baseband inputs to the modulators through the two Dual D/A Converters, and sets the Step Attenuators for the proper output power based upon alignment data. Final output power adjustment is achieved through the level control to the modulators. Drivers and receivers buffer and convert the high speed data signals to the appropriate FPGA operational levels. An integral Oscilloscope accepts the transmit clock and the receive clocks from the receiver under test channel 1, 2, and combiner. The Oscilloscope display via the USB port graphically illustrates the timing jitter and lock range of the receiver under test.

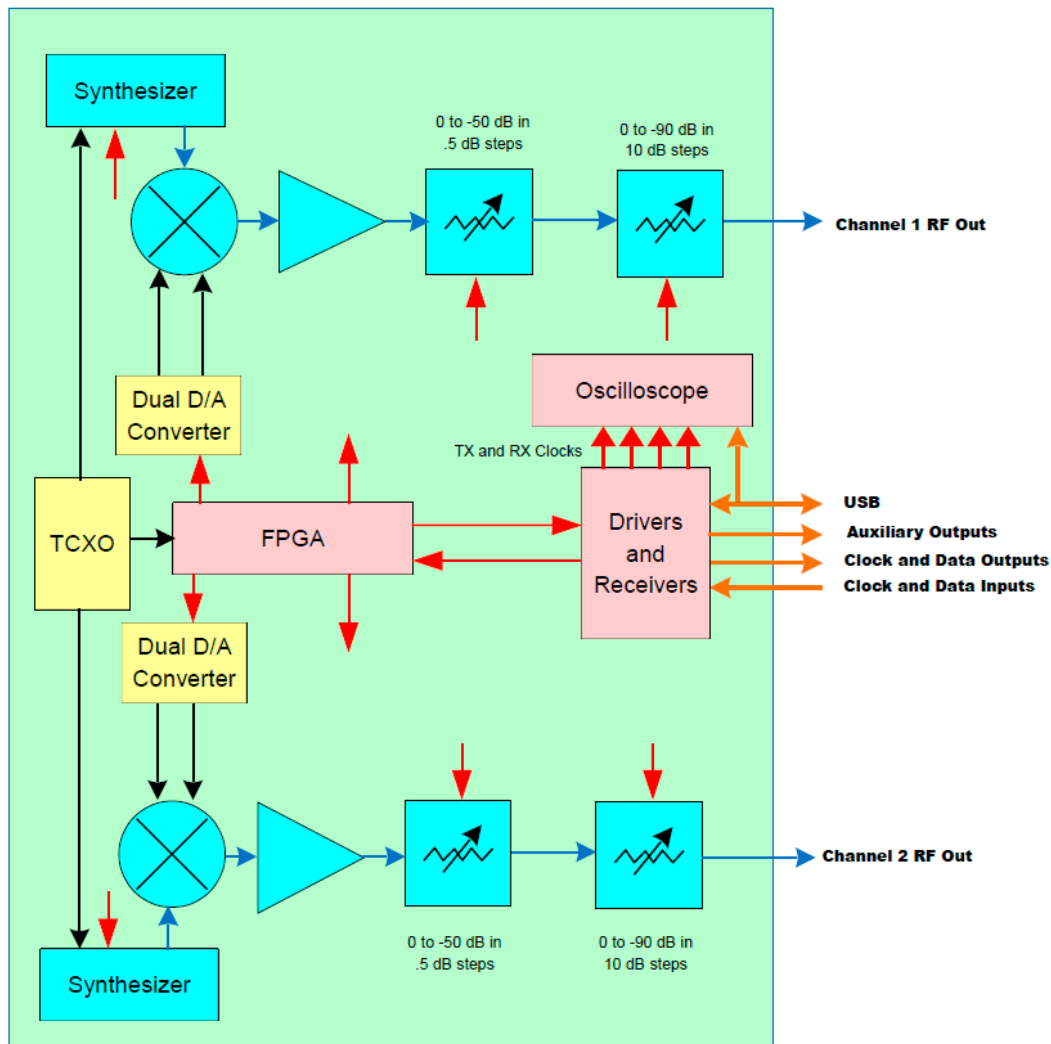


Figure 1: Receiver Analyzer System-Level Block Diagram



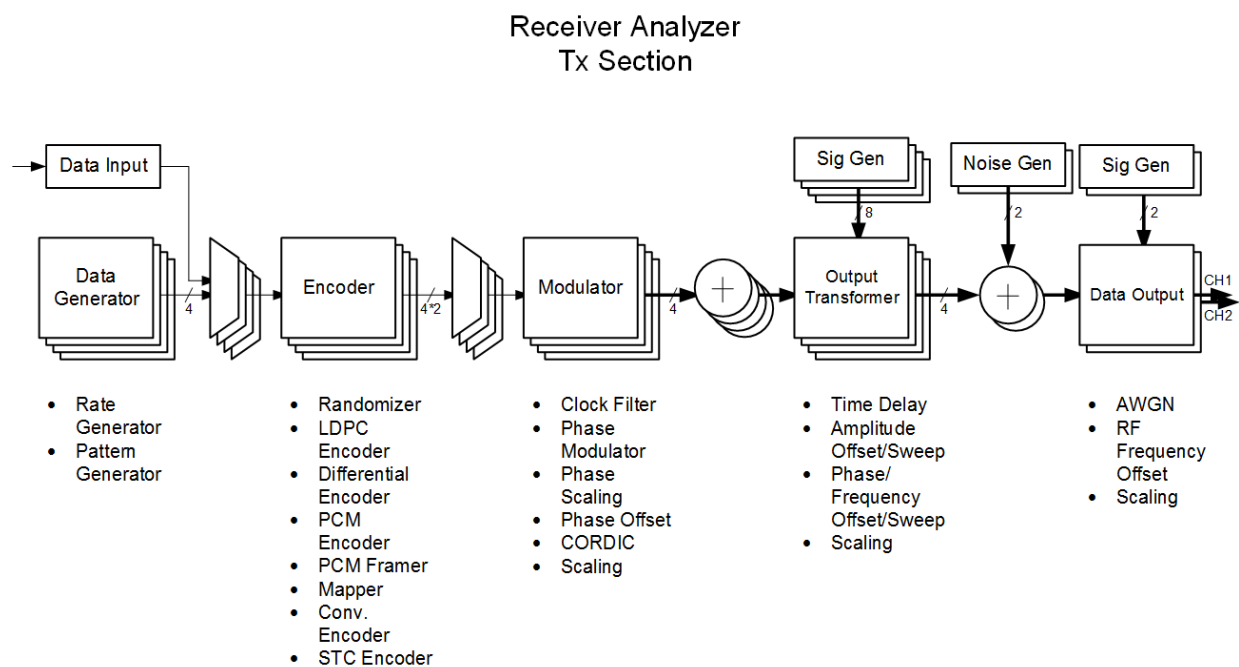


Figure 2: Signal Synthesis Block Diagram

## Receiver Analyzer Output Transformer

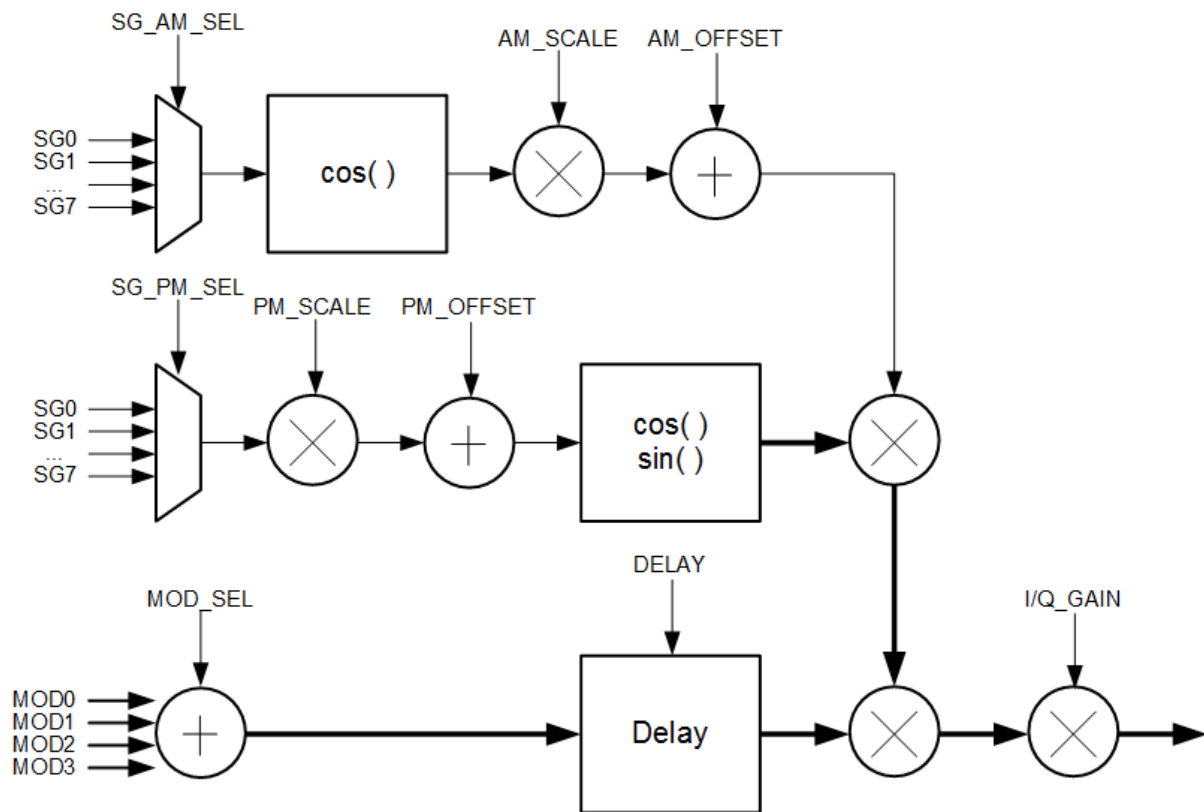


Figure 3: Output Transformer Block Diagram

## 4 Installation Instructions

### 4.1 Mechanical

The Receiver Analyzer's enclosure fits in a standard 19" rack, occupying just 1U of rack space. Mechanical layouts are provided in Figure 4 and Figure 5.

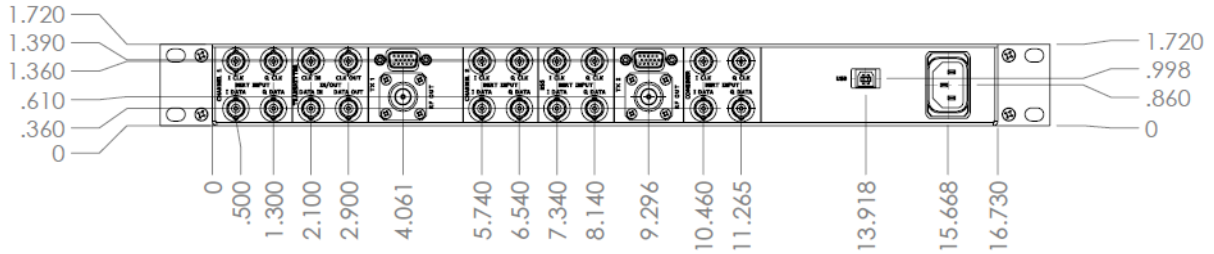


Figure 4: Mechanical Drawing – Back View

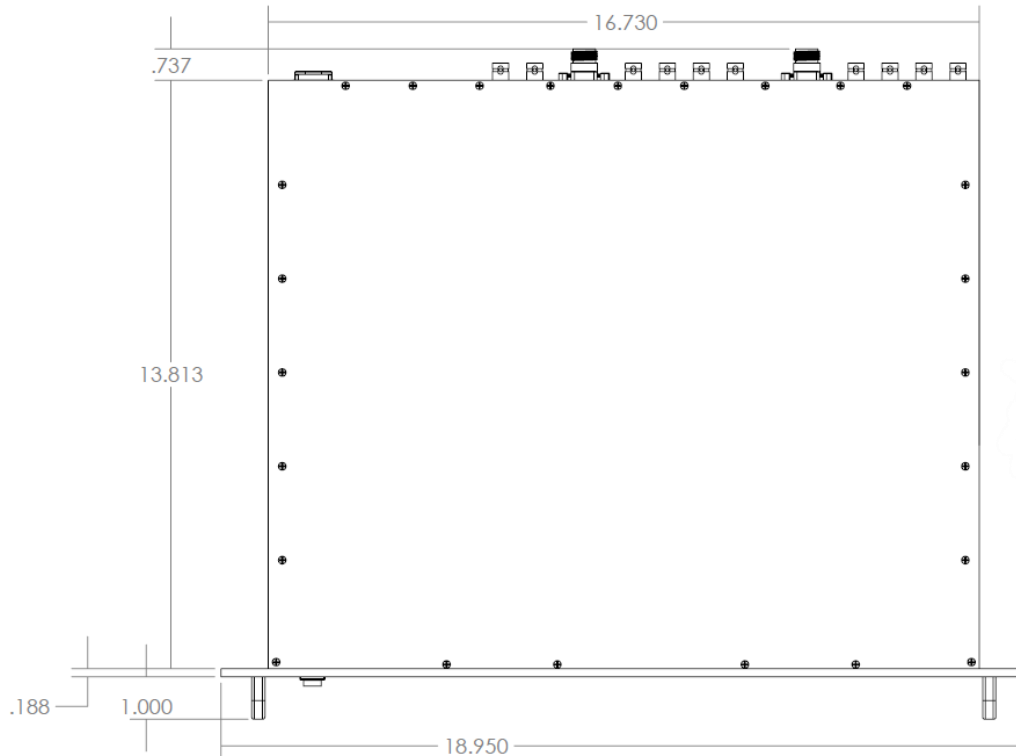


Figure 5: Mechanical Drawing – Top View

## 4.2 Thermal

The storage temperature of the Rack Mount Receiver Analyzer 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.

The Rack Mount Receiver Analyzer 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. A rear panel cooling fan is also provided. Whenever feasible, it is helpful to leave an open rack space above and below the Rack Mount Receiver Analyzer for additional heat dissipation.

## 4.3 Electrical

The Rack Mount Receiver Analyzer is available only in a dual channel configuration, with all pertinent electrical connections located on the rear panel.

### 4.3.1 Receiver Analyzer Connections

The electrical interface connector layout for the Receiver Analyzer is shown in Figure 6.



Figure 6: Receiver Analyzer Back Panel

Table 2: Rear Panel Connector Specifications

Function	Electrical Characteristics	Connector Type
Channel 1, In-phase (I) Clock BERT Input	75 ohm TTL	75 ohm BNC
Channel 1, In-phase (I) Data BERT Input	75 ohm TTL	75 ohm BNC
Channel 1, Quadrature (Q) Clock BERT Input	75 ohm TTL	75 ohm BNC
Channel 1, Quadrature (Q) Data BERT Input	75 ohm TTL	75 ohm BNC
Channel 2, In-phase (I) Clock BERT Input	75 ohm TTL	75 ohm BNC
Channel 2, In-phase (I) Data BERT Input	75 ohm TTL	75 ohm BNC
Channel 2, Quadrature (Q) Clock BERT Input	75 ohm TTL	75 ohm BNC
Channel 2, Quadrature (Q) Data BERT Input	75 ohm TTL	75 ohm BNC
Combiner, In-phase (I) Clock BERT Input	75 ohm TTL	75 ohm BNC
Combiner, In-phase (I) Data BERT Input	75 ohm TTL	75 ohm BNC
Combiner, Quadrature (Q) Clock BERT Input	75 ohm TTL	75 ohm BNC
Combiner, Quadrature (Q) Data BERT Input	75 ohm TTL	75 ohm BNC

Function	Electrical Characteristics	Connector Type
BSS, In-phase (I) Clock BERT Input	75 ohm TTL	75 ohm BNC
BSS, In-phase (I) Data BERT Input	75 ohm TTL	75 ohm BNC
BSS, Quadrature (Q) Clock BERT Input	75 ohm TTL	75 ohm BNC
BSS, Quadrature (Q) Data BERT Input	75 ohm TTL	75 ohm BNC
Transmitter Clock In	75 ohm TTL	75 ohm BNC
Transmitter Clock Out	75 ohm TTL	75 ohm BNC
Transmitter Data In	75 ohm TTL	75 ohm BNC
Transmitter Data Out	75 ohm TTL	75 ohm BNC
Channel 1, Auxiliary Output 1	75 ohm TTL	Ch1 DB-15, Pin 6
Channel 1, Auxiliary Output 2	75 ohm TTL	Ch1 DB-15, Pin 11
Channel 1, Auxiliary Output 3	75 ohm TTL	Ch1 DB-15, Pin 12
Channel 1, Auxiliary Output 4	75 ohm TTL	Ch1 DB-15, Pin 13
Channel 1, Auxiliary Output 5	75 ohm TTL	Ch1 DB-15, Pin 14
Channel 1, Auxiliary Output 6	75 ohm TTL	Ch1 DB-15, Pin 15
Channel 2, Auxiliary Output 1	75 ohm TTL	Ch2 DB-15, Pin 6
Channel 2, Auxiliary Output 2	75 ohm TTL	Ch2 DB-15, Pin 11
Channel 2, Auxiliary Output 3	75 ohm TTL	Ch2 DB-15, Pin 12
Channel 2, Auxiliary Output 4	75 ohm TTL	Ch2 DB-15, Pin 13
Channel 2, Auxiliary Output 5	75 ohm TTL	Ch2 DB-15, Pin 14
Channel 2, Auxiliary Output 6	75 ohm TTL	Ch2 DB-15, Pin 15
Tx 1 RF Output	50 ohms	N
Tx 2 RF Output	50 ohms	N
USB Control	5 V Standard	USB-B
Power	90-264 V-rms AC, 47-63 Hz	EAC309X

#### 4.3.2 Digital Status Outputs

The receiver analyzer digital status outputs allow the user to monitor internal status in real time. There are two female DB-15 auxiliary connectors used for this purpose. The channel 1 connector is defined as J9, while the channel 2 connector is defined as J19, as shown in Figure 7.



Figure 7: Receiver Analyzer Back Panel, J9 and J19 Labeled

The female DB-15 connector pins are numbered as shown in Figure 8.

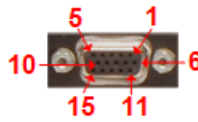


Figure 8: Female DB-15 Connector, Numbered

Table 3 describes the status output signal parameters.

Table 3: Digital Status Output Descriptions

Signal	Function	Connector	Pin	Note
CH1I Error	CH 1, Aux Output 1	J9	6	High when error detected on CH1I input, low otherwise. Delayed from CH1I input by 1/2 bit time plus approximately 80 ns
CH2I Error	CH 2, Aux Output 1	J19	6	High when error detected on CH2I input, low otherwise. Delayed from CH2I input by 1/2 bit time plus approximately 80 ns
CH1 RF On	CH 1, Aux Output 2	J9	11	High when CH1 RF enabled, low when RF disabled
CH2 RF On	CH 2, Aux Output 2	J19	11	High when CH2 RF enabled, low when RF disabled
CH1I Sync Detect	CH 1, Aux Output 3	J9	12	High when CH1I synchronization detected, low otherwise (only valid when running Sync Time Test)
CH2I Sync Detect	CH 2, Aux Output 3	J19	12	High when CH2I synchronization detected, low otherwise (only valid when running Sync Time Test)
CMBI Sync Detect	CH 1, Aux Output 4	J9	13	High when CMBI synchronization detected, low otherwise (only valid when running Sync Time Test)

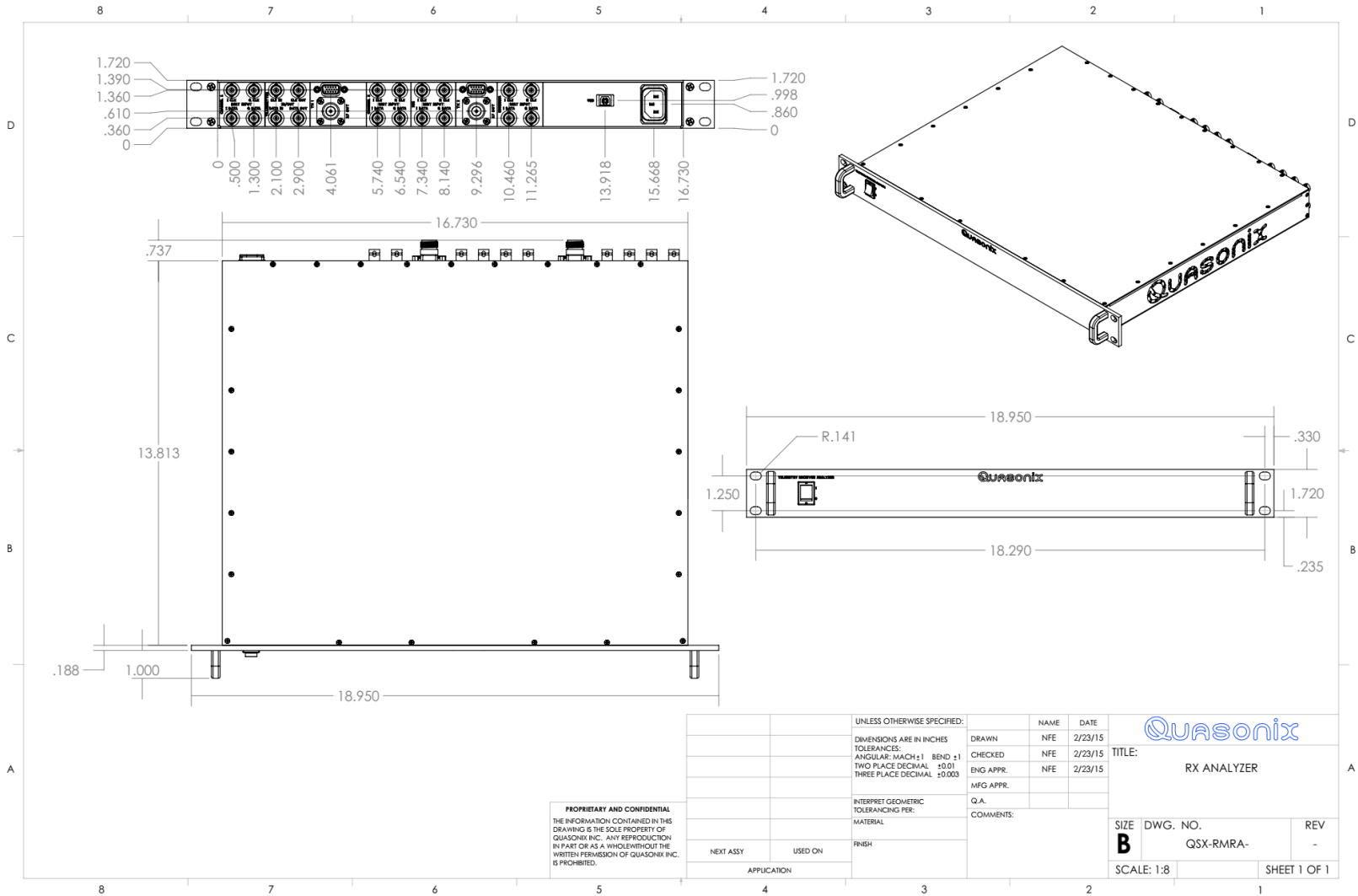


Figure 9: Receiver Analyzer Installation Drawing

## 5 Operating Instructions

### 5.1 Front-Panel

The Receiver Analyzer front panel contains only a power switch.



Figure 10: Receiver Analyzer Front Panel

### 5.2 Back Panel

A variety of connectors are located on the Receiver Analyzer back panel, shown in Figure 11. Enlarged illustrations of the left and right half of the back panel are shown in Figure 12 and Figure 13.



Figure 11: Receiver Analyzer Back Panel

An enlarged photo of the left half of the back panel is shown in Figure 12. It contains the following connectors: BERT I and Q Clock and Data Input for Channel 1, Transmitter I and Q Clock and Data In/Out, Transmitter 1 RF Output and DB-15 connector, and BERT I and Q Clock and Data Input for Channel 2.



Figure 12: Receiver Analyzer Back Panel, Left Side Enlarged



An enlarged photo of the right half of the back panel is shown in Figure 13. It contains the following connectors: BERT I and Q Clock and Data Input for Best Source Selection (BSS), Transmitter 2 RF Output and DB-15 connector, BERT I and Q Clock and Data Input for Diversity Combiner, USB Control port, Power Supply port.



**Figure 13: Receiver Analyzer Back Panel, Right Side Enlarged**

### 5.3 Receiver Analyzer User Interface

The Rack Mount Receiver Analyzer's remote control interface is a Windows-based graphical user interface that enables configuration and monitoring of the unit via USB. The client provides easy-to-read, real-time status information to the user. The user interface is built upon Microsoft's ubiquitous .NET Framework, which is a software-based coding foundation that facilitates consistent application performance across various hardware platforms, as well as enhanced security. .NET is compatible with Windows XP, Windows Vista, and Windows 7.

The graphical user interface provides manual control of all signal generator and bit error rate testing (BERT) functions.

The user interface includes:

- Near real time bit count, bit rate, bit errors, bit error rate, clock sync, and data inversion for each enabled channel
- BER test with time limit, error limit, or both
- Free run, Single, and Repeat test modes for BERT
- Auto Detect Analyzer on power up
- Ability to Save and Load stored configurations
- Automated tests which store all acquired data in .CSV files for post-test processing and analysis
- Selectable data directory
- Test tabs for a variety of functions including BER Sweep, Modulation Index, Sync Time, and Break Frequency
- Digital clock
- BER Power, Eb/N0, Frequency, and Bitrate sweeps work with receivers that have no serial interface (the RA prompts the user for the required information)
- Automatically scans for attached Quasonix receivers at start up

The left side of the Receiver Analyzer user interface window is used to set up the signal generator, modulator, BERTs, and any system level parameters. A separate Rx Status window now contains the current status and statistics for running standard bit error rate (BER) tests. The right side (with all of the tabs) enables more sophisticated testing. Values in the right hand tests are copied over the identical fields on the left side when they are being used.

Figure 14 shows the Quasonix Receiver Analyzer User Interface.

When Multipath is running (set on the Multipath test tab), a "Multipath running" notification message displays in green at the top left side user interface window, as shown in Figure 14. If an error condition occurs, a message displays on the screen in red.

**Note:** A scroll bar automatically displays on the right side of the interface window to make it easier for operators using monitor displays set to greater than 100% (larger print) to see the full interface.

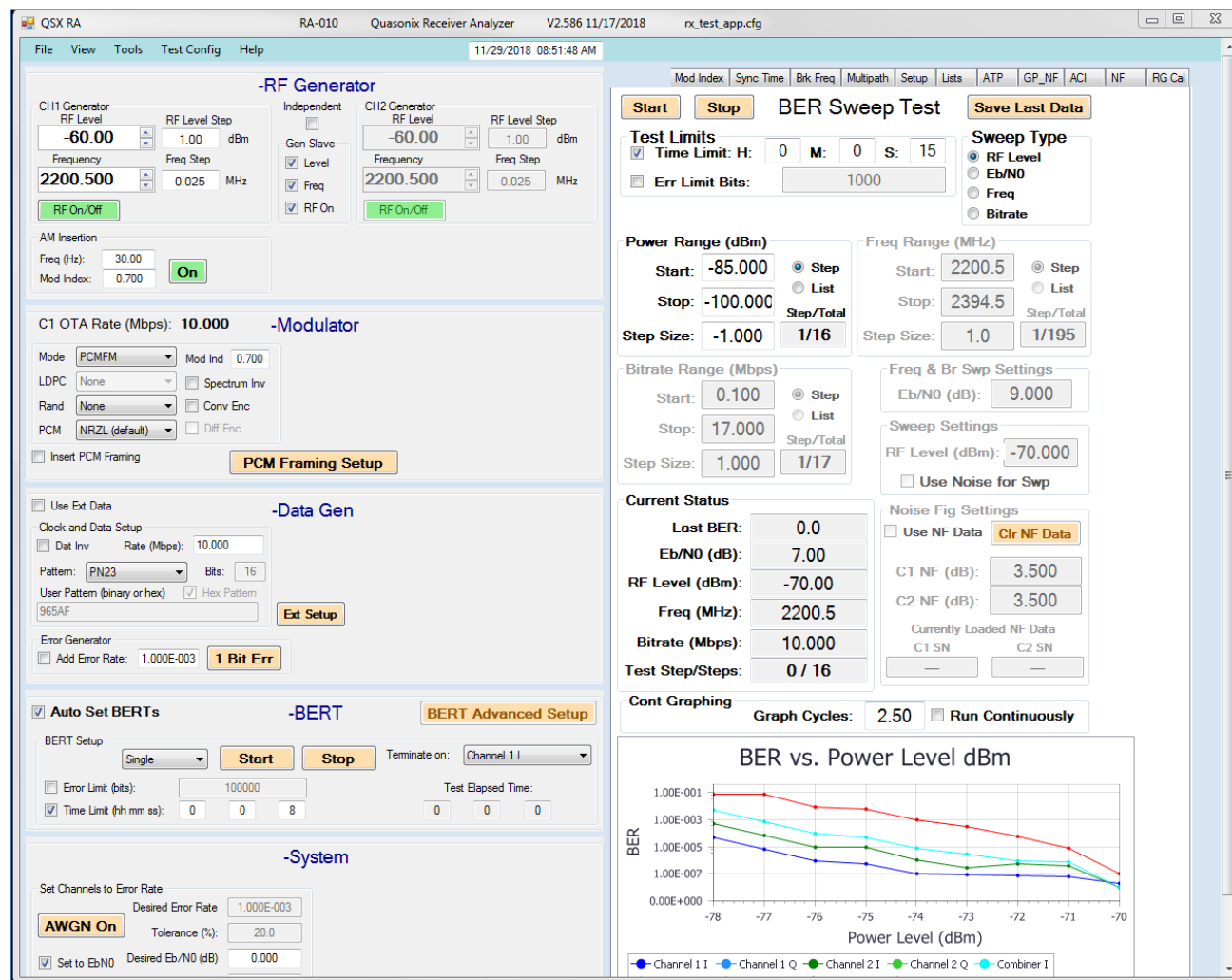


Figure 14: Receiver Analyzer User Interface

### 5.3.1 Menu Bar

The Receiver Analyzer user interface has a variety of menus available on the top of the screen: File, View, Tools, Test Config, and Help. These menus provide some common functions and keyboard shortcuts to the functions.

#### 5.3.1.1 File Menu

The File menu provides an exit option and displays a keyboard shortcut. The File menu is shown in Figure 15.

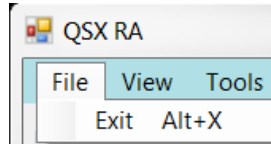


Figure 15: File Menu

#### 5.3.1.2 View Menu

The View menu provides access to a variety of status windows. Each of the options provides access to a quick selection menu containing the following:

- Move On Screen – Moves only the selected window to the upper left corner of the monitor screen
- Switch To – Switches to the selected window
- Show – Displays only the selected window
- Hide – Closes only the selected window

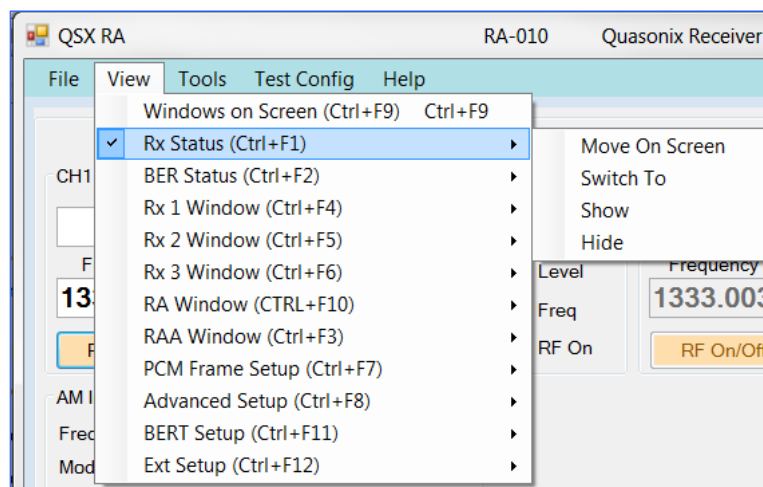


Figure 16: View Menu

#### 5.3.1.2.1 Windows on Screen

The Windows on Screen option positions all open windows at coordinates staggered from 0,0 on the main Windows screen so they display on any system, even if they were saved off-screen on another system. If a window is open but

it doesn't display on the Desktop, click on the Windows on Screen option to position open windows where they may be viewed. An icon does not display in the Taskbar at the bottom of a Windows screen. If the window is still not visible, click on the View menu, then the desired window. Click on Switch To to display the window “on top” of everything displayed on the Desktop.

#### 5.3.1.2.2 Rx Status

The Receiver Status window consists of four subsections: Channel 1, Channel 2, Combiner, and BSS. Identical fields are contained within each subwindow. They are used to continuously display updated test results. The fields do not display if the I or Q Channel check box is not checked.

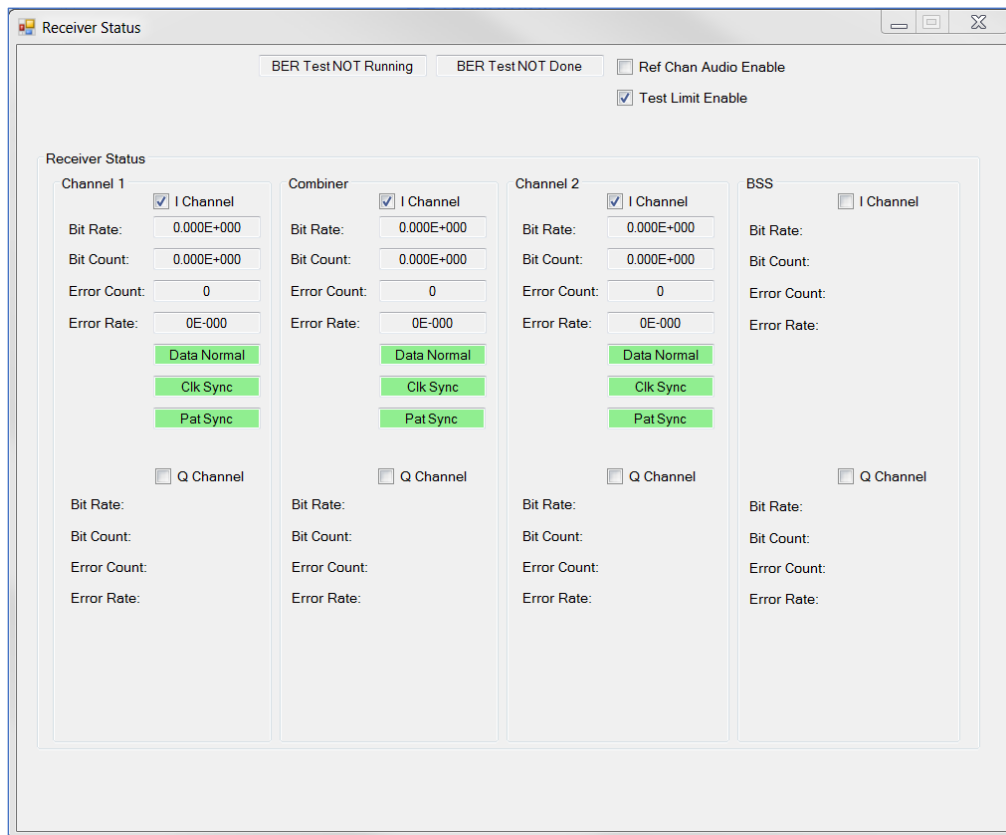


Figure 17: Receiver Status Screen

##### 5.3.1.2.2.1 Receiver Status Window, Top Section

The top of the Receiver Status window consists of two display fields and two check boxes, as shown in Figure 18.

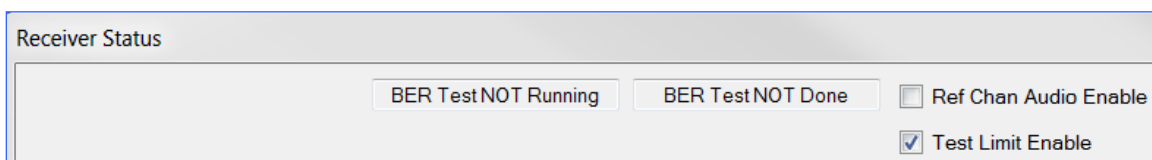


Figure 18: Receiver Status Window, Top Section

- BERT Activation Status - Indicates BERT Test not running or displays green with BERT Test Running
- BER Test Status - Indicates BER Test not done or displays green with BERT Test Done
- Ref Chan Audio Enable check box - When this box is checked, the unit beeps when errors are detected
- Test Limit Enable check box - When this box is checked, a red Test Limit line displays on certain graphs for Bitrate or Frequency sweep tests

#### 5.3.1.2.2.2 I Channel and Q Channel Sections

The Receiver Status window, shown in Figure 19, displays current receiver information as a test is running. Each field is described below. Receiver connectors may be attached to the receiver analyzer using any of the BERTs regardless of the names shown on the Status window (think of eight individual bit error rate testers).

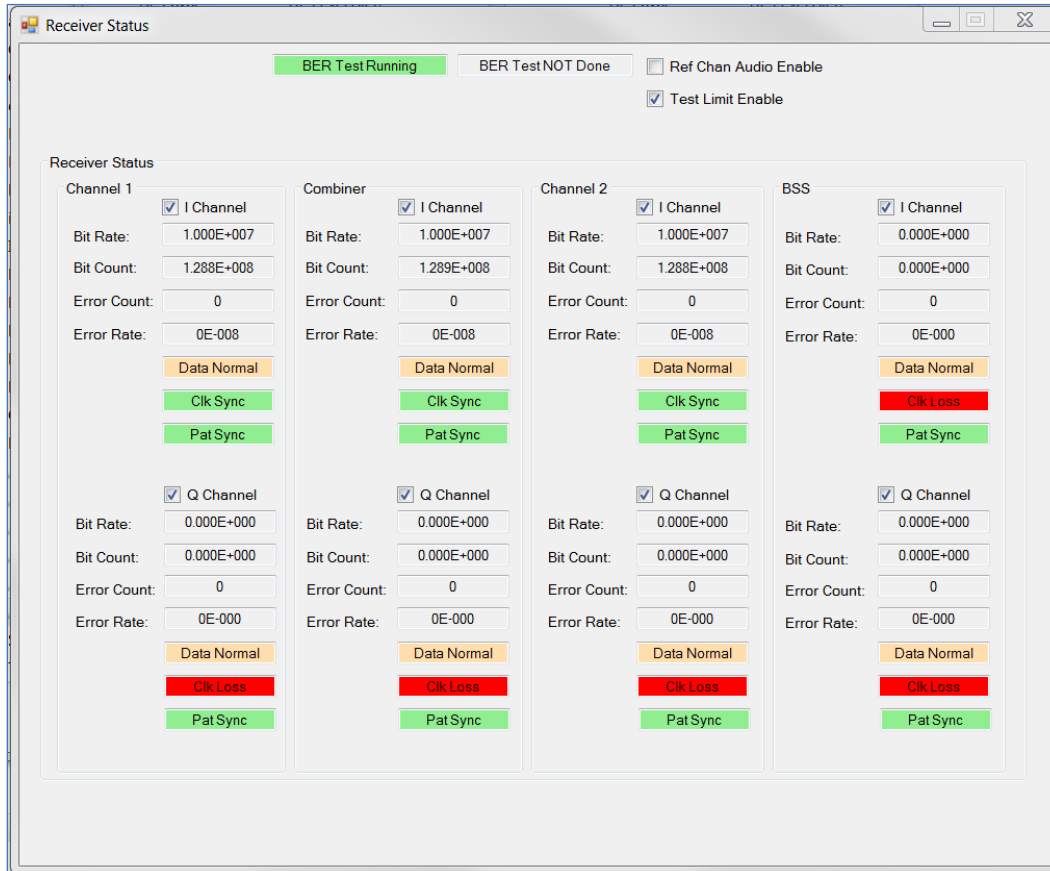


Figure 19: Receiver Status Window, All Eight (8) BERTs Selected

- I Channel or Q Channel Check box – Enables the corresponding channel
- Bit Rate – Continuous display of the channel bit rate for the duration of a test
- Bit Count – Continuous display of the channel bit count for the duration of a test

- Error Count – Continuous display of the channel error count for the duration of a test
- Error Rate – Continuous display of the error rate for the duration of a test run in Free Run or Single mode  
When running in Repeat mode, the Error Rate is only updated at the end of each test. It remains on display while the test is repeated. When the repeated test is complete, the Error Rate for the repeated test is updated again.
- Data Normal/Data Inverted - Displays Data Normal for a regular data stream; if the data is inverted, the box changes to blue and Data Inverted displays
- Clock Sync - When clock synchronization is achieved, the box is green and displays Sync; if synchronization is lost, the box changes to red and displays Clk Loss. There is a selection for an alternate sync method on the Setup screen that allows sync to be determined by a user entered %BER. This is useful in cases where the Receiver Analyzer is being used as a BERT but is NOT the signal source, therefore, the standard sync method will never indicate sync.
- Pattern Sync - Displays when sending a fixed length pattern and a fixed length pattern was detected; if the fixed length pattern sent does not match the one detected, the box changes to red and displays Pat Loss, as shown in Figure 20; Sync Loss may occur if there are no pattern transitions when sending fixed length patterns.

Receiver Status		
Channel 1	Combiner	Channel 2
<input checked="" type="checkbox"/> I Channel	<input checked="" type="checkbox"/> I Channel	<input checked="" type="checkbox"/> I Channel
Bit Rate: 6.920E+006	Bit Rate: 6.922E+006	Bit Rate: 6.919E+006
Bit Count: 5.516E+009	Bit Count: 5.517E+009	Bit Count: 5.516E+009
Error Count: 2.338E+009	Error Count: 2.339E+009	Error Count: 2.338E+009
Error Rate: 4.239E-001	Error Rate: 4.239E-001	Error Rate: 4.239E-001
Data Normal	Data Normal	Data Normal
Clk Loss	Clk Loss	Clk Loss
Pat Loss	Pat Loss	Pat Loss

Figure 20: Receiver Status Window, Pattern Mismatch Indicated

### 5.3.1.2.3 BER Status

The BER Display screen provides much of the same status information as that on the Receiver Status screen but in an abbreviated format. It also displays a large, easy to read error rate window for Channel 1, Channel 2, and the Combiner.

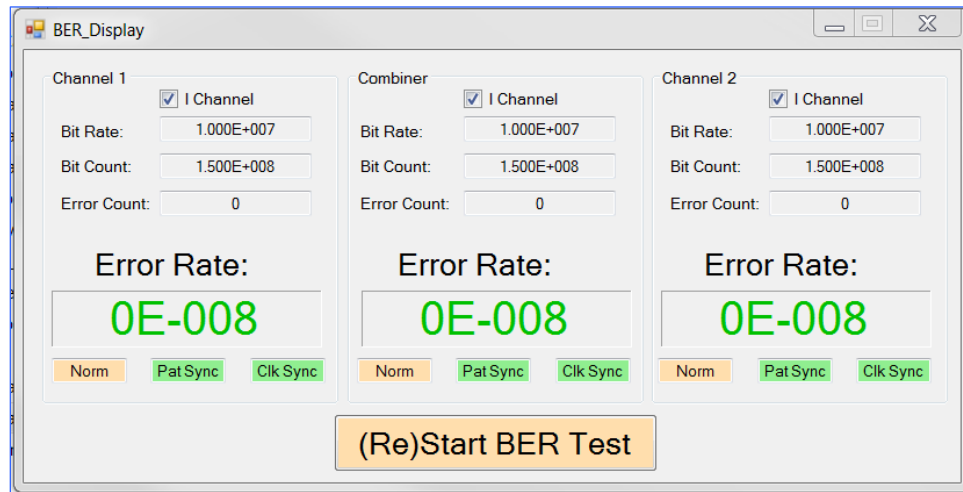


Figure 21: BER Display Screen

- I Channel check box - Enables the channel (depending on the subwindow the check box is located in, such as Channel 1)
- Bit Rate – Continuous display of the channel bit rate for the duration of a test
- Bit Count – Continuous display of the channel bit count for the duration of a test
- Error Count – Continuous display of the channel error count for the duration of a test
- Error Rate – Continuous display of the error rate for the duration of a test run in Free Run or Single mode  
When running in Repeat mode, the Error Rate is only recorded at the end of each test. It remains on display while the test is repeated. When the repeated test is complete, the Error Rate for the repeated test is displayed.
- Norm/Inv - - Displays Norm for a regular data stream; if the data is inverted, the box changes to blue and Inv displays (Figure 22)
- Pat Sync – When pattern synchronization is achieved, the box is green and displays Pat Sync; if synchronization is lost, the box changes to red and displays Pat Loss (Figure 22)
- Clk Sync - When clock synchronization is achieved, the box is green and displays Clk Sync; if synchronization is lost, the box changes to red and displays Clk Loss (Figure 22)
- (Re) Start BER Test button - Starts the Bit Error Rate (BER) test; This button functions identically to the Start button on the main screen BER Test Control window (shown in Figure 48)



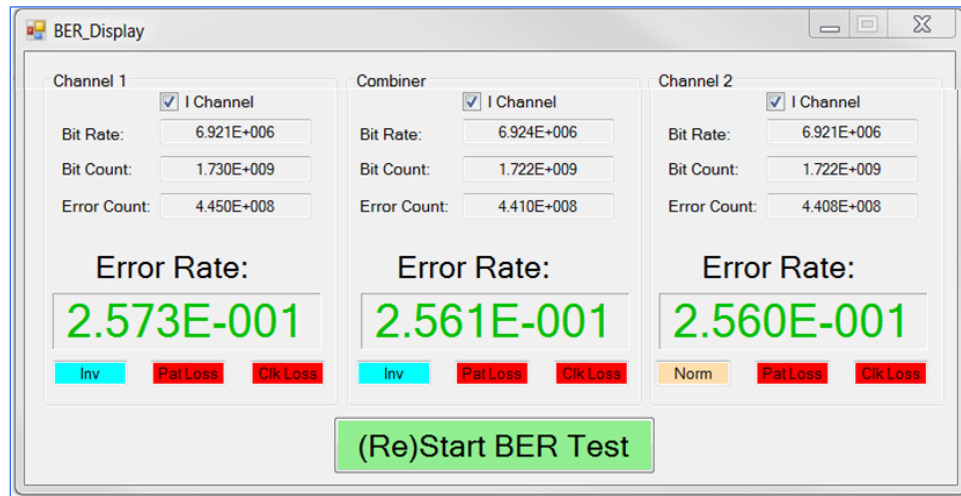


Figure 22: BER Display Screen with Inverted and Sync Losses Displayed

#### 5.3.1.2.4 Rx 1 Window

Refer to Appendix A, section 10.1, Rx Terminal Window.

#### 5.3.1.2.5 Rx 2 Window

The Receiver Channel 2 screen performs the same functions for Channel 2 as the Receiver Channel 1 screen does for Channel 1.

#### 5.3.1.2.6 Rx 3 Window

The Receiver Channel 3 screen displays information for the Combiner in the same format as Receiver Channel 1 and Receiver Channel 2. It always receives Intermediate Frequency (IF) at 70 MHz from Channel 1 and Channel 2.

#### 5.3.1.2.7 RA Window (Currently Quasonix Factory Use Only)

Refer to Appendix A, section 10.2, RA Window (Currently Quasonix Factory Use Only).

#### 5.3.1.2.8 RAA Window (Currently Quasonix Factory Use Only)

Refer to Appendix A, section 10.3, RAA Window (Currently Quasonix Factory Use Only).

#### 5.3.1.2.9 PCM Frame Setup

This option displays the same PCM Frame Setup window as the PCM Framing Setup button in the Modulator window. Refer to section 5.3.2.4.1 for detailed information.

#### 5.3.1.2.10 Advanced Setup

This option displays the same Advanced Setup window as the Advanced Setup button in the Setup tab. Refer to section 5.3.3.6.3 for detailed information.

#### 5.3.1.2.11 BERT Setup

This option displays the BERT Advanced Setup window. It is also accessible via the BERT Advanced Setup button in the BERT window on the main screen. Refer to section 5.3.2.6.2 for detailed information.

#### 5.3.1.2.12 Ext Setup

This option displays the External Clock/Data Setup window. It is also accessible via the Ext Setup button in the Data Gen window on the main screen. Refer to section 5.3.2.5.1 for detailed information.

### 5.3.1.3 Tools Menu

The Tools menu is shown in Figure 23.

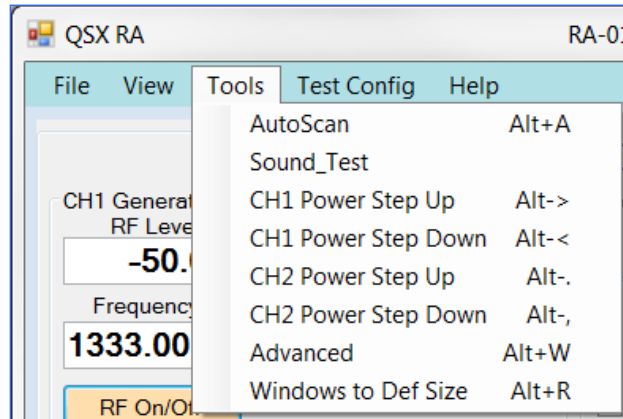


Figure 23: Tools Menu

- Autoscan – Looks at all serial ports and tries to find a Receiver Analyzer board with a valid model number; if found, it connects to the Receiver Analyzer
- Sound\_Test - Plays an audible sound test of an installed .wav file; when Audible Test Notifications on the main window is checked, a .wav file plays to alert a user that a test has ended; mostly used with ATP; A .wav file may be changed by copying a new one into the install folder on your PC
- CH1 Power Step Up - Provides a keyboard shortcut to allow quick increments of Channel 1 power steps from the keyboard
- CH1 Power Step Down - Provides a keyboard shortcut to allow quick decrements of Channel 1 power steps from the keyboard
- CH2 Power Step Up - Provides a keyboard shortcut to allow quick increments of Channel 2 power steps from the keyboard
- CH2 Power Step Down - Provides a keyboard shortcut to allow quick decrements of Channel 2 power steps from the keyboard
- Advanced - Provides access to advanced features (currently Quasonix factory only)
- Windows to Def Size – Sets all windows (shown in the View list) to their default sizes but does not move them

### 5.3.1.4 Test Configuration Menu

The Test Configuration menu is shown in Figure 24.

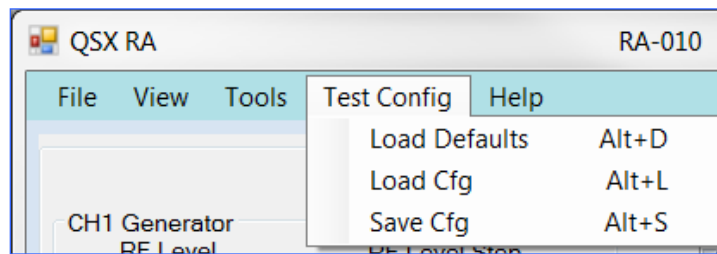


Figure 24: Test Config Menu

- Load Defaults – Loads all factory default parameters
- Load Configuration – Loads a selected (previously saved) user configuration
- Save Configuration – Saves the current configuration to a user-selected file name

#### 5.3.1.5 Help Menu

The Help menu currently provides three options, About, Eb/N0 Help, and Keyboard Shortcuts, as shown in Figure 25.

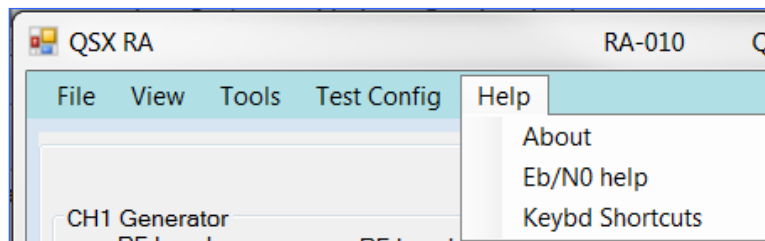


Figure 25: Help Menu

The About screen provides the receiver analyzer software version number and date along with the copyright statement (Figure 26).

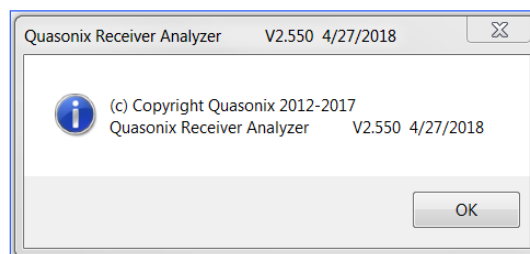


Figure 26: About Screen

The Eb/N0 vs. BER Help screen, shown in Figure 27, provides a quick table of Eb/N0 values. Based on the modulation and  $10^{-5}$  error rate, the user can do a quick lookup to find the optimum Eb/N0.

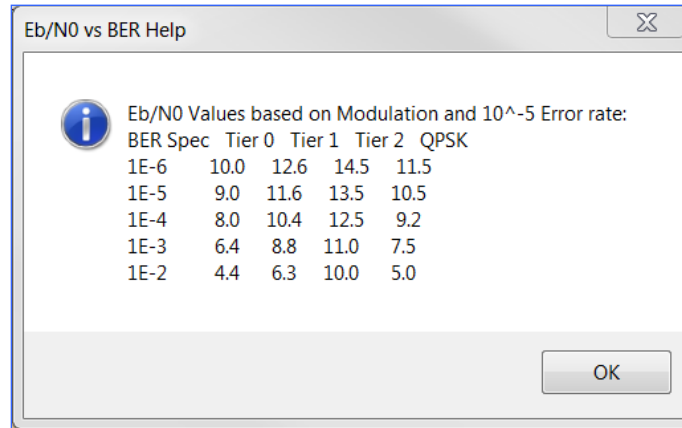


Figure 27: Eb/N0 vs. BER Help Screen

The Keybd Shortcuts Help screen, shown in Figure 28, provides a quick reference to all keyboard shortcuts available in the Receiver Analyzer GUI.

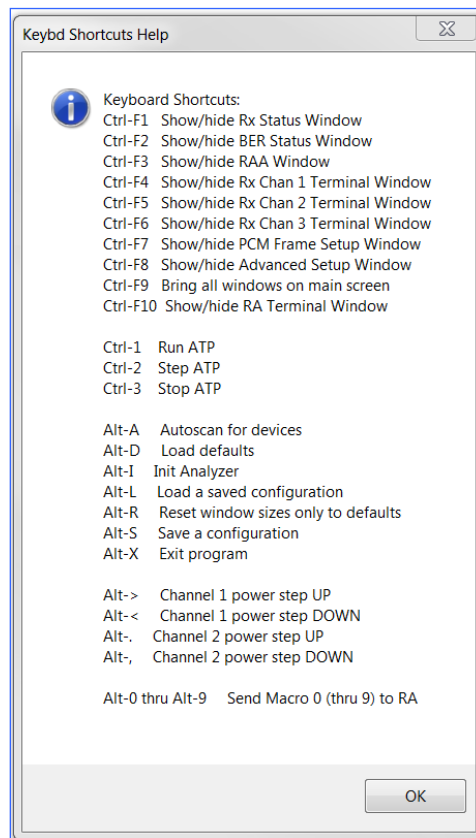


Figure 28: Keyboard Shortcut Help Window

### 5.3.2 Receiver Analyzer Controls

The left side of the Receiver Analyzer user interface screen is used to set up RF generator, modulation, data generation, BERT, and System settings. The sections may be opened or closed by clicking on the blue section name. A plus sign in front of the name indicates the section is closed (collapsed) while a minus sign in front of the name indicates the section is open (fully displayed). Sections may be opened in any order and left open or closed based on desired usage. The current state of these sections is saved with the configuration.

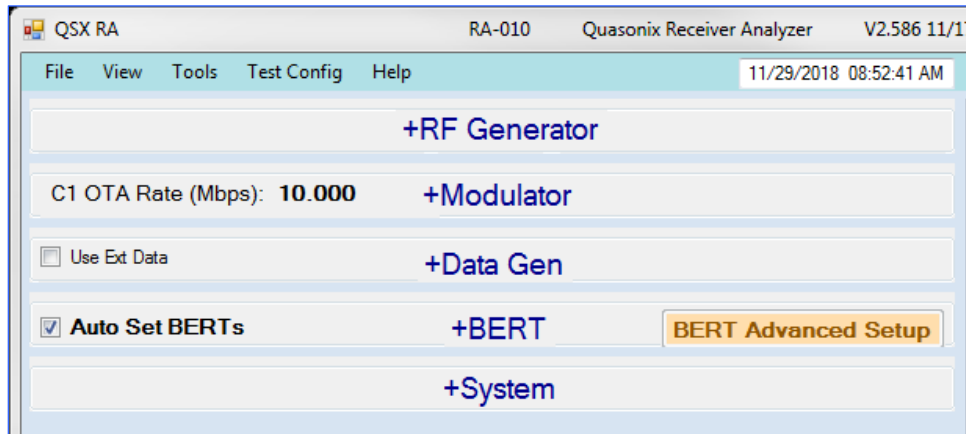


Figure 29: Receiver Analyzer Controls Screen, All Sections

#### 5.3.2.1 RF Generator

The RF Generator section, shown in Figure 30, includes signal generator setup for Channel 1 and Channel 2, Independent check box, Slave settings, and AM Insertion for Channel 1.

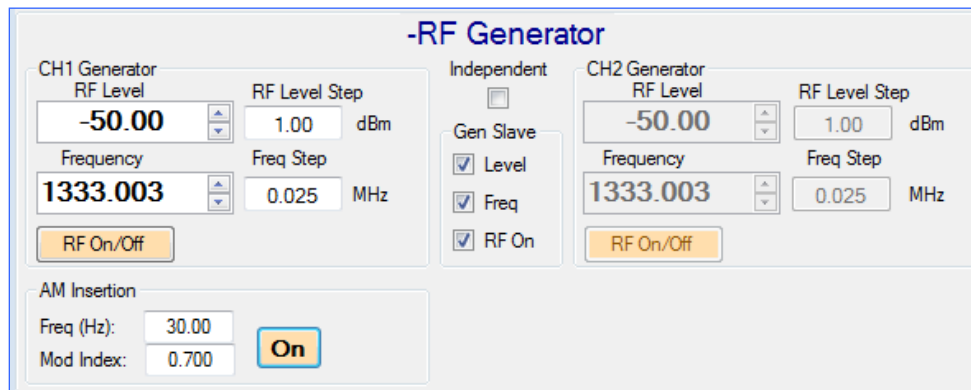


Figure 30: Receiver Analyzer Controls Screen, RF Generator Section Open

##### 5.3.2.1.1 CH1 and CH2 Generator

Channel 1 and Channel 2 Generator sections, shown in Figure 31, are used to set parameters for the internal signal generators.

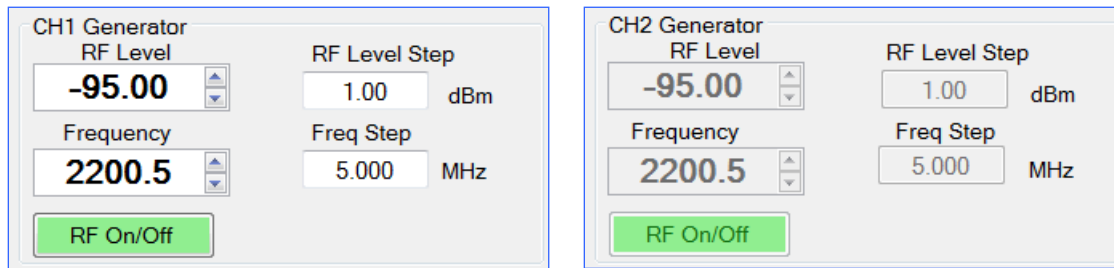


Figure 31: Channel Generator Sections

- RF Level – The power level output of the signal, in dBm, sent by the Receiver Analyzer’s internal transmitter(s)
- RF Level Step (dBm) – Sets the step size for the power level (used by the up/down arrows)
- Frequency – Frequency, in MHz, of the signal sent by the Receiver Analyzer’s internal transmitter(s); frequency is rounded to nearest 1 kHz internally, but displays rounded off to the nearest 0.1 MHz; This is likely to change in the future. Available frequencies include P, lower L, upper L, S, and C bands.
- Frequency Step (MHz) – Sets the frequency step size used by the Frequency up/down arrows
- RF On/Off button – Turns RF On or Off

### 5.3.2.2 Independent

When checked, the Independent option (shown in Figure 32) sets the receiver analyzer to act as two completely independent transmitters. This may affect the operation of some tests. Figure 33 and Figure 34 show the differences in the RF Generator, Modulator, Data Gen, BERT, and System windows. When Independent is checked, all settings on the left side of each window are duplicated on the right side, and they operate independent of each other.



Figure 32: Independent Check Box

**-RF Generator**

CH1 Generator RF Level: -50.00 dBr, Frequency: 1800.000 MHz, RF Level Step: 1.00 dBr, Freq Step: 0.025 MHz, RF On/Off: On

CH2 Generator RF Level: -50.00 dBr, Frequency: 1800.000 MHz, RF Level Step: 1.00 dBr, Freq Step: 0.025 MHz, RF On/Off: On

Independent: ☐ Gen Slave: ☐ Level: ☒ Freq: ☒ RF On: ☒

AM Insertion: Freq (Hz): 30.00, Mod Index: 0.700, On

**-Modulator**

C1 OTA Rate (Mbps): 10.000, Mode: SOQPSK, Mod Ind: 1.000, LDPC: None, Spectrum Inv: ☐ Conv Enc: ☐ PCM: NRZL (default), Diff Enc: ☒ Insert PCM Framing: ☐ PCM Framing Setup

**-Data Gen**

Use Ext Data: ☐ Clock and Data Setup: Dat Inv: ☐ Rate (Mbps): 10.000, Pattern: PN23, Bits: 16, User Pattern (binary or hex): 965AF, Hex Pattern: ☒ Ext Setup

Error Generator: Add Error Rate: 1.000E-003, 1 Bit Err

**-BERT**

Auto Set BERTs: ☒ BERT Setup: Single, Start, Stop, Terminate on: Channel 11, Error Limit (bits): 100000, Time Limit (h:m:ss): 0:0:8, Test Elapsed Time: 0:0:0

**-System**

Set Channels to Error Rate: Desired Error Rate: 1.000E-003, Tolerance (%): 20.0, AWGN On, Set to Eb/N0: 0.000, Use AWGN: ☒ NF (dB): 3.5

Figure 33: Independent Not Checked

**-RF Generator**

CH1 Generator RF Level: -50.00 dBr, Frequency: 1800.000 MHz, RF Level Step: 1.00 dBr, Freq Step: 0.025 MHz, RF On/Off: On

CH2 Generator RF Level: -50.00 dBr, Frequency: 1800.000 MHz, RF Level Step: 1.00 dBr, Freq Step: 0.025 MHz, RF On/Off: On

Independent: ☒ Gen Slave: ☐ Level: ☒ Freq: ☒ RF On: ☒

AM Insertion: Freq (Hz): 30.00, Mod Index: 0.700, On

**-Modulator**

C1 OTA Rate (Mbps): 10.000, Mode: SOQPSK, Mod Ind: 1.000, LDPC: None, Spectrum Inv: ☐ Conv Enc: ☐ PCM: NRZL (default), Diff Enc: ☒ Insert PCM Framing: ☐ PCM Framing Setup

**-Data Gen**

Use Ext Data: ☐ Clock and Data Setup: Dat Inv: ☐ Rate (Mbps): 10.000, Pattern: PN23, Bits: 16, User Pattern (binary or hex): 965AF, Hex Pattern: ☒ Ext Setup

Error Generator: Add Error Rate: 1.000E-003, 1 Bit Err

**-BERT**

Auto Set BERTs: ☒ BERT Setup: Single, Start, Stop, Terminate on: Channel 11, Error Limit (bits): 100000, Time Limit (h:m:ss): 0:0:8, Test Elapsed Time: 0:0:0

**-System**

Set Channels to Error Rate: Desired Error Rate: 1.000E-003, Tolerance (%): 20.0, AWGN On, Set to Eb/N0: 0.000, Use AWGN: ☒ NF (dB): 3.5

Figure 34: Independent Checked

### 5.3.2.3 Generator Slave

The Generator Slave section, shown in Figure 35, allows the Channel 2 signal generator to be a slave to the Channel 1 signal generator. In other words, the level, frequency, and RF On settings for the Channel 1 generator are automatically duplicated for the Channel 2 generator when the appropriate boxes are checked.

**Gen Slave**

☒ Level

☒ Freq

☒ RF On

Figure 35: Generate Slave Window

- Level – When checked, the values set in the Channel 1 Generator Level (power level) and Level Step options, are duplicated for the Channel 2 Generator. The Level and Level Step options for the Channel 2 Generator are greyed out.
- Frequency – When checked, the values set in the Channel 1 Generator Frequency and Frequency Step options, are duplicated for the Channel 2 Generator. The Frequency and Frequency Step options for the Channel 2 Generator are greyed out.
- RF On – When checked, the RF On/Off value in the Channel 1 Generator is duplicated for the Channel 2 Generator. The RF On/Off button for the Channel 2 Generator is greyed out.

#### 5.3.2.3.1 AM Insertion

The AM Insertion window, shown in Figure 36, is used to add AM to the RF output.

- Freq (Hz) - Sets the frequency for AM output
- Mod Index - Sets the amplitude modulation index; This is the scaling factor or ratio of amplitude modulation to the signal going out from the receiver analyzer to a receiver; Valid range is 0.000001 to 2.000
- On/Off button - Enable or disable AM insertion



Figure 36: AM Insertion Window

#### 5.3.2.4 Modulator

The Modulator section, shown in Figure 37, includes over the air (OTA) channel data rate, mode, and modulation index selections along with several check boxes to enable/disable options.

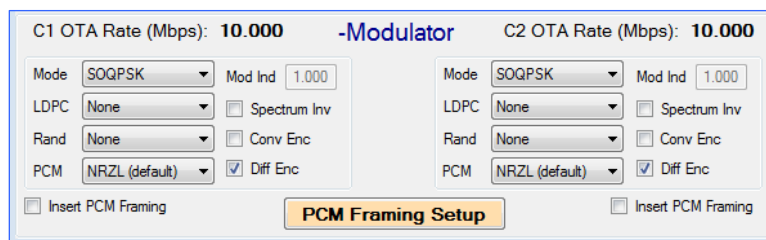


Figure 37: Receiver Analyzer Controls Screen, Modulator Section Open

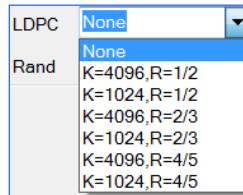
- Channel OTA Rate – Channel 1 or 2 Over the Air (OTA) data rate in Mbps  
This field displays the actual over-the-air data rate, in bits per second (bps), based on the user selected rate plus any additional encoding, such as CE or LDPC.  
The OTA rate is displayed to make the user aware of the *actual* bandwidth usage based on their current transmitter selections.



The OTA rate displays in red if the value exceeds 23Mbps for PCMFM or \*psk, or 46Mbps for SOQPSK, STC, or MHCPM.

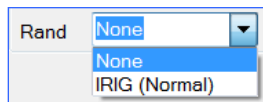
Waveform modes are selected using the down arrow to access the drop down menu. Available modes are:

- PCM/FM (ARTM Tier 0)
- SOQPSK (ARTM Tier I)
- Multi-h CPM (ARTM Tier II)
- STC
- DPM
- Legacy (PSK) suite, which includes:
  - BPSK
  - Offset QPSK (OQPSK)
  - QPSK
- Carrier
- Modulation Index - Allows the operator to manually set the modulation scale index for PCM/FM RF output. The default index for PCM/FM mode is 0.700, and DPM mode is 0.800. The default index for all other modes is 0.100.
- LDPC (SOQPSK or STC modes only) – Disable Low Density Parity Check (None) or select an LDPC mode, as shown in Figure 38

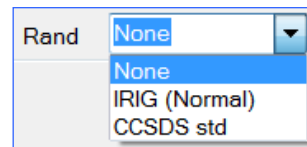


**Figure 38: Receiver Analyzer Controls Screen, Modulator, LDPC Selection**

- Rand– Disable the randomizer (None) or select IRIG (Normal) for non-LDPC operation, as shown in Figure 39. The CCSDS Std option, shown in Figure 40, is only available when LDPC is enabled. Selecting a randomizer ensures the pattern never has too many ones or zeroes in a row. The randomizer is not available when using external clock and data sources.



**Figure 39: Receiver Analyzer Controls Screen, Modulator, Non-LDPC Enabled Rand Selection**



**Figure 40: Receiver Analyzer Controls Screen, Modulator, LDPC Rand Selection**

- PCM – Select the PCM Encoding value from the drop down menu, shown in Figure 41; default setting is NRZL

Possible settings include:

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

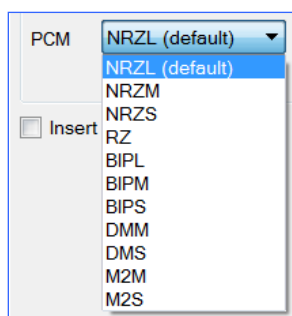


Figure 41: Receiver Analyzer Controls Screen, Modulator, PCM Selection

- Spectrum Inv check box - When checked, the spectrum is inverted (mirror image)
- Conv Enc check box – When checked, convolutional encoding is enabled
- Diff Enc check box – When checked, differential encoding is enabled

The Receiver Analyzer can emulate basic PCM encoder frame formatting as described in IRIG 106 Chapter 4. This capability is useful for system level testing such as verifying decomm lock.

- Insert PCM Framing check box – When checked, enables PCM framing per the parameters described in the PCM Frame Setup Window (section 5.3.2.4.1). If unchecked, the data is transmitted with no PCM frame-level formatting.
- PCM Framing Setup button – Accesses PCM Frame Setup window for configuration of PCM format

#### 5.3.2.4.1 PCM Frame Setup Window

This window, shown in Figure 42, displays when the PCM Framing Setup button is activated.

The screenshot shows the 'PCM\_Frame\_Setup' window with two main sections: 'Channel 1 PCM Framing' and 'Channel 2 PCM Framing'. Each section contains the following controls:

- Minor Frame Sync Word:** A dropdown menu set to 'IRIG'.
- Bits:** A text box set to '16'.
- User Sync Word (bin or hex):** A checkbox labeled 'Hex Pattern' is unchecked. Below it is a text box containing '1110101110010000' for Channel 1 and '0000000000000000' for Channel 2.
- Minor Frame Length:** A text box set to '4096'.
- Bits (incl hdr):** A text box set to '16'.
- Major Frame Length:** A text box set to '256'.
- Minor Frames:** A text box set to '16'.
- Insert Subframe ID:** A checked checkbox.
- Subframe ID Word Length:** A text box set to '16'.
- Subframe ID Word Position:** A text box set to '0'.
- PCM Rate Control:** Two radio buttons: 'Increase OTA rate' (unchecked) and 'Decrease User rate' (checked).

A 'Close' button is located at the bottom center of the window.

Figure 42: PCM Frame Setup Window

The Channel 1 PCM Framing window includes the following selections.

- **Minor Frame Sync Word** – This dropdown menu enables selection of the IRIG recommended pattern of length, 16 to 33, or any arbitrary user-specified sync word in binary or hexadecimal format.
- **Bits** – The number of bits in the user pattern; display changes automatically; If Minor Frame Sync Word is IRIG, the user can specify a value from 16 to 33
- **User Sync Word (binary or hex)** – A unique pattern specified by the person running the test; Only available when Pattern is “User”

If Pattern is “IRIG” the value displays (greyed out) but is not editable.

- **Hex Pattern check box** – When checked, the user pattern is displayed as a hexadecimal value; Only available when Pattern is “User”
- **Minor Frame Length** – Used to enter the length of the minor frame (including sync word and subframe ID word, if enabled), up to 16384 bits
- **Major Frame Length** – Used to enter the number of minor frames in a major frame, up to 256. This parameter only affects the count range of the subframe ID, if enabled.
- **Insert Subframe ID check box** – When checked, enables subframe ID insertion

If enabled, an additional word is added to each minor frame that increments each minor frame, from 1 up to the major frame length. Presently, the subframe ID word is always the same length as the minor frame sync word, and it appears in the word immediately following the minor frame sync word.

- **Subframe ID Word Length** – Display only field which changes based on Bits specified
- **Subframe ID Word Position** – Display only field; currently fixed at zero

- PCM Frame Rate Control – Enables user control of the over-the-air (OTA) data rate; This parameter is ignored (and greyed out) if external clock and data are being used.
- Increase OTA Rate – When selected, this parameter allows the OTA rate to increase when PCM Framing is enabled; PCM Framing is enabled by checking the box next to Insert PCM Framing on the Modulator window.
- Decrease User Rate – When selected, the user rate is decreased to maintain the current over-the-air rate (OTA)
- Close button – Closes the PCM Frame Setup window.

Settings are saved as long as the application is open. To save for future use, go to the Setup screen and click on the Save Config button (refer to section 5.3.3.6). If the setting is not intentionally saved, the PCM Frame values reset to the defaults when the application is reopened.

### 5.3.2.5 Data Gen

The Data Gen section, shown in Figure 43, includes Clock and Data Setup and Error Generator.

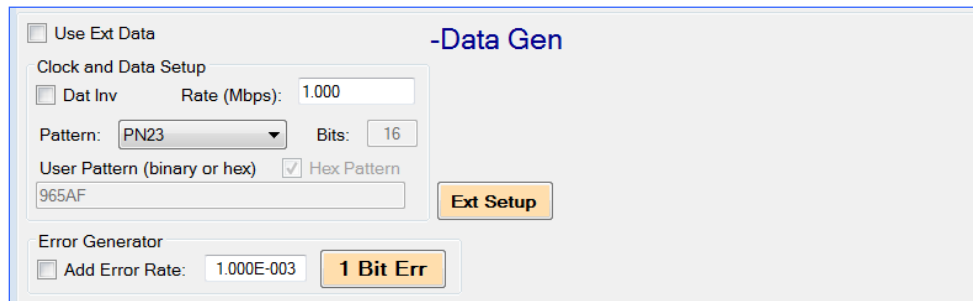


Figure 43: Receiver Analyzer Controls Screen, Data Gen Section Open

#### 5.3.2.5.1 Clock and Data Setup

The Clock and Data Setup window allows the user to change data patterns or data rate, to invert data, and to switch between internal and external clock and data. The Clock and Data Setup window is shown in Figure 44.

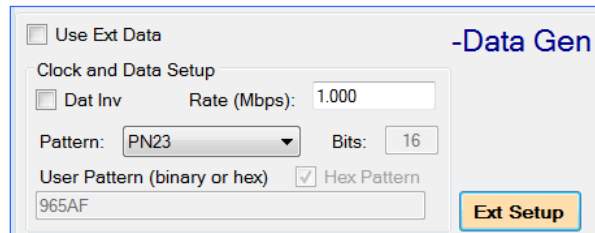


Figure 44: Clock and Data Setup

- Use Ext Data check box – When checked, the receiver analyzer looks for an external clock and data source; the Data Invert option (in the Modulator window) is greyed out since it only applies to internal clock and data

When running in Independent mode, each channel may use different clock and data sources (one channel may use internal data, and the other may use external data).

- Data Inv check box – When checked, the data stream is inverted; not available when using external clock and data sources; useful when the data stream starts out inverted, in effect, un-inverts the data
- Rate (Mbps) – Data rate in Mbps – If internal clock and data are used, typing a number in this field sets the data rate; if external clock/data are used, then the value typed here must match the external clock rate for tests to work correctly
- Pattern – Sets the data pattern used by the receiver analyzer; This is 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)
  - Mark (all 1s) - A pattern of all ones (1111)
  - Space (all 0s) - A pattern of all zeroes (0000)
  - Alt01 - A pattern alternating zeroes and ones (0101)
  - 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
    - User Pattern (binary or hex) – A unique pattern specified by the person running the test; Only available when Pattern is “User”
    - Hex Pattern check box – When checked, the user pattern is displayed as a hexadecimal value; Only available when Pattern is “User”
- Bits – the number of bits in the user pattern; Only available when Pattern is “User”
- External Setup button – Displays the External Clock/Data Setup window, shown in Figure 45, which enables clock and data setup for external data

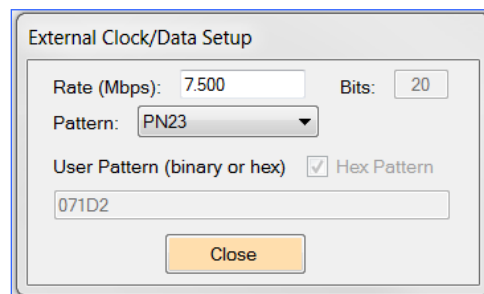


Figure 45: External Clock/Data Setup Window

### 5.3.2.5.2 Error Generator

The Error Generator window, shown in Figure 46, allows the user to add one known bit error rate to a test stream.

- Add Error Rate check box - When checked, adds the error rate typed in the Add Error Rate field.
- Add Error Rate field - A text field in which the user may type a bit error rate
- 1 Bit Err button - Click on this button to add a single bit error to the test stream

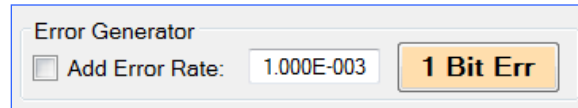


Figure 46: Error Generator

### 5.3.2.6 BERT

The BERT section, shown in Figure 47, is used for BER Test Control.

The Auto Set BERTs check box updates the Advanced BERT parameters with the data generator information automatically whenever a change is made in the Data Gen window. If Independent mode is enabled, all of the information is updated *except* Channel 2 I and Q—those parameters are updated by the user independently.

When the Auto Set BERT check box is checked, the BERT Advanced Setup button is disabled (greyed out).

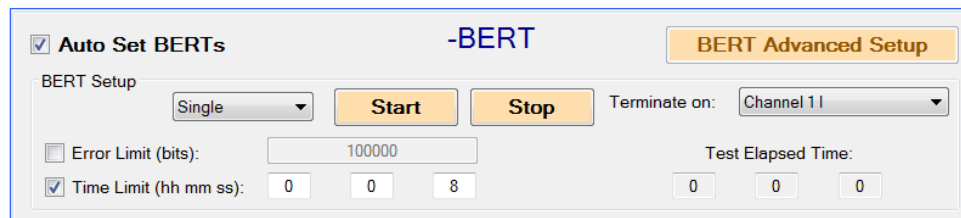


Figure 47: Receiver Analyzer Controls Screen, BERT Section Open

#### 5.3.2.6.1 BERT Setup

The BERT Setup window is used to set up parameters for a bit error rate (BER) test. The user controlled parameters include Terminate on, Error Limit, Time Limit, and run type. In addition, Start and Stop buttons are provided. The window also displays Test Elapsed Time. The BER Test Control window is shown in Figure 48.



Figure 48: BERT Setup

- BERT Mode
  - Free Run – Continuously runs the BER test
  - Single – Runs the BER test one time based on the programmed time or error limit
  - Repeat – Runs the BER test until it reaches the programmed time or error limit, then repeats the test; When running in Repeat mode, the receiver status is continually updated during the test except for the Error Rate which is only updated at the end of each test
- Start button – Starts (or Restarts) the Bit Error Rate (BER) test
- Stop button – Stops the BER test
- Terminate on: A drop down menu of enabled channels (bit error rate testers), first to finish, and last to finish which determines the reference channel to be used in conjunction with the Error Limit and Bits fields to stop a BER test; For example, if Error Limit is checked and Channel 1 I is selected, all tests will terminate when Channel 1 I reaches the error limit specified in the Bits field
  - Channel 1 I – Stops the test when Channel 1 I reaches the specified number of bits in the Error Limit or reaches the specified Time Limit
  - Channel 2 I – Stops the test when Channel 2 I reaches the specified number of bits in the Error Limit or reaches the specified Time Limit
  - Combiner I – Stops the test when Combiner I reaches the specified number of bits in the Error Limit or reaches the specified Time Limit
  - First to Finish – Stops the test when the first enabled channel reaches the specified number of bits in the Error Limit
  - Last to Finish – Stops the test when the last enabled reaches the specified number of bits in the Error Limit
- Error Limit (Bits) – Sets a specific number of bit errors; the test terminates if it reaches the error limit on the selected “Terminate on” parameter
- Time Limit (Hours, Minutes, Seconds) – Sets a specific time limit for the BER test; the test terminates when it reaches the time limit
- Test Elapsed Time (Hours, Minutes, Seconds) – Current test elapsed time in seconds

#### 5.3.2.6.2 BERT Advanced Setup

The BERT Setup screen, shown in Figure 49, enables configuration of eight independent BERTs: Channel 1 I, Combiner I, Channel 2 I, Best Source Selector (BSS) I, Channel 1 Q, Combiner Q, Channel 2 Q, and Best Source Selector (BSS) Q.

The Automatic button switches back to Auto Set BERTs and closes the BERT Setup window. The Close button closes the Bert Setup window.

The screenshot shows the 'Bert Setup' window with eight configuration panels arranged in a 2x4 grid. Each panel is for a specific BERT (Bert 1 through Bert 8). The parameters for each BERT are: Pattern (PN23), Bits (16), Hex Pattern (checked), User Pattern (965AF), and Source (Chan 1 DG). At the bottom of the window are two buttons: 'Auto Set BERTs' and 'Close'.

Figure 49: Bert Setup Window

The following parameters may be set for each BERT. All changes take effect immediately after they are entered. Changes and the state of all parameters are also saved in the Saved Configuration file.

- Pattern – Sets the data pattern used by the receiver analyzer; This is 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)
  - Mark (all 1s) - A pattern of all ones (1111)
  - Space (all 0s) - A pattern of all zeroes (0000)
  - Alt01 - A pattern alternating zeroes and ones (0101)
  - 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
- Bits – the number of bits in the user pattern
- User Pattern (binary or hex) – A unique pattern specified by the person running the test
  - Hex Pattern check box – When checked, the user pattern is displayed as a hexadecimal value
- Source – Provides a menu of possible data sources for BERTs, shown in Figure 50
  - Chan 1 DG – Channel 1 Data Generator; This is source data specified by parameter settings in the Data Gen, Channel 1 settings
  - Chan 2 DG - Channel 2 Data Generator; This is source data specified by parameter settings in the Data Gen, Channel 2 settings
  - External – Not currently available
  - Other – Any other data source or user pattern provided by the user



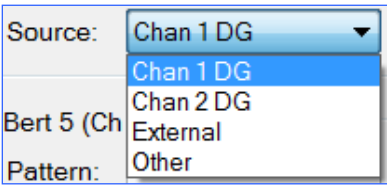


Figure 50: Bert Setup Window, Source Selections

5.3.2.7 System

The System section includes Set Channels to Error Rate and Reset BERT on Change.

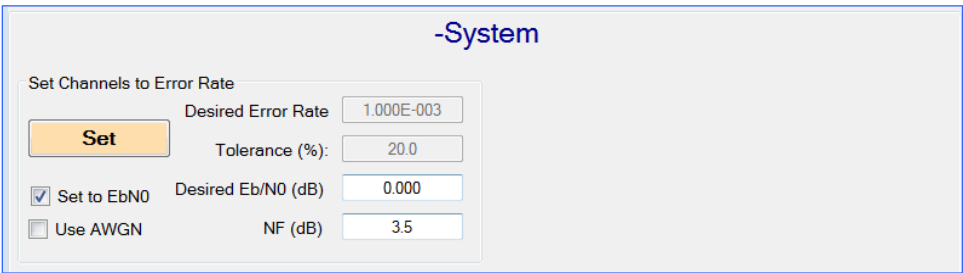


Figure 51: Receiver Analyzer Controls Screen, System Section Open

5.3.2.7.1 Set Channels to Error Rate

The Set Channels to Error Rate window, shown in Figure 52, sets the RF output such that a specified Eb/N0 is detected by the receiver. This can be done in two ways: by lowering the RF level until the desired Eb/N0 is achieved, or by using a fixed RF level. AWGN (Additive White Gaussian Noise) may be added to the RF output to achieve the same Eb/N0.

After selecting or typing the desired values, click on the Set button to run the test with these values. The Set button changes to AWGN On or AWGN Off, as shown in Figure 53, when the Use AWGN option is checked.

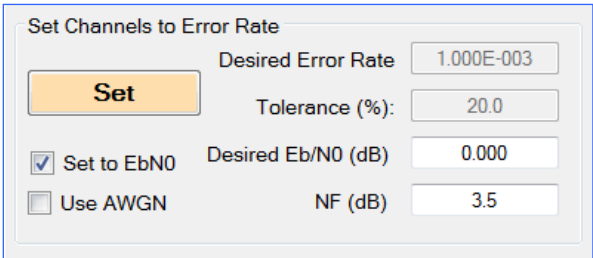


Figure 52: Set Channels to Error Rate, No AWGN Used

Check boxes

- Set to Eb/N0 - When checked, uses the value in the Desired Eb/N0 (dB) field when running a test.
- Use AWGN - When checked, uses the current RF level with AWGN added to achieve the desired Eb/N0

#### Buttons

- Set – Used to set the Eb/N0 level
- AWGN Off - When this button is green, Additive White Gaussian Noise is being added to the signal. Click on the Awgn Off button to stop adding noise to the output. Refer to Figure 53.



Figure 53: Set Channels to Error Rate, AWGN On/AWGN Off

Desired Error Rate – Directly set the preferred error rate; Not available when EbN0 is used

Tolerance (%) – Set the error tolerance percentage; Not available when EbN0 is used

Desired Eb/N0 (dB) – Energy per Bit divided by Noise value typed by the user; used in conjunction with Set to Eb/N0 check box

NF (dB) - Noise Figure value typed by the user; used to determine the desired RF level (or AWGN level) based on the desired Eb/N0

5.3.3 User Interface Test Tabs

The Receiver Analyzer User Interface right hand window consists of a variety of test options accessed via individual tabs at the top of the screen, as shown in Figure 54.

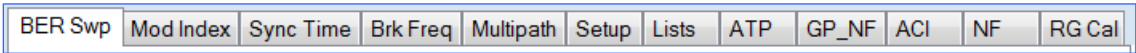


Figure 54: User Interface Test Tabs

The options consist of: BER Sweep Test, Modulation Index Test, Sync Time Test, Break Frequency Test, Multipath Test, Setup, Lists, ATP, General Purpose Noise Figure Test, Noise Figure Test, Receiver RG Calibration, and Adjacent Channel Interference Test. Other tests may be added in future versions.

### 5.3.3.1 Bit Error Rate (BER) Sweep Test

The Bit Error Rate (BER) Sweep Test, shown in Figure 55, is used to test the sensitivity of the receiver under test.

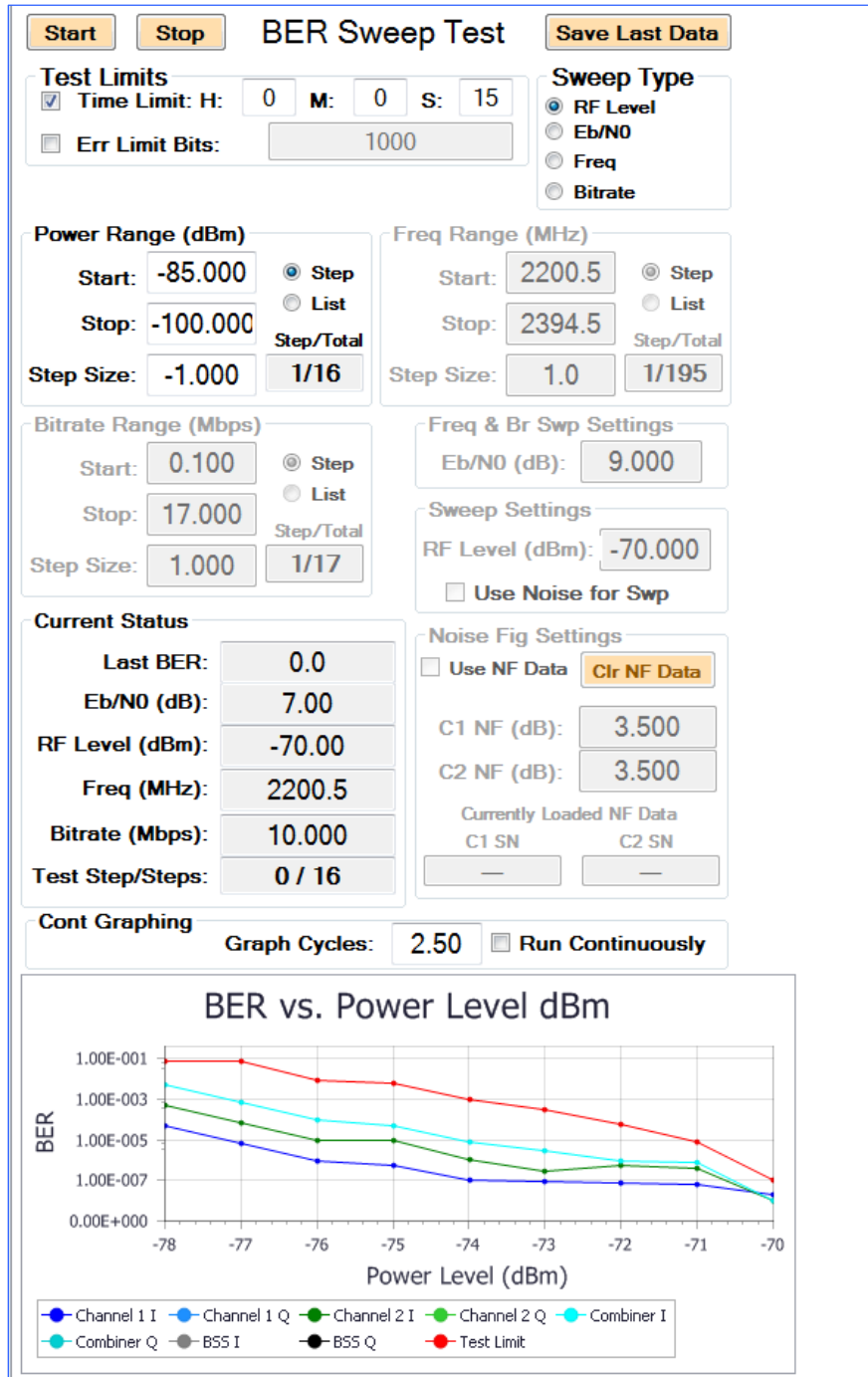


Figure 55: Bit Error Rate (BER) Sweep Test

There are four types of Sweep available from the BER Test screen. They are:

- Power Sweep - The RA transmits certain power levels, as determined by a Step/List setting, and records the bit error rates
- Frequency Sweep - The RA transmits a signal at a power level determined by the desired Eb/N0 and given noise figure across various frequencies, determined by a Step/List setting, and records the bit error rate levels. The default Eb/N0 is selected to give  $10^{-5}$  (theoretical) error rate for the current mode but may be changed by the user.
- Bitrate Sweep - The RA transmits a signal at a power level determined by the desired Eb/N0 and given noise figure across various bit rates, determined by a Step/List setting, and records the bit error rate levels. The default Eb/N0 is selected to give  $10^{-5}$  (theoretical) error rate for the current mode but may be changed by the user.
- Eb/N0 Sweep - This sweep combines the Eb/N0, Frequency, and Bitrate sweeps to generate one large test data file.

#### 5.3.3.1.1 Buttons

The BER Sweep Test screen contains three buttons: Start, Stop, and Save Last Data, as shown in Figure 56.

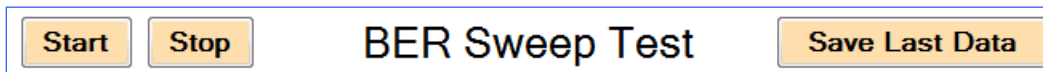


Figure 56: Bit Error Rate (BER) Sweep Test Screen Buttons

- Start – The Start button is used to start a new BER sweep test. This button always causes the test to start over at the beginning.
  - Pause - After clicking on the Start button, it changes to a green Pause button. This indicates the test is running and may be paused by clicking on this button.
  - Cont. - When a test is paused, the button changes to a yellow Cont. button. This indicates that the test is in a paused state and is waiting for the user to take action. The test is continued by clicking on the Cont. button. When the test is continued, the button changes back to a green Pause button.
- Stop – The Stop button immediately terminates a test.
- Save Last Data – The Save Last Data button saves the current BER test information. A Save File message displays, as shown in Figure 57. Click on YES to save the file. Files are always saved to the data path set on the Setup screen. The file name, shown in Figure 58, is determined based on the test type, current settings, and the current date and time. It is slightly different for every test type.

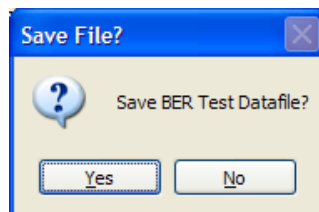


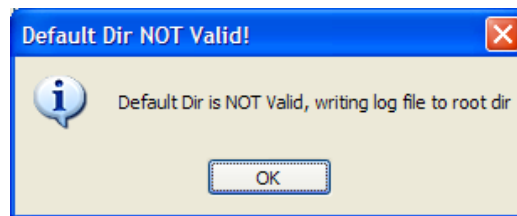
Figure 57: Save File Message

C:\BER\_PWR\_SWP\_SN-0\_0\_0\_FR2200.5\_BR1.000\_20150716154937.csv

Test Type	Serial Number	Freq.	Bit Rate	Date yyyy-mm-dd	Time hr-mm-ss
-----------	---------------	-------	----------	--------------------	------------------

**Figure 58: Example of Saved BER File Name Format**

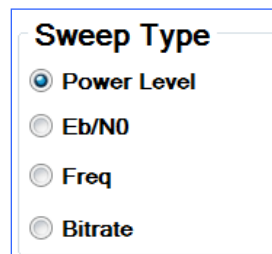
If a default location was not specified (in the Setup screen), the file is saved in the root directory (C:/). An invalid default message displays as shown in Figure 59.



### Figure 59: Default Directory Not Valid Message

#### 5.3.3.1.2 Sweep Type

The Sweep Type window, shown in Figure 60, is used to



**Figure 60: BER Sweep Test, Sweep Type**

- Power Level – When this option is selected, RF power level is used as the basis for the sweep
- Eb/N0– When this option is selected, Eb/N0 is used as the basis for the sweep
- Freq - When this option is selected, frequency is used as the basis for the sweep
- Bitrate - When this option is selected, bit rate is used as the basis for the sweep

### 5.3.3.1.3 Test Limits

The Test Limits window, shown in Figure 61, is used to set up time and/or bit rate limits for a particular BER test. One or both of the check boxes may be checked. Fields are greyed out when a box is not checked. The values in these fields override any Error Limit or Time Limit values that may be set in the standard BER Test Control window.

Figure 61: BER Sweep Test, Test Limits

- Time Limit – When this box is checked, the test is set to run for the length of time specified in the hours, minutes, and seconds boxes.
- Error Limit Bits – When this box is checked, the test runs up to the number of bits specified. Type the number of bits to test.

If both Test Limits boxes are checked, the test will run until either the test time elapses or the number of errors specified are detected, whichever comes first.

### 5.3.3.1.4 Test Ranges

The Range window changes slightly depending on the value selected in the Sweep Type window, as shown in Figure 62.

- Power Range - Selects transmitter starting and ending levels, in dBm, and the step size in dBm; the user may also select List, in which case the values in the appropriate list (on the Lists screen) are used instead
- Eb/N0 Range - Selects the start and stop Eb/N0, in dB, and the step size in dB; the user may also select List, in which case the values in the appropriate list (on the Lists screen) are used instead
- Freq Range - Selects the transmitter start, stop, and step frequencies, in MHz; the user may also select List, in which case the values in the appropriate list (on the Lists screen) are used instead
- Bitrate Range - Selects the start, stop, and step bit rates, in Mbps; the user may also select List, in which case the values in the appropriate list (on the Lists screen) are used instead
- Step/Total - Shows the current step in the sweep test along with the total number of steps in the test

Power Range (dBm)

Start: -70.000

Stop: -85.000

Step Size: -1.000

☐ Step

☒ List

Step/Total

1/5

Eb/N0 Range (dB)

Start: 11.200

Stop: 2.000

Step Size: -1.000

☒ Step

☐ List

Step/Total

1/10

Bitrate Range (Mbps)

Start: 0.100

Stop: 17.000

Step Size: 1.000

☒ Step

☐ List

Step/Total

1/17

Freq Range (MHz)

Start: 2200.5

Stop: 2394.5

Step Size: 10.0

☒ Step

☐ List

Step/Total

1/20

Figure 62: BER Sweep Test, Ranges

Pwr dBm	Pwr Eb/N0	Freq MHz	Br PCM	Br non-PCM	Mod Index
-60.000	0.000	200.0	0.040	0.100	0.350
-70.000	1.000	250.0	0.150	0.150	0.500
-90.000	2.000	270.0	0.350	0.350	0.600
-105.000	3.000	270.5	0.750	0.750	0.700
-110.000	4.000	300.0	1.000	1.250	0.800
	5.000	350.0	1.400	2.000	0.900
	6.000	400.0	2.000	3.000	1.000
	7.000	450.0	3.000	4.000	1.500
	8.000	500.0	3.500	5.000	2.000
	9.000	500.5	5.900	5.900	3.000
	10.000	550.0	8.000	10.000	3.500
	11.000	600.0	10.000	15.000	
	12.000	639.5	15.000	17.000	
		640.0	17.000	25.000	
		650.0			
		700.0			

Figure 63: Sample List Table

5.3.3.1.5 Current Status

The Current Status window, shown in Figure 64, displays the current test status while the test is running. Eb/N0 does not display during a Power Level test since that value would be irrelevant.



Current Status	
Last BER:	0.0
Eb/N0 (dB):	7.00
RF Level (dBm):	-70.00
Freq (MHz):	2200.5
Bitrate (Mbps):	10.000
Test Step/Steps:	0 / 10

Figure 64: BER Sweep Test, Current Status

The Current Status window displays the following information for Channel 1.

- Last BER – The last Bit Error Rate for a test step
- Eb/N0 (dB) – The Eb/N0 setting (in decibels) for the current test step
- RF Level (dBm) – This is the exact power level being applied based on calculation of settings in use
- Freq (MHz) - The frequency, in megahertz, for the current test step
- Bitrate (Mbps) - The bit rate (in megabits per second) for the current test step
- Test Step/Steps - The test step that is running and the total number of steps in the test

#### 5.3.3.1.6 Sweep Settings

When Eb/N0, frequency, or bitrate is selected in the Sweep Type window, the Sweep Settings window, shown in Figure 65, is enabled. It displays the RF level, in dBm, and provides the option of using additive white Gaussian noise during the sweep.

When Use Noise for Swp is checked, the software calculates the appropriate amount of noise to use to achieve the desired Eb/N0 (typed in the Freq & Br Swp Settings window) based on the power value typed in the RF Level (dBm) field in the Sweep Settings window.

Sweep Settings	
RF Level (dBm):	-70.000
<input type="checkbox"/> Use Noise for Swp	

Figure 65: BER Sweep Test, Sweep Settings

When Freq or Bitrate is selected in the Sweep Type window, the Freq & Br Swp Settings window, shown in Figure 66, is enabled.

Figure 66 shows a dialog box titled "Freq & Br Swp Settings". Inside the dialog, there is a label "Eb/N0 (dB):" followed by a text input field containing the value "9.000".

Figure 66: BER Sweep Test, Frequency and Bitrate Sweep Settings

### 5.3.3.1.7 Noise Figure Settings

The Noise Fig Settings window is shown in Figure 67. This functionality is only available for use with Quasonix receivers.

- Use NF File check box - When checked, the user is prompted to load a noise figure file for the current serial number receiver(s) if they are not already loaded, as indicated by the Currently Loaded NF Data fields in Figure 67. With valid noise figure data loaded, the accuracy of the tests is improved over frequency versus just using the normal fixed noise figure entered in the C1 and C2 NF fields.
- Clr NF File button - Clears currently loaded noise figure data and resets the C1 SN and C2 SN fields to blank ( -- ); It is important to delete unwanted files so they do not reappear during reinitialization of the receiver analyzer (settings are retained in the saved configuration)
- C1 NF (dB) - Channel 1 noise figure setting, in decibels; recalculated whenever the frequency changes
- C2 NF (dB) - Channel 2 noise figure setting, in decibels; recalculated whenever the frequency changes

Figure 67 shows a dialog box titled "Noise Fig Settings". It contains a checkbox labeled "Use NF Data" which is currently unchecked. To the right of the checkbox is a button labeled "Clr NF Data". Below the checkbox are two text input fields: "C1 NF (dB):" with the value "3.500" and "C2 NF (dB):" with the value "3.500". At the bottom, there is a section titled "Currently Loaded NF Data" with two sub-fields: "C1 SN" and "C2 SN", both of which contain the text "--".

Figure 67: BER Sweep Test, Noise Figure Settings

### 5.3.3.1.8 Continuous Graphing

The Continuous Graphing window, shown in Figure 68, is enabled when the BER Test Power Level Sweep is selected. This option is greyed out (disabled) for all other sweep tests.

Figure 68 shows a dialog box titled "Cont Graphing". It contains a label "Graph Cycles:" followed by a text input field containing the value "2.50". To the right of the input field is a checkbox labeled "Run Continuously", which is currently disabled (greyed out).

Figure 68: BER Sweep Test, Continuous Graphing

- Graph Cycles – The user may type the number of cycles of data to leave on the display as it moves across the screen when in Run Continuous mode; oldest points are on the left, new points are added on the right; when the number of complete graph cycles is exceeded, oldest points are dropped off of the left side
- Run Continuously check box – When checked, the Power Range test runs continuously and points are continuously added to the right side of the graph

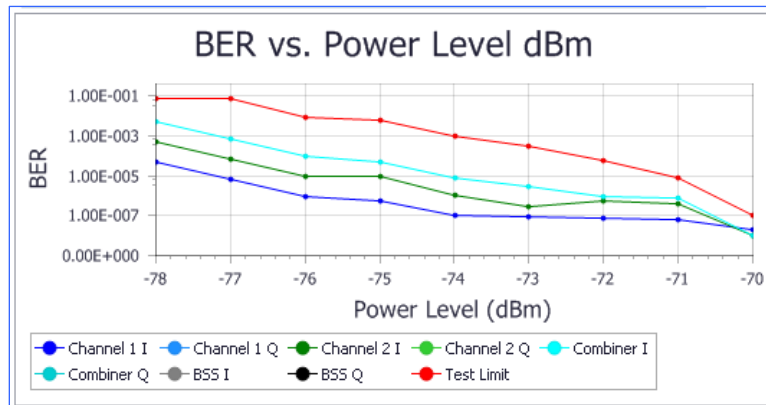


Figure 69: BER Sweep Test, Example Graph

### 5.3.3.2 Modulation Index Test

A PCM/FM receiver typically operates at a modulation index of 0.7 and may adapt (track) any changes in the input modulation. The Modulation Index Test generates RF outputs for the receiver using varying modulation indices and dwell times at a given power level and frequency to determine the ability of the receiver to lock onto/track a range of indices.

The Modulation Index Test screen is shown in Figure 70.

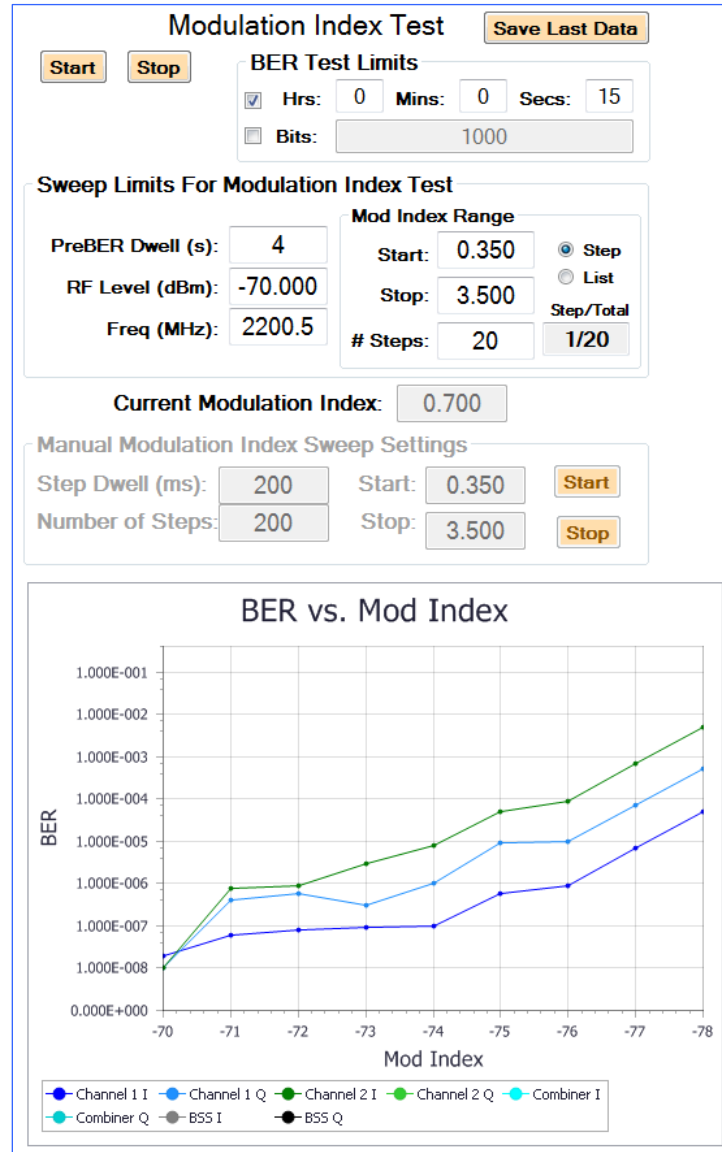


Figure 70: Modulation Index Test

#### 5.3.3.2.1 Modulation Index Test Buttons

The Modulation Index Test screen contains three buttons: Start, Stop, and Save Last Data, as shown in Figure 71.

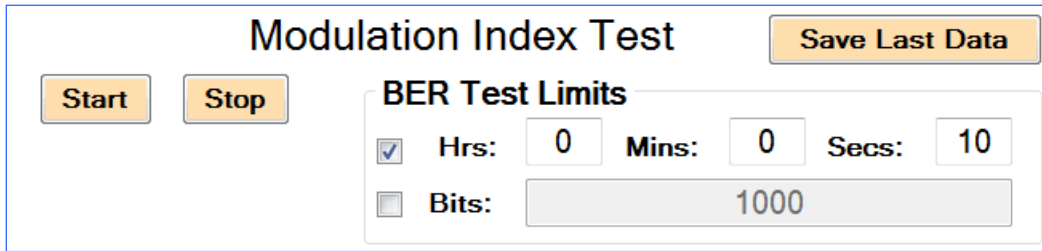


Figure 71: Modulation Index Test Screen Buttons

- Start – The Start button is used to start a new modulation index test.
- Stop – The Stop button immediately terminates a test.
- Save Last Data – The Save Last Data button saves the current modulation index test information. A Save File message displays, as shown in Figure 72. Click on Yes to save the file. Files are always saved to the data path set on the Setup screen. The file name, shown in Figure 73, is determined based on the test type, current settings, and the current date and time. It is slightly different for every test type.

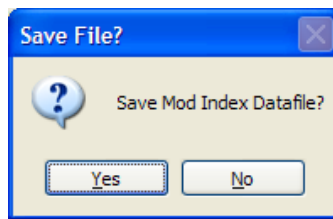


Figure 72: Save File Message

C:\MIT\_SN-3333\_4444\_5555\_PWR-50.000\_FR2200.5\_BR0.100\_20150327142819.csv

Test Type	Serial Number	Power Level	Freq.	Bit Rate	Date yyyy- mm-dd	Time hr-mm- ss
--------------	------------------	----------------	-------	-------------	------------------------	----------------------

Figure 73: Example of Saved Modulation Index Test File Format

If a default location was not specified (using the Setup screen), the file is saved in the root directory (C:/). An invalid default message displays as shown in Figure 74.

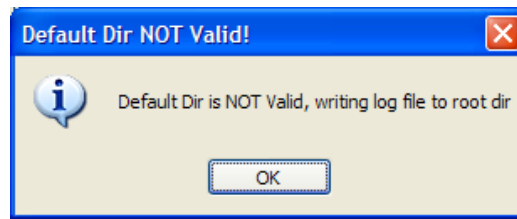


Figure 74: Default Directory Not Valid Message

### 5.3.3.2.2 BER Test Limits

The BER Test Limits window, shown in Figure 75, is used to set time and/or bit rate limits for a particular BER test. One or both of the check boxes may be checked. Fields are greyed out when a box is not checked.

Figure 75: Modulation Index Test, BER Test Limits

- Time – When this box is checked, the test is set to run for the length of time specified in the hours, minutes, and seconds boxes.
- Bits – When this box is checked, the test runs up to the number of error bits specified.

If both Test Limits boxes are checked, the test will until either the test time elapses or the number of errors specified are detected, whichever comes first.

### 5.3.3.2.3 Sweep Limits for Modulation Index Test

The Sweep Limits for Modulation Index Test window, shown in Figure 76, allows the user to select specific limits for the test.

Figure 76: Sweep Limits for Modulation Index Test

- PreBER Dwell (s) – Time, in seconds, during which the receiver analyzer waits, before the BER, while the systems power up and achieve a ready state; Valid range is 3 seconds minimum to 20 seconds maximum
- RF Level (dBm) - The power level being applied; Valid range is -20.000 to -119.000
- Freq (MHz) - The frequency, in megahertz, for the test
- (Mod Index Range) Start – Type the desired starting modulation index (minimum value is 0.350, maximum value is 7.0)
- (Mod Index Range) Stop – Type the desired ending modulation index (minimum value is 0.0350, maximum value is 7.000)
- Number of Steps – Number of steps in the test; this is a user selected number; In the special case of the Mod Index sweep, the test starts at the start value and determines "# steps" exponential steps to the stop index. These are the values that are used. If the user selects List instead of Step, the list of values in the mod index list on the List screen is used instead.
- Step/Total - Shows the current step in the sweep test along with the total number of steps in the test

RF Level dBm	Eb/N0	Freq MHz	Br PCM	Br non-PCM	Mod Index
-85.000	0.000	200.0	0.040	0.100	0.4
-90.000	1.000	250.0	0.150	0.150	0.5
-91.000	2.000	270.0	0.350	0.350	0.6
-92.000	3.000	270.5	0.750	0.750	0.7
-93.000	4.000	300.0	1.000	1.250	0.8
-94.000	5.000	350.0	1.400	2.000	0.9
-95.000	6.000	400.0	2.000	3.000	1.0
-96.000	7.000	450.0	3.000	4.000	1.5
-97.000	8.000	500.0	3.500	5.000	2.0
-98.000	9.000	500.5	5.900	5.900	3.0
-99.000	10.000	550.0	8.000	10.000	3.5
-100.000	11.000	600.0	10.000	15.000	
-101.000	12.000	639.5	15.000	17.000	
-102.000		640.0	17.000	25.000	
-103.000		650.0			
-104.000		700.0			

Figure 77: Sample List Table

#### 5.3.3.2.4 Current Modulation Index

The Current Modulation Index field, shown in Figure 78, displays the current modulation index value during the test.

Current Modulation Index: 0.700

Figure 78: Current Modulation Index

### 5.3.3.2.5 Manual Modulation Index Sweep Settings (Currently Unavailable)

The Manual Modulation Index Sweep Settings window is currently greyed out and unavailable.

### 5.3.3.2.6 BER vs. Mod Index Graph

This window provides an easy to read, real-time graph of the of the selected test. The display axes change depending on the test. All of the graphing functionality is being revised and will be updated in a future version.

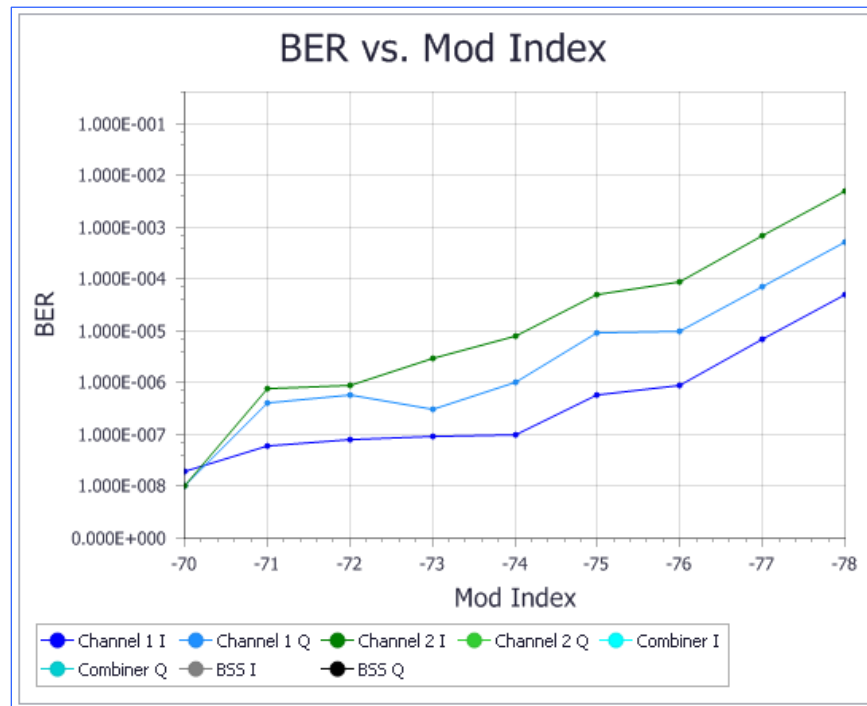


Figure 79: Modulation Index Test, BER vs. Mod Index Graph



### 5.3.3.3 Sync Time Test

The Sync Time Test indicates how quickly a receiver can acquire an incoming RF signal and achieve synchronization to the data. It measures the number of bits required to sync or amount of time, in milliseconds, required to sync.

The Sync Time Test screen is shown in Figure 80.

### Sync Time Test

**Test Type**

☒ Sync Time

☐ Sync Loss Time

**Start** **Stop** **Save Last Data**

☒ Adjust for Sync Window Delay

☐ Subtract Average latency (Most Recent)

**Freq Offset During Sync Time Test**

☐ Static Offset: (kHz)

☐ Random Offset: (kHz max)

☒ Swept Offset: (kHz max)  (rate kHz/s):

☐ No Offset: Current Freq Offset (kHz):

**Sync Time Test Configuration**

RF Off Time (s)

RF On Time (s)

Iterations:

Sync Window Size (bits):

Sync Threshold (%):

Sync Threshold (bits):

RF Level (dBm):

**Current Status**

Current Iteration:

Current Sync Time (ms):

Avg (ms):

Std Dev (ms):

Current Sync Time (bits):

Avg (bits):

Std Dev (bits):

Window Correction Bits : ms

Latency Correction Bits : ms

Figure 80: Sync Time Test

### 5.3.3.3.1 Sync Time Test Buttons, Test Type, and Check Boxes

The Sync Time Test screen contains three buttons: Start, Stop, and Save Last Data, as shown in Figure 81.

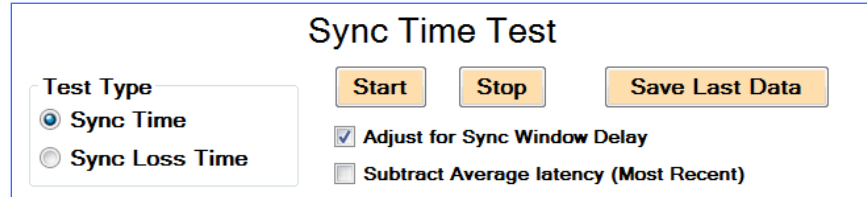


Figure 81: Sync Time Test Screen Buttons, Test Type, and Check Boxes

- Start – The Start button is used to start a new sync time test.
- Stop – The Stop button immediately terminates a test.
- Save Last Data – The Save Last Data button saves the current sync time test information. A Save File message displays, as shown in Figure 82. Click on Yes to save the file. Files are always saved to the data path set on the Setup screen. The file name, shown in Figure 83, is determined based on the test type, current settings, and the current date and time. It is slightly different for every test type.

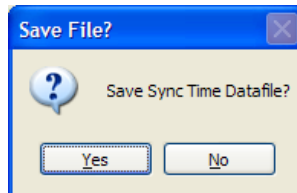


Figure 82: Save File Message

C:\STT\_-95.000\_2200\_0.0000\_20150723113100.csv

Test	Sync Time	Freq.	Bit	Date	Time
Type	Level		Rate	yyyy-	hr-mm-
				mm-dd	ss

Figure 83: Example of Saved Sync Time Test File

If a default location was not specified (using the Setup screen), the file is saved in the root directory (C:/). An invalid default message displays as shown in Figure 84.

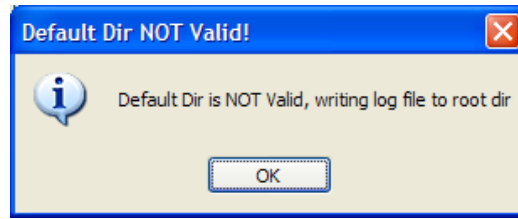


Figure 84: Default Directory Not Valid Message

There are two selections for Test Type, as shown in Figure 85.

- Sync Time – When selected, the sync time test measures how quickly after a receiver acquires incoming RF data that synchronization to the data is achieved. It measures the number of bits required to sync or amount of time, in milliseconds, required to sync.
- Sync Loss Time – When selected, the test measures the time from RF shutoff until data synchronization is lost; Because the receiver cannot possibly output good data when it has no RF input, this measurement indicates the latency through the receiver from RF in to Bits out. The resulting information displays in the Latency Correction Bits : ms field in the Current Status section of the test screen

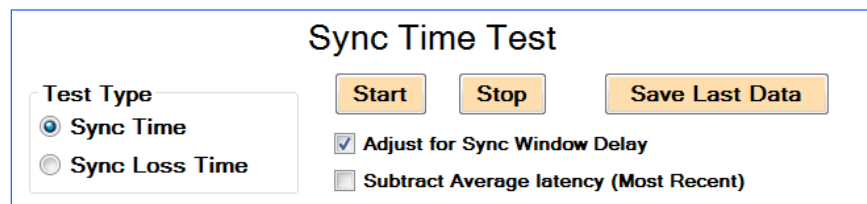


Figure 85: Sync Time Test Screen Buttons, Test Type, and Check Boxes

The Sync Time Test check boxes work in conjunction with the Test Type selection to make the test results more representative of the actual number of bits a receiver loses due to resynchronization after a signal drop out. Both boxes may be checked at the same time.

- Adjust for Sync Window Only – Corrects sync time test by removing known delay time from the measured result based on the Sync Window Size (bits) and Sync Threshold (%) configurations.
- Subtract Average latency (Most Recent) – Corrects sync time test by removing intrinsic receiver latency from the measured result

#### 5.3.3.3.2 Frequency Offset During Sync Time Test

The receiver analyzer allows static or time varying offsets to emulate the two primary scenarios in which synchronization usually occurs (flat fading or initial acquisition).

There are four offset selections, as shown in Figure 86.

**Freq Offset During Sync Time Test**

☐ Static Offset: (kHz) 10.000  
☐ Random Offset: (kHz max) 40.000  
☒ Swept Offset: (kHz max) 25.000 (rate kHz/s): 8.750  
☐ No Offset:

Current Freq Offset (kHz): 0.000

Figure 86: Sync Time Test, Freq Offset During Sync Time Test Window

- Static Offset – When selected, synchronization may be tested at a fixed frequency offset, in kHz, relative to the selected carrier frequency. This selection emulates flat fading since the offset does not change. Negative values are permitted.
- Random Offset – When selected, synchronization may be tested at a random frequency, in kHz max, each sync time measurement. This selection emulates initial acquisition since the frequency changes while RF is Off and is unknown to the receiver.
- Swept Offset – When selected, synchronization may be tested at a continuously changing frequency, in kHz max. This selection emulates initial acquisition since the frequency changes at all times, even when the RF is Off.

Swept frequency offsets also tests tracking across the full specified frequency range. The swept frequency offset varies linearly in a range from carrier minus the maximum specified offset to carrier plus the maximum specified offset, changing direction at each endpoint and then sweeping toward the other endpoint. The rate of change is constant, as specified by the user in kHz/s.

- No Offset – When selected, synchronization is tested at exactly the carrier frequency, in MHz.

The last field, Current Freq Offset is display only.

- Current Freq Offset – The currently set frequency offset is displayed in kHz.

### 5.3.3.3 Sync Time Test Configuration

The Sync Time Test Configuration window is shown in Figure 87. The Sync Loss Time Test Configuration window is shown in Figure 88.

**Test Type**

☒ Sync Time

☐ Sync Loss Time

**Sync Time Test Configuration**

RF Off Time (s)	5
RF On Time (s)	1
Iterations:	10
Sync Window Size (bits):	512
Sync Threshold (%):	62.5
Sync Threshold (bits):	320
RF Level (dBm):	-70.000

Figure 87: Sync Time Test Configuration

**Test Type**

☐ Sync Time

☒ Sync Loss Time

**Sync Loss Time Test Configuration**

RF On Time (s)	5
RF Off Time (s)	1
Iterations:	10
Sync Window Size (bits):	512
Sync Threshold (%):	62.5
Sync Threshold (bits):	320
RF Level (dBm):	-70.000

Figure 88: Sync Loss Time Test Configuration

- RF Off Time (s) – Amount of time, in seconds, to turn off the RF to force the receiver to lose lock; for sync time, must be long enough to allow loops to drift from their locked state
- RF On Time (s) – Amount of time, in seconds, to turn on the RF during the test; for sync loss, must be long enough to allow loops to lock and fully stabilize
- Iterations – Number of times to repeat the test (measure sync time with these settings)
- Sync Window Size (bits) – Number of bits (size of the window in bits) examined by the RA to determine synchronization; Parameter limits are 100 minimum, 4095 maximum, 512 default
- Sync Threshold (%) – The percent of the window size required to determine synchronization; Parameter limits are 62.5 minimum, 100.0 maximum, 62.5 default
- Sync Threshold (bits) – The number of bits required to determine synchronization
- RF Level (dBm) – Output power level in dBm to use in the test

#### 5.3.3.3.4 Current Status

The current status display fields are shown in Figure 89 and Figure 90.

**Test Type**

☒ Sync Time

☐ Sync Loss Time

<b>Current Status</b>	
Current Iteration:	0
Current Sync Time (ms):	0.000
Avg (ms):	0.000
Std Dev (ms):	0.000
Current Sync Time (bits):	0
Avg (bits):	0.0
Std Dev (bits):	0.0
Window Correction Bits : ms	128 : 0.019
Latency Correction Bits : ms	0 : 0.000

Figure 89: Sync Time Current Status

**Test Type**

☐ Sync Time

☒ Sync Loss Time

<b>Current Status</b>	
Current Iteration:	0
Current Sync Loss Time (ms):	0.000
Avg (ms):	0.000
Std Dev (ms):	0.000
Current Sync Loss Time (bits):	0
Avg (bits):	0.0
Std Dev (bits):	0.0
Window Correction Bits : ms	384 : 0.056
Latency Correction Bits : ms	0 : 0.000

Figure 90: Sync Loss Time Current Status

- Current Iteration – The currently running iteration of the test
- Current Sync Time (ms) – How much time it took from RF power On to the time, in milliseconds, until synchronization was achieved  
or Current Sync Loss Time (ms) – How much time it took from RF power Off to the time, in milliseconds, until synchronization was lost
- Avg (ms) - Average of the Sync Times in milliseconds  
or Avg (ms) – Average of the Sync Loss Times in milliseconds
- Std Dev (ms) - Standard Deviation of the Sync Time, in milliseconds  
or Std Dev (ms) - Standard Deviation of the Sync Loss Time, in milliseconds
- Current Sync Time (bits) – The number of bits received from the time the RF was powered On until synchronization was achieved  
or Current Sync Loss Time (bits) – The number of bits received from the time the RF was powered Off until synchronization was lost
- Avg (bits) - Average of the Sync Times in bits  
or Avg (bits) – Average of the Sync Loss Times in bits
- Std Dev (bits) - Standard Deviation of the Sync Time, in bits  
or Std Dev (bits) - Standard Deviation of the Sync Loss Time, in bits
- Window Correction Bits : ms – Displays the correction values used based on the size of the Sync Window and the Sync Threshold (%)

- Latency Correction Bits : ms – Displays when the Sync Time is the selected Test Type and Subtract Average Latency (Most Recent) is checked, otherwise this field is greyed out; Displays the number of bits of delay through the receiver that are not due to the synchronization process and the equivalent time it takes for this to occur (in milliseconds)

Refer to section 9, Appendix A for additional Sync Time Test setup scenarios and theory.

**5.3.3.4 Break Frequency Test**

The Break Frequency Test screen is shown in Figure 91.

Break Frequency Test

Start

Stop

Save Last Data

BER Test Limits

☒ Hrs: 0 Mins: 0 Secs: 15

☐ Bits: 1000.000

Sweep Limits For Break Frequency Test

Fade Rate Start (Hz): 10.0

Fade Rate Stop (Hz): 75000.0

PreBER Dwell (s): 1

Number of Steps: 12

RF Level (dBm): -70.000

Fade Depth (dB): 20

Break Frequency Test Status

Current Step: 0

Chan 1 I BER: 0.000

Chan 2 I BER: 0.000

Comb I BER: 0.000

Current Fade Rate (Hz): 10.0

Figure 91: Break Frequency Test

**5.3.3.4.1 Break Frequency Test Buttons**

The Break Frequency Test screen contains three buttons: Start, Stop, and Save Last Data, as shown in Figure 92.



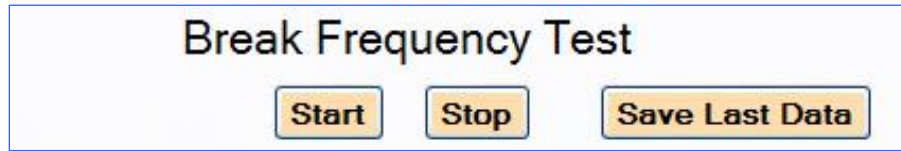


Figure 92: Break Frequency Test Screen Buttons

- Start – The Start button is used to start a new break frequency test.
- Stop – The Stop button immediately terminates a test.
- Save Last Data – The Save Last Data button saves the current sync time test information. A Save File message displays, as shown in Figure 93. Click on YES to save the file. Files are always saved to the data path set on the Setup screen. The file name, shown in Figure 94, is determined based on the test type, current settings, and the current date and time. It is slightly different for every test type.

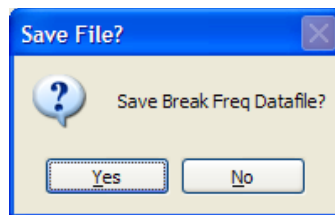


Figure 93: Save File Message

C:\BFT\_SN-0\_0\_0\_FR2200.5\_BR1.000\_20150716154937.csv

Test	Serial	Freq.	Bit	Date	Time
Type	Number		Rate	yyyy-	hr-mm-
				mm-dd	ss

Figure 94: Example of Saved Break Frequency Test File Format

If a default location was not specified (using the Setup screen), the file is saved in the root directory (C:/). An invalid default message displays as shown in Figure 95.

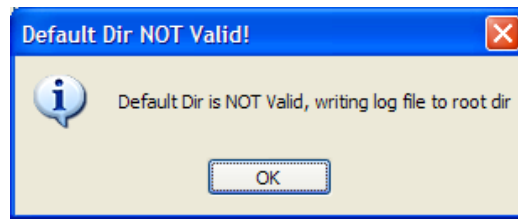


Figure 95: Default Directory Not Valid Message

#### 5.3.3.4.2 BER Test Limits

The BER Test Limits window, shown in Figure 96, is used to set time and/or bit rate limits for a particular Break Frequency test. One or both of the check boxes may be checked. Fields are greyed out when a box is not checked.

Figure 96: Break Frequency Test, BER Test Limits

- Time – When this box is checked, the test is set to run for the length of time specified in the hours, minutes, and seconds boxes.
- Bits – When this box is checked, the test runs up to the number of error bits specified.

If both Test Limits boxes are checked, the test will until either the test time elapses or the number of errors specified are detected, whichever comes first.

#### 5.3.3.4.3 Sweep Limits for Break Frequency Test

The Sweep Limits for Break Frequency Test window, shown in Figure 97.

Figure 97: Break Frequency Test, Sweep Limits

- Fade Rate Start (Hz) – Start rate at which the interfering reflections change with respect to the main signal
- Fade Rate Stop (Hz) – Stop rate at which the interfering reflections change with respect to the main signal
- PreBER Dwell (s) – Time, in seconds, during which the receiver analyzer waits, before running the BER; Valid range is 3 seconds minimum to 20 seconds maximum
- Number of Steps – Number of steps to use in the test (log scale from Start to Stop rates)
- RF Level (dBm) – This is the exact RF level being used for the test
- Fade Depth (dB) - Maximum decrease in nominal signal due to interference from reflections

#### 5.3.3.4.4 Break Frequency Test Status

The current test status values (presently for Channel 1 I, Channel 2 I, and Combiner I only) are shown in Figure 98.

Break Frequency Test Status	
Current Step:	0
Chan 1 I BER:	0.000
Chan 2 I BER:	0.000
Comb I BER:	0.000
Current Fade Rate (Hz):	10.0

Figure 98: Break Frequency Test Status

- Current Step - Step currently being executed in the break frequency test
- Channel 1 I BER - Current bit error rate for channel 1, channel I
- Channel 2 I BER - Current bit error rate for channel 2, channel I
- Combiner I BER – Current bit error rate for combiner I channel
- Current Fade Rate (Hz) – Rate at which the signal changes due to reflections

### 5.3.3.5 Multipath Setup

In wireless communication, multipath is a propagation phenomenon that results in radio signals reaching the receiving antenna by two or more paths. Causes of multipath include reflection from water bodies and terrestrial objects such as mountains and buildings. Multipath may cause constructive or destructive interference (i.e., fading).

Space Time Coding (STC) is a special case of multipath. STC modulation encodes the data stream into two separate signals that each contain a complete copy of the source data, and intentionally transmits these two copies over different paths—typically from transmit antennas located on the top and bottom of the test aircraft. The two signals—called Pilot 0 and Pilot 1—are orthogonal, so that they do not constructively or destructively interfere with each other. However, each signal is subject to reflections in the propagation path, which may cause constructive or destructive interference on that signal.

Each path taken from a transmitting antenna to a receiving antenna is generally referred to as a ray. Each ray is affected by its propagation path and may have different frequency, phase, amplitude, and time delay. To simulate the receiving antenna's signal, the Receiver Analyzer sums up to four received rays.

The Multipath Setup, shown in Figure 99, generates the desired sum of signals based on the scenario being simulated. A Multipath Setup for STC is shown in Figure 100.

**Multipath Normal Setup**

Ray	0	1	2	3	
<b>Source(s)</b>					
Modulator 0	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	PCMFM
Modulator 1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Modulator 2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Modulator 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Effect(s)</b>					<b>Step</b>
Freq (Hz)	0.000	10.000	0.000	10.000	0.100
Phase (deg)	0	90	0	-90	5
Delay (ns)	0	0	0	0	5
Rel Mag	1.000	0.800	1.000	0.800	0.100
<b>Destination(s)</b>					
CH1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
CH2	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	

Configure RA for MP

Restore Defaults

Power Correction Method  
☒ T<sub>pwr</sub> = RF Level  
☐ Mag 1 = RF Level

Total Power in each channel output at requested RF Level

Figure 99: Multipath Normal Setup, PCM/FM

**Multipath Normal Setup**

Ray	0	1	2	3	
<b>Source(s)</b>					
Modulator 0	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	(P0) STC
Modulator 1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	(P1)
Modulator 2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Modulator 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Effect(s)</b>					<b>Step</b>
Freq (Hz)	0.000	10.000	0.000	10.000	0.100
Phase (deg)	0	90	0	-90	5
Delay (ns)	0	0	0	0	5
Rel Mag	1.000	0.800	1.000	0.800	0.100
<b>Destination(s)</b>					
CH1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
CH2	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	

Configure RA for MP

Restore Defaults

Power Correction Method  
☒ T<sub>pwr</sub> = RF Level  
☐ Mag 1 = RF Level

Total Power in each channel output at requested RF Level

Figure 100: Multipath Normal Setup, STC

- Ray – A copy of the main signal that may be distorted by a time-varying phase shift (i.e., frequency), a static phase shift, a time shift, and/or an amplitude change; by convention, one ray from each source is chosen as the undistorted line-of-sight main signal

### Source(s)

- Modulator 0 through 3 – Modulated signal source(s) for one or more rays; the modulation type that is active for any Modulator is indicated in the right-hand column; for “normal” mode, Modulators 0/1 are active for STC, and only Modulator 0 is active for other modulation types; for “independent” mode, Modulators 0/1 or 2/3 are active for STC, and only Modulator 0 or Modulator 2 is active for other modulation types

### Mode(s)

- The modulator mode displays in the last column. When STC mode is enabled, P0 and P1 are always noted.

Figure 101 shows Independent mode enabled in the RF Generator window, STC selected as the Mode in Channel 1, and PCM/FM is selected in Channel 2. STC P0 and P1, and PCM/FM are shown for each Source Modulator in the multipath setup.

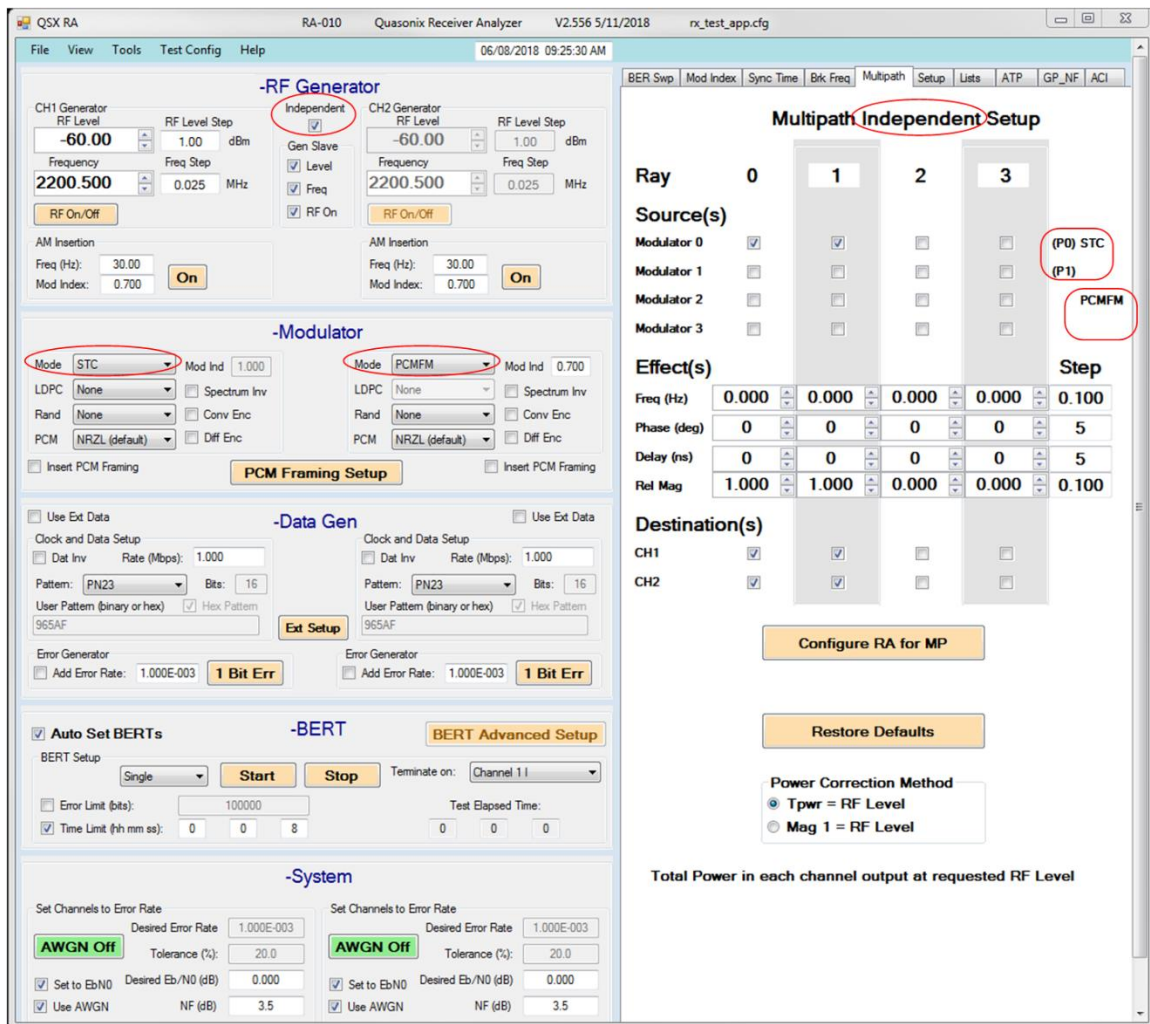


Figure 101: Multipath Independent Setup, STC P0/P1 Notations

### Effect(s)

- Freq (Hz) – Rate of phase change in Hertz; 1 Hz equals 360 degree phase shift per second; valid range is -1E6 to +1E6; may be typed directly or may use the up/down arrows to increase or decrease the frequency at a rate based on the value in the Step column; if multipath is running, these values are updated as soon as they change
- Phase (deg) – Static phase offset in degrees; valid range is -360 to +360; may be typed directly or may use the up/down arrows to increase or decrease the phase at a rate based on the value in the Step column; if multipath is running, these values are updated as soon as they change
- Delay (ns) – Delay in nanoseconds; valid range is 0 to 5000 nanoseconds; may be typed directly or may use the up/down arrows to increase or decrease the delay at a rate based on the value in the Step column; if multipath is running, these values are updated as soon as they change
- Relative Magnitude – Magnitude, with 1.000 typically being the main signal; valid range is 0 to 1.000; may be typed directly or may use the up/down arrows to increase or decrease the relative magnitude at a rate based on the value in the Step column; if multipath is running, these values are updated as soon as they change

**Note:** Magnitude specifies signal **amplitude**, *not* signal **power**. So, if a reference signal has magnitude 1.0, magnitudes of 0.707, 0.5, and 0.316 will yield powers of -3 dB, -6 dB, and -10 dB respectively relative to the reference.

- Step - Sets the step size used by Frequency, Phase, Delay, and Relative Magnitude when the up/down arrows are used to set the level

Effect(s)					Step
Freq (Hz)	0.000	0.100	-0.100	0.000	0.100
Phase (deg)	0	0	0	0	5
Delay (ns)	0	100	100	0	5
Rel Mag	1.000	0.800	0.800	0.000	0.100

Figure 102: Multipath Setup, Effect(s)

### Destination(s)

- CH1 check boxes – When checked, indicates the ray is included in the Channel 1 RF output
- CH2 check boxes – When checked, indicates the ray is included in the Channel 2 RF output

Destination(s)				
CH1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
CH2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Figure 103: Multipath Setup, Destination(s)

Two buttons:

- Configure RA for MP - Configures the receiver analyzer to match multipath settings on screen and turn multipath On; After being clicked, the button turns green to indicate that multipath is active. Also, a green text message displays at the top of the RF Generator section on the left hand side letting the user know that “Multipath is Running!!!” (Figure 106) This is in case the user saves the configuration with this active but from another screen, where on startup or load of the configuration it might not be obvious that the multipath is running. The green color helps remind the user that multipath may have an effect on tests being run, but it is not an error condition.

Use the green MP Off button, shown in Figure 105, to turn multipath Off.

- Restore Defaults – Resets multipath settings to defaults, based on mode (“normal” or “independent”) and modulation type; The default has only a single undistorted line-of-sight ray for each active Modulator source

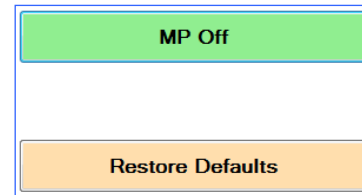
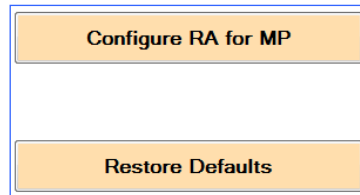


Figure 104: Multipath Buttons—Multipath Off

Figure 105: Multipath Buttons—Multipath Running

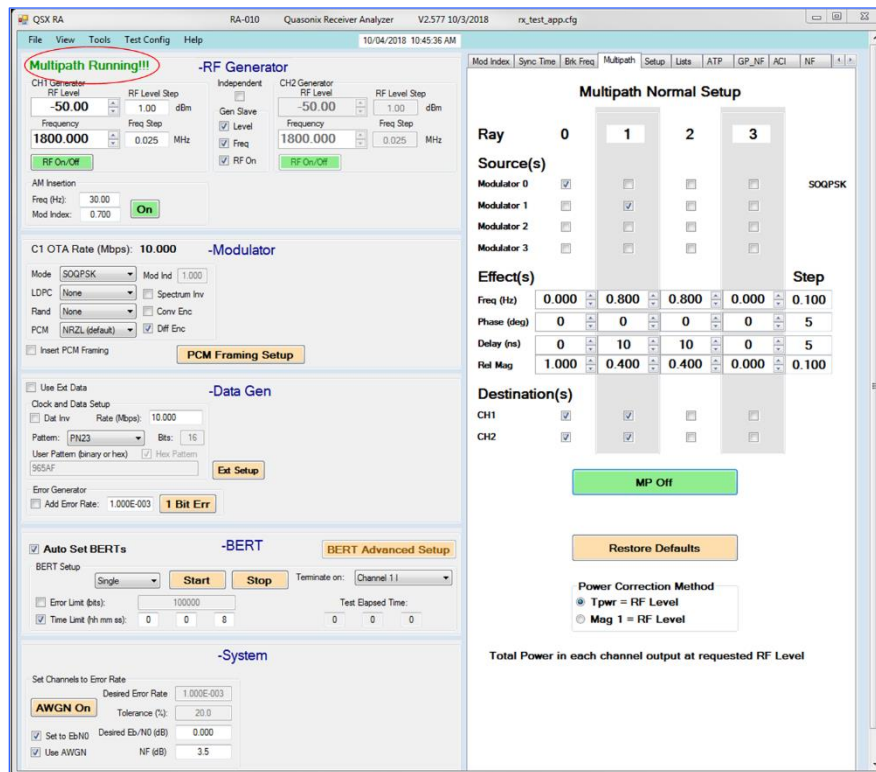


Figure 106: Multipath Running Message

Power Correction Method (Select one):

- **Tpwr = RF Level** (Total power in each channel output at the requested RF level)
- **Mag 1 = RF Level** (Any Magnitude 1.0 in the form (Rel Mag) will be output at the requested RF level)

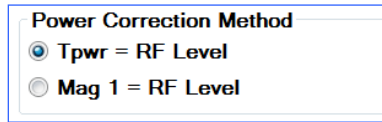


Figure 107: Multipath Setup, Power Correction Method

#### 5.3.3.5.1 Power Correction Method

The Power Correction Method affects scaling of output signals as well as scaling of additive noise (AWGN).

##### **Tpwr = RF Level**

Selecting **Tpwr = RF Level** scales the selected rays such that their sum equals the total output power in the RF Level setting. Also, AWGN is scaled relative to the calculated ray sum. This setting is most useful for STC, to achieve a desired output power regardless of Pilot 0/Pilot 1 amplitude differences, phase differences, or delay differences. Note, scaling is pre-calculated assuming the multipath signals are orthogonal, rather than measured in real-time as an external Noise and Interference Test Set (NITS) would do. If the signals are truly orthogonal (for example, STC or rays delayed by more than a symbol time), then AWGN is equivalent to adding noise using NITS. For typical multipath, however, orthogonality is unlikely.

**Examples** (STC modulation, **Tpwr = RF Level**, with RF Level set to -50 dBm):

First suppose Pilot 0 is set to relative magnitude 1.0 and Pilot 1 is set to relative magnitude 1.0. Then Pilot 0 will be output at -53 dBm and Pilot 1 will be output at -53 dBm, so the total power is  $10 \cdot \log_{10}(10^{(-53/10)} + 10^{(-53/10)}) = -50$  dBm. AWGN is scaled relative to the total output signal power of -50 dBm.

Now suppose Pilot 0 is set to relative magnitude 1.0 and Pilot 1 is set to relative magnitude 0.316 (i.e., 10 dB down from P0). Then Pilot 0 will be output at -50.414 dBm and Pilot 1 will be output at -60.414 dBm, so the total power is  $10 \cdot \log_{10}(10^{(-50.414/10)} + 10^{(-60.414/10)}) = -50$  dBm. AWGN is scaled relative to the total output signal power of -50 dBm.

##### **Mag 1 = RF Level**

Selecting **Mag 1 = RF Level** scales the selected rays such that any ray with relative magnitude 1.0 has output power equal to the RF Level setting. Also, AWGN is scaled relative to any ray with relative magnitude 1.0. This method is probably best for typical multipath, with the “direct” ray set to a relative magnitude of 1.0.

**Example** (PCM/FM modulation, **Mag 1 = RF Level**, with RF Level set to -50 dBm):

Suppose Ray 0 is set to relative magnitude 1.0 and Ray 1 (a copy of the Ray 0 signal with no delay) is set to relative magnitude 0.818. Then Ray 0 will be output at -50 dBm and Ray 1 will reinforce or cancel Ray 0, depending on their relative phases. When the rays are at 0 degrees phase offset (maximum reinforcement), the total power is  $10 \cdot \log_{10}(((1+0.818)^2) \cdot 10^{(-50/10)}) = -44.8$  dBm. When the rays are at 180 degrees phase offset (maximum cancellation), the total power is  $10 \cdot \log_{10}(((1-0.818)^2) \cdot 10^{(-50/10)}) = -64.8$  dBm. This results in 20 dB peak-to-min fade depth, 5.2 dB over and 14.8 dB under the RF Level set point. AWGN is scaled relative to the Ray 0 output signal power of -50 dBm (since Ray 0 has magnitude 1.0).



### 5.3.3.6 Setup

The Setup screen, shown in Figure 108, is used to configure a variety of receiver analyzer settings.

Current Data Path: C:\Receiver Analyzer 2\Test Data

Buttons: AutoScan, Rescan Com Ports, Load Config, Save Config, Restore Def, Init Analyzer, Disconnect Rcvrs, Init Recvr, Windows Ports.

Load CFG flags:
 

- ☐ No Window Chg
- ☐ No Macro Chg
- ☐ No Path Chg
- ☐ No Chan Chg

☐ Zero Cable Loss

Cable Loss (dB) over Frequency

Freq (MHz)	Chan 1	Chan 2
200.0	0.095	0.095
700.0	0.150	0.150
1000.0	0.170	0.170
1600.0	0.180	0.180
2000.0	0.200	0.200
4400.0	0.270	0.270
4700.0	0.280	0.280
5250.0	0.340	0.340

Max Allowed RF Level (dBm): 3.000

Current C1 Cable Loss (dB): 0.206

Current C2 Cable Loss (dB): 0.206

☐ Auto Time Stamp (Seconds): 10

☐ Alt Sync Method (%BER): 30.00

Connections:

Dev	Port	Chan	Gen	Serial #	Version
RA:	COM6			96470002	RA V1.205 5/10/2018
RAA:	---			---	---
Rx 1:	---	---	---	---	---
Rx 2:	---	---	---	---	---
Rx 3:	---	---	---	---	---

Rack Identification

RA Rack Model #: QSX-RXAN-281D-A1-1111

RA Rack Serial #: RA-010

RA Rack HW Rev: A

☐ Confirm Devices on Autoscans

☐ Audible Test Notifications

☐ Warn about RF OFF during Tests

☒ Do NOT connect to Receivers

☐ Sync Rcvrs Independently

Advanced Setup

Figure 108: Setup Screen

Key items of interest to the customer at this time:

- Current Data Path – The default file location used when saving test results
- Load Config button – Loads a saved test configuration
- Save Config button – Saves the settings from the GUI currently in use
- Restore Defaults button – Restores all settings to factory defaults
- Load CFG Flags check boxes – When checked, sets configuration flags on load to prevent certain changes to the configuration setup, such as positions of windows on a screen, from occurring:
  - a. No Window Change – Do not load window size and position data (keep them where they are currently set)
  - b. No Macro Change – Do not load macro data

- c. No Path Change – Do not load path settings
- d. No Channel Change – Do not load channel enable/disable information

- Zero Cable Loss check box - When checked, sets cable loss to zero (0); overrides standard cable loss settings so external equipment may be used without additional offsets affecting the setup (basically assumes perfect cables)
- Cable Loss (dB) over Frequency table - List the cable losses for the current set of RF cables being used, shown in Figure 109

Note that all three lists must be the same length or an error is generated and the Zero Cable Loss box will be checked. Also, you must save the configuration and reload it or restart for the new cable losses to take effect.

- Frequency (MHz) - Frequencies measured
- Channel 1 - Cable loss offset for each listed frequency on Channel 1
- Channel 2 - Cable loss offset for each listed frequency on Channel 2

Max Allowed RF Level (dBm):

Current C1 Cable Loss (dB):

Current C2 Cable Loss (dB):

☐ Auto Time Stamp (Seconds)

☐ Alt Sync Method (%BER)

☐ Zero Cable Loss

Cable Loss (dB) over Frequency		
Freq (MHz)	Chan 1	Chan 2
200.00	0.095	0.095
700.00	0.150	0.150
1000.0	0.170	0.170
1600.0	0.180	0.180
2000.0	0.200	0.200
4400.0	0.270	0.270
4700.0	0.280	0.280
5250.0	0.340	0.340

Figure 109: Setup Window, Fields

- Max Allowed RF (dBm) - Maximum RF level; allows user to set a limit on the output power of the Receiver Analyzer to prevent damage to attached equipment, if necessary
- Current C1 Cable Loss (dB) - Displays the current cable loss being used for channel 1 (read only)
- Current C2 Cable Loss (dB) - Displays the current cable loss being used for channel 2 (read only)
- Alt Sync Method (%BER) check box - When checked, the sync display status uses percent (%) of BER instead of the normal sync status indication. This can be useful if the Receiver Analyzer is being used as a BERT but is NOT the signal source. In that case, the Receiver Analyzer will never declare sync unless the alternate method is used.

Connections, shown in Figure 110, displays all detected (and connected) receiver analyzers, analog receiver analyzers, and receivers, along with the port assigned, channel, receiver generation, if appropriate, and serial number and firmware version information.

Connections:					
Dev	Port	Chan	Gen	Serial #	Version
RA:	COM6			2	RA V1.130 4/24/2015
RAA:	---			---	---
Rx 1:	---	---	---	---	---
Rx 2:	---	---	---	---	---
Rx 3:	---	---	---	---	---

Figure 110: Setup Screen, Connections

#### 5.3.3.6.1 Receiver Analyzer Rack Identification

Receiver Analyzer rack identification, shown in Figure 111, displays the Quasonix Receiver Analyzer rack model number, serial number, and hardware version for the detected receiver analyzers.

RA Rack Model #:	Qsx-RXAN-Z-1111
RA Rack Serial #:	RA-010
RA Rack HW Rev:	A

Figure 111: Setup Screen, Receiver Analyzer Rack Identifiers

#### 5.3.3.6.2 Other Options Check Boxes

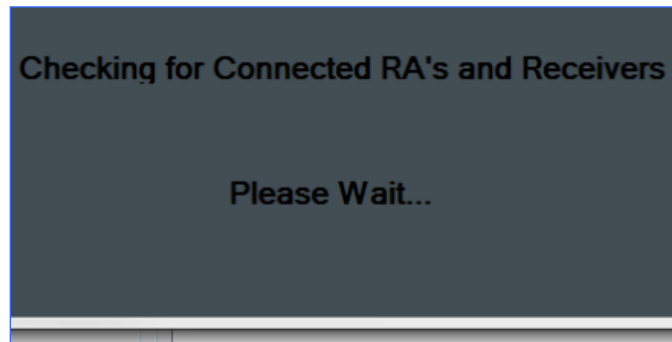
Three additional options settings are shown in Figure 112.

<input type="checkbox"/>	Confirm Devices on Autoscan
<input type="checkbox"/>	Audible Test Notifications
<input type="checkbox"/>	Warn about RF OFF during Tests
<input checked="" type="checkbox"/>	Do NOT connect to Receivers
<input type="checkbox"/>	Sync Rcvrs Independently

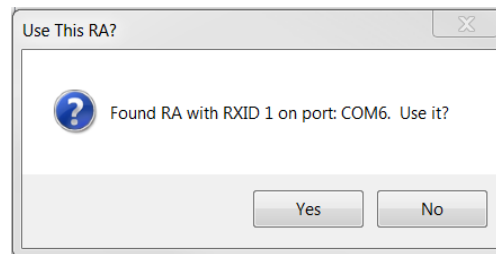
Figure 112: Other Options on Setup Screen

These options include:

- Confirm Devices on Autoscan - Enable/Disable check box; Used in conjunction with AutoScan button on Setup tab and Autoscan option in Tools menu; When checked and AutoScan is activated, the software begins checking for connected devices (Figure 113) and message windows display for each found device. The user has the option to use or not use the found devices, as shown in Figure 114. Ordinarily, this is NOT checked and the Receiver Analyzer uses the first valid found devices.

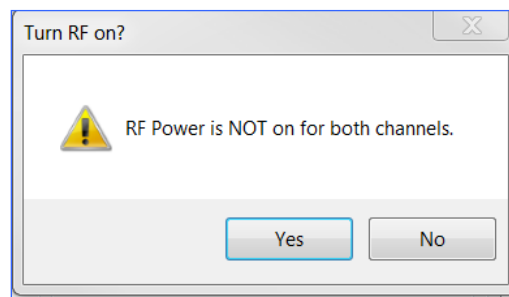


**Figure 113: Checking for Connected Devices Message**



**Figure 114: Found Devices Message Window**

- Audible Test Notifications - Enable/Disable check box; Plays the sound stored in file "Test\_Sound.wav" whenever a test or alignment finishes successfully or the "Fail\_sound.wav" file if there is a failure
- Warn about RF OFF during Tests - Displays a dialog box (Figure 115) letting the user know RF is Off if the user starts certain tests with RF not turned on. Click on the Yes button to turn RF On.



**Figure 115: RF Not On Message**

- Do NOT Connect to Receivers - If a receiver connection is available, this selection disables the automatic connection when checked.
- Sync Rcvrs Independently – If the RA is set to Independent mode in the RF Generator window, and the Sync QSX Receiver to RA button in the System window is executed, Channel 1 and Channel 2 data is sent separately

### 5.3.3.6.3 Advanced Setup

Some options were moved to the Advanced Setup window, shown in Figure 116. Click on the Advanced Setup button at the bottom of the Setup window to display the advanced options. After making desired selections, click on the Close button to apply the changes and close the window.

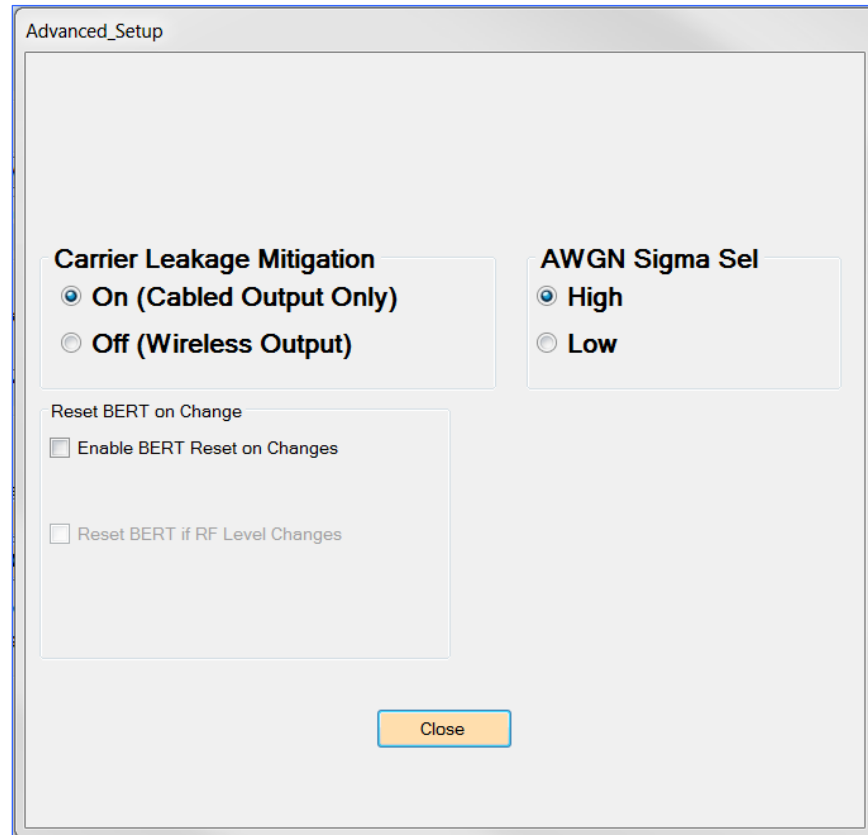


Figure 116: Setup Screen, Advanced Setup Window

#### 5.3.3.6.3.1 Carrier Leakage Mitigation

The Receiver Analyzer wideband RF generator employs I/Q modulation that is subject to some degree of carrier leakage. Typically, L- and S-band carrier suppression is 30 dB or better. However, when additive noise is a significant part of the transmitted signal power, dynamic range constraints can effectively decrease carrier suppression by as much as 16 dB. Especially in C-band, this may lead to degraded performance due to carrier leakage. Worse, the degradation may differ between the CH1 and CH2 RF outputs.

Carrier Leakage Mitigation literally sidesteps the issue by putting a 20 MHz frequency offset on the modulated signal, and tuning the RF synthesizer 20 MHz the other direction to place the transmitted signal at the desired frequency. This process effectively shifts carrier leakage from the center of the modulated waveform to 20 MHz away; that is, from the point of maximum impact to a point of little or no impact.

There are two main downsides to this approach. The first is that image products will generally appear on the far side of the off-shifted carrier. The second is that the carrier itself becomes an out-of-band signal at all but the highest bit rates. These two together are cosmetic issues as long as the Receiver Analyzer is driving the test Receiver via a

cabled connection. However, for a wireless connection, these undesired signals may cause unintended interference. Therefore, Carrier Leakage Mitigation should only be On in a cabled system, as shown in Figure 117.

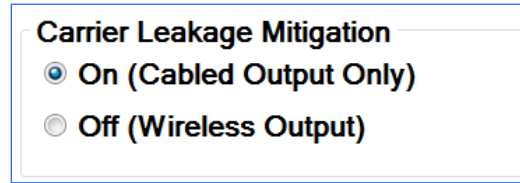


Figure 117: Setup Screen, Carrier Leakage Mitigation

#### 5.3.3.6.3.2 AWGN Sigma Select

True Additive White Gaussian Noise (AWGN) has theoretically infinite bandwidth and infinite noise peaks. Practical implementation of the noise generator, however, imposes limits on bandwidth and peak noise.

Noise bandwidth is automatically adjusted based on bit rate to provide an essentially flat noise spectrum in the bandwidth of interest. No user settings are required for proper operation.

Peak noise is controlled by AWGN Sigma Select, as shown in Figure 118. In the High setting, additive noise varies up to 6.34 sigma. This setting approximates true AWGN as faithfully as possible. In the Low setting, additive noise is clipped at 4.00 sigma. This setting reduces dynamic range requirements by 4 dB, which has the direct benefit of decreasing carrier leakage by that same amount. The Low setting may be especially useful when Carrier Leakage Mitigation must be set to Off.



Figure 118: Setup Screen, AWGN Sigma Select

#### 5.3.3.6.3.3 Reset BERT on Change

The Reset BERT on Change window, shown in Figure 119, allows the user to automatically restart a test immediately if a change occurs in one of the parameters (such as a user changing the RF level in the middle of a test).

- Enable BERT Reset on Changes - When checked, allows the user to select BERT reset on changes
- Reset BERT RF Level Changes - When checked, automatically restarts a test that was running when a user changes the RF level (shown greyed out/disabled in Figure 119 since Enable BERT Reset on Changes is not checked)



Figure 119: Reset BERT on Change Section

5.3.3.7 Lists

Most tests provide range setups which have Step/List options. In each case, if List is selected, the appropriate list from the List screen, shown in Figure 120, is used for the test. Users may edit and save the lists to saved configurations for reuse.

RF Level dBm	Eb/NO	Freq MHz	Br PCM	Br non-PCM	Mod Index
-85.000	0.000	200.0	0.040	0.100	0.4
-90.000	1.000	250.0	0.150	0.150	0.5
-91.000	2.000	270.0	0.350	0.350	0.6
-92.000	3.000	270.5	0.750	0.750	0.7
-93.000	4.000	300.0	1.000	1.250	0.8
-94.000	5.000	350.0	1.400	2.000	0.9
-95.000	6.000	400.0	2.000	3.000	1.0
-96.000	7.000	450.0	3.000	4.000	1.5
-97.000	8.000	500.0	3.500	5.000	2.0
-98.000	9.000	500.5	5.900	5.900	3.0
-99.000	10.000	550.0	8.000	10.000	3.5
-100.000	11.000	600.0	10.000	15.000	
-101.000	12.000	639.5	15.000	17.000	
-102.000		640.0	17.000	25.000	
-103.000		650.0			
-104.000		700.0			

Figure 120: Lists Table

### 5.3.3.8 General Purpose Noise Figure Test

The General Purpose Noise Figure Test determines the noise figure of a receiver across desired frequencies and bit rates. This test may be used with any receiver. Since there is no serial interface, it requires tedious prompts to change parameters with each test point. Users of Quasonix receivers with a serial interface may use the Noise Figure Test described in section 5.3.3.9.

## Noise Figure Test

Channel: 1
Start
Stop

**Freq Range (MHz)**

Start: 2200.5
☒ Step  
☐ List

Stop: 2300.5
Step/Total

Step Size: 50.0
1 / 3

**Bitrate Range (Mbps)**

Start: 1.000
☐ Step  
☒ List

Stop: 23.000
Step/Total

Step Size: 1.000
1 / 14

**Current Stats:**

Frequency (MHz):	2200.5	Noise BER:	---
Bitrate (Mbps):	0.040	First BER:	---
RF Level (dBm):	-40.000	2nd BER:	---
Test Step/Steps:	1 / 42	NF (dB):	---

Figure 121: General Purpose Noise Figure Test Window

1. Use the Channel drop down menu to select the receiver analyzer channel for the noise figure test.
2. Set the desired Start, Stop, and Step Size for the Frequency Range (in MHz) and Bitrate Range (in Mbps) used for the test, or select List to use the values in the List table.
  - Start – The desired start frequency for the selected range
  - Stop – The desired stop frequency
  - Step Size – Frequency increment used for each successive measurement
  - Step/Total - Shows the current step in the sweep test along with the total number of steps in the test
  - List - If List is selected, the appropriate list from the Lists screen is used to take data points.



RF Level dBm	Eb/N0	Freq MHz	Br PCM	Br non-PCM	Mod Index
-85.000	0.000	200.0	0.040	0.100	0.4
-90.000	1.000	250.0	0.150	0.150	0.5
-91.000	2.000	270.0	0.350	0.350	0.6
-92.000	3.000	270.5	0.750	0.750	0.7
-93.000	4.000	300.0	1.000	1.250	0.8
-94.000	5.000	350.0	1.400	2.000	0.9
-95.000	6.000	400.0	2.000	3.000	1.0
-96.000	7.000	450.0	3.000	4.000	1.5
-97.000	8.000	500.0	3.500	5.000	2.0
-98.000	9.000	500.5	5.900	5.900	3.0
-99.000	10.000	550.0	8.000	10.000	3.5
-100.000	11.000	600.0	10.000	15.000	
-101.000	12.000	639.5	15.000	17.000	
-102.000		640.0	17.000	25.000	
-103.000		650.0			
-104.000		700.0			

Figure 122: Sample List Table

After clicking on the Start button, the Enter Unit Under Test Information window, shown in Figure 123, provides receiver information to the noise figure test software. The information will be stored in the data file generated by the test.

- 3. Type the appropriate information about the receiver unit under test.
- 4. Click on the Close button to continue.

Enter Unit Under Test Information

Please enter information about the unit under test:

Manufacturer Name:

Quasonix

Model Number:

QSX-RDMS-3R3D-Q0-1111-00-14

Serial Number:

1007

Tested By:

Johnny Tester

Close

Figure 123: Enter Unit Under Test Information Window

5. When the Set Receiver Mode, Freq and Bitrate window displays (Figure 124), access the **receiver under test** and set the Mode, Frequency, and Bit Rate to the values displayed in the window.
6. Click on the OK button when the receiver under test is configured for the test.

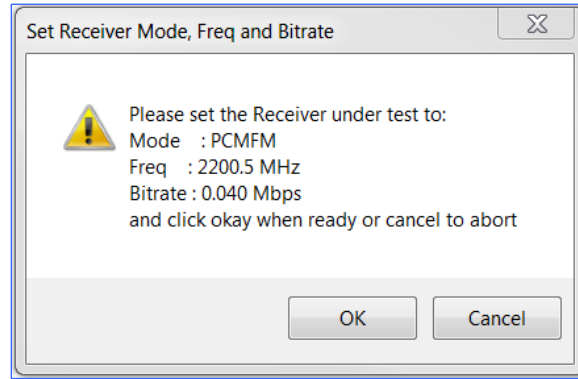


Figure 124: Set Receiver Mode, Freq and Bitrate Window

The Noise Figure Test starts and the test status is updated in the Current Stats fields. The current step is incremented in the Step/Total fields for Frequency Range and Bitrate Range.

The Current Stats fields (Figure 125) provide the following information:

Current Stats:			
Frequency (MHz):	---	Noise BER:	---
Bitrate (Mbps):	---	First BER:	---
RF Level (dBm):	---	2nd BER:	---
Test Step/Steps:	1 / 42	NF (dB):	---

Figure 125: Current Stats

- Frequency (MHz) - Current frequency, in megahertz
- Bitrate (Mbps) - Current bit rate, in Mbps
- RF Level (dBm) - Current power level reading from receiver, in dBm
- Test Step/Steps - Current test step and the total steps (Frequency and Bitrate)
- Noise BER - Value used internally by the receiver analyzer to determine the noise figure
- First BER - Value used internally by the receiver analyzer to determine the noise figure
- 2nd BER - Value used internally by the receiver analyzer to determine the noise figure
- NF (dB) - Value of the last noise figure point that ran, in dB

### 5.3.3.9 Noise Figure Test

The Noise Figure Test determines the noise figure of a receiver across desired frequencies. This Noise Figure Test is only useful with 2<sup>nd</sup> or 3<sup>rd</sup> Generation Quasonix receivers with direct (serial) communications to the receivers. This test is also used internally at Quasonix.

Use the Channel drop down menu to select the channel for the noise figure test. Use the Start/Stop buttons to start (or pause/continue) a test, or to stop a test before it completes.

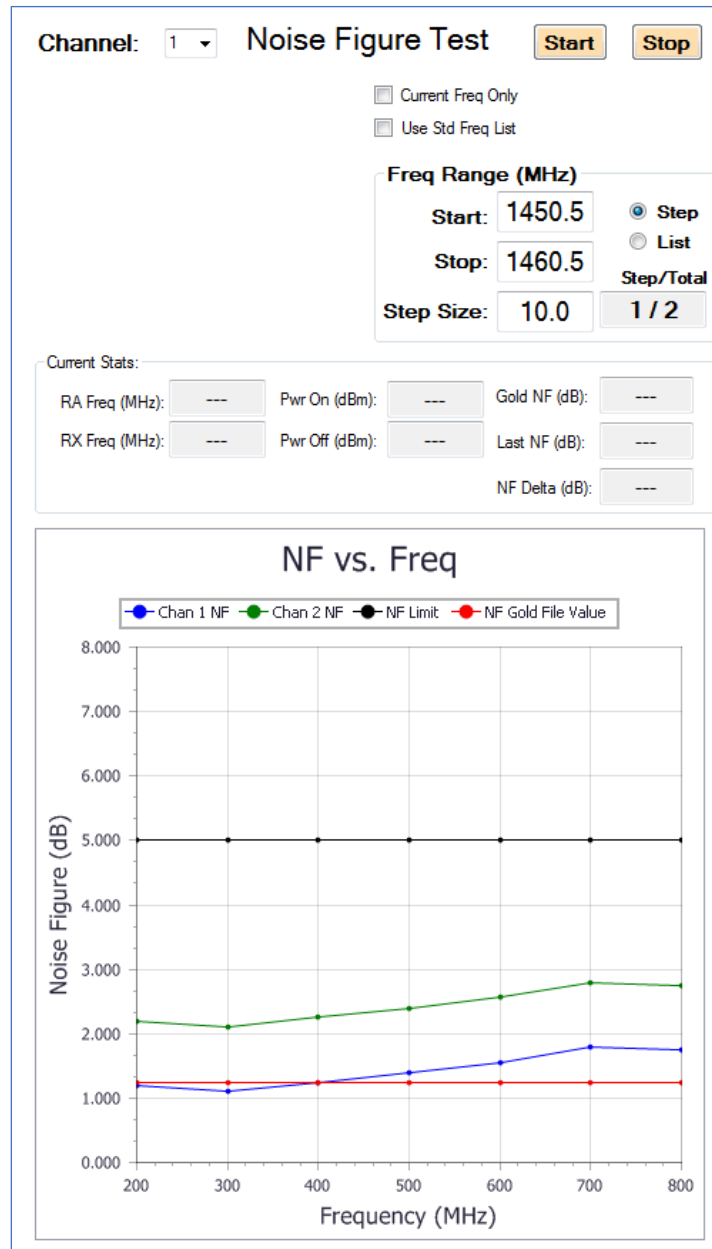


Figure 126: Noise Figure Test Window

### 5.3.3.9.1 Frequency Range

The Frequency Range options, shown in Figure 127, are used to set the desired frequency values for the noise figure test.

Figure 127: Noise Figure Test, Frequency Settings

- Current Freq Only check box - When checked, the test uses only the frequency currently set in the Receiver Analyzer Generator
- Use Std Freq List check box – When checked, the test uses frequency information from the standard/default/saved List (shown in Figure 128) to take data points; Start, Stop, and Step size selections are greyed out, and the List option is selected
- Step/List options – When Step is selected, the test uses the frequency information entered by the user; when List is selected, the test uses the *current* List (may be the default list, if no changes were made, or the most recent customized list)
- Start – The desired start frequency, in MHz, for the selected range
- Stop – The desired stop frequency, in MHz
- Step Size – Frequency increment used for each successive measurement
- Step/Total - Shows the current step in the sweep test along with the total number of steps in the test

RF Level dBm	Eb/N0	Freq MHz	Br PCM	Br non-PCM	Mod Index
-85.000	0.000	200.0	0.040	0.100	0.4
-90.000	1.000	250.0	0.150	0.150	0.5
-91.000	2.000	270.0	0.350	0.350	0.6
-92.000	3.000	270.5	0.750	0.750	0.7
-93.000	4.000	300.0	1.000	1.250	0.8
-94.000	5.000	350.0	1.400	2.000	0.9
-95.000	6.000	400.0	2.000	3.000	1.0
-96.000	7.000	450.0	3.000	4.000	1.5
-97.000	8.000	500.0	3.500	5.000	2.0
-98.000	9.000	500.5	5.900	5.900	3.0
-99.000	10.000	550.0	8.000	10.000	3.5
-100.000	11.000	600.0	10.000	15.000	
-101.000	12.000	639.5	15.000	17.000	
-102.000		640.0	17.000	25.000	
-103.000		650.0			
-104.000		700.0			

Figure 128: Sample List Table

### 5.3.3.9.2 Current Stats

The current statistics display, as shown in Figure 129, as the noise figure test executes.

Current Stats:

RA Freq (MHz): 2240.5
Pwr On (dBm): -9.080
Gold NF (dB): ---

RX Freq (MHz): 2241.5
Pwr Off (dBm): -24.220
Last NF (dB): -8.984

NF Delta (dB): ---

Figure 129: Noise Figure Test, Current Stats

- RA Freq (MHz) - Current receiver analyzer frequency in megahertz
- RX Freq (MHz) - Current receiver frequency in megahertz
- Pwr On (dBm) - Current power level reading from receiver with RF On, in dBm
- Pwr Off (dBm) - Current power level reading from receiver with RF Off, in dBm
- Gold NF (dB) - Value of the noise figure in a Gold Noise Figure file loaded via the Setup screen, in dB
- Last NF (dB) - Value of the last noise figure point that ran, in dB
- NF Delta (dB) - Noise figure delta; the difference between the value in Gold NF and Last NF

### 5.3.3.9.3 Noise Figure vs. Frequency Graph

This is a real-time graph of the of the current Noise Figure vs. Frequency data. Graphs are being revised and will be available in a future version.

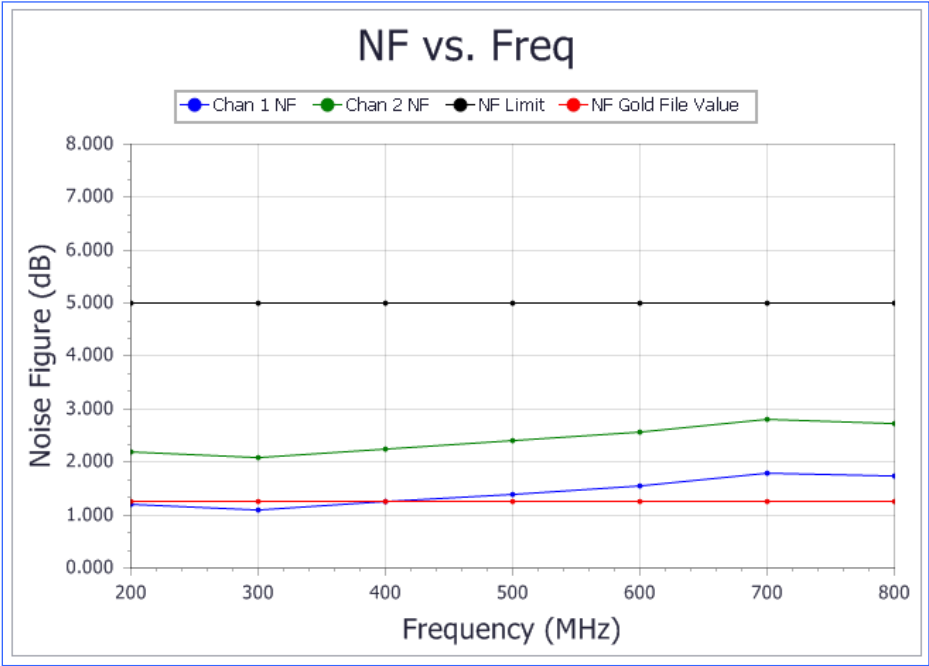


Figure 130: Noise Figure Test, Noise Figure vs. Frequency Graph

### 5.3.3.10 Receiver Gain Calibration

The Receiver Gain Sweep, shown in Figure 131, is a performance verification test that requires a serial interface. Receiver Gain is swept across frequencies and graphed in real time. The RA transmits a signal at a power level determined by the desired RF level across various frequencies, determined by a Step/List setting, and records the power level detected by the receiver.

The sweep file may be saved for reference, if desired.

Receiver Calibration capability is only available to the Quasonix factory.

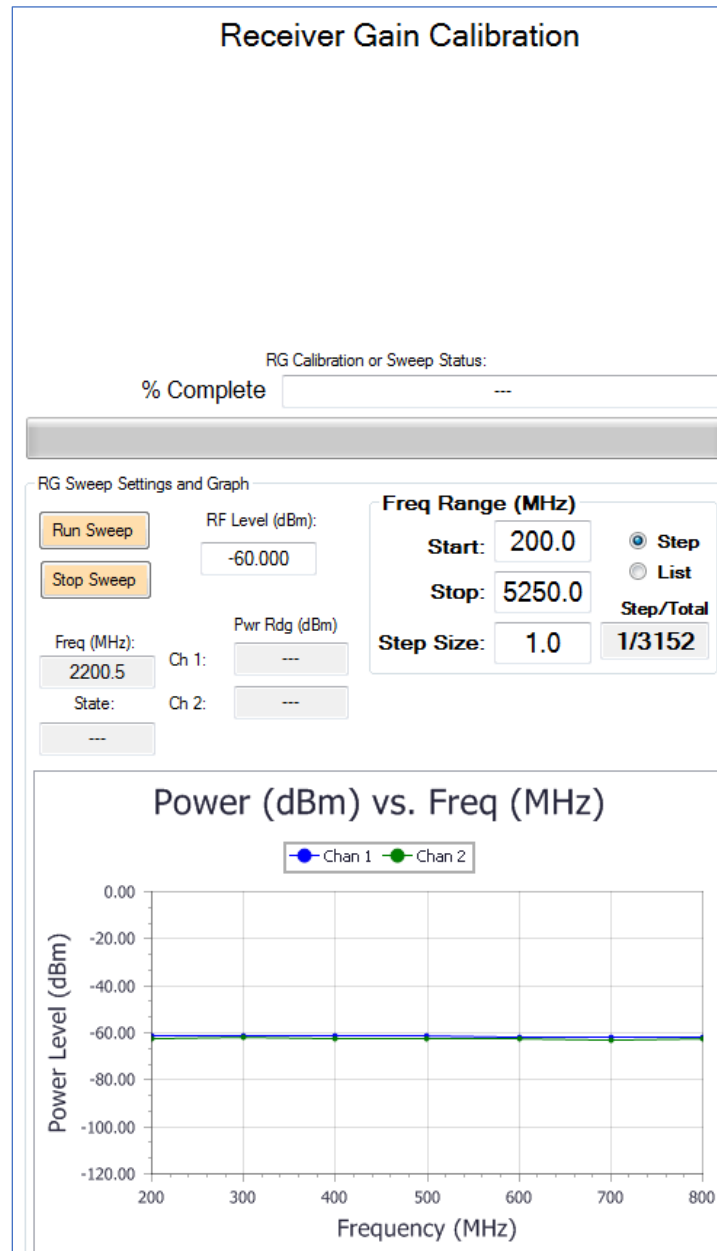


Figure 131: Receiver Gain Calibration

### 5.3.3.10.1 RG Calibration or Sweep Status

The RG Sweep Status window, shown in Figure 132, displays the Receiver Gain sweep status while the test is running.

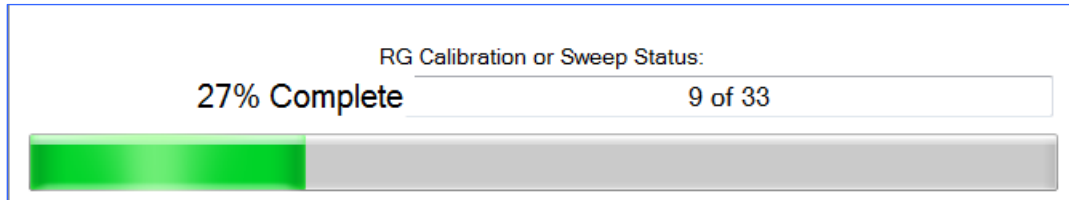


Figure 132: RG Sweep Status Example

### 5.3.3.10.2 RG Sweep Settings and Graph

In addition to the buttons to start and stop the RG sweep, this section allows the user to enter the desired RF level for the sweep. When the test is running, current status displays for Frequency, internal state machine, and the power readings for channel 1 and channel 2.

The figure shows a software window titled "RG Sweep Settings and Graph". It contains several controls:
 

- Two orange buttons: "Run Sweep" and "Stop Sweep".
- A text field for "RF Level (dBm)" with the value "-60.000".
- A text field for "Freq (MHz)" with the value "2200.5".
- A text field for "State" with the value "---".
- Two text fields for "Pwr Rdg (dBm)": "Ch 1:" and "Ch 2:", both with the value "---".

Figure 133: RG Sweep Settings and Graph


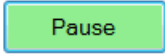

- RF Level (dBm) - The power level output of the signal, in dBm, sent by the Receiver Analyzer's internal transmitter(s)
- Freq (MHz) - Frequency, in MHz, of the signal sent by the Receiver Analyzer's internal transmitter(s); frequency is rounded to nearest 1 kHz internally, but displays rounded off to the nearest 0.1 MHz; This is likely to change in the future. Available frequencies include P, lower L, upper L, S, and C bands.
- State – Quasonix Factory use only
- Pwr Rdg (dBm) – Power reading in dBm
  - Ch 1 - Power reading for receiver Channel 1
  - Ch 2 - Power reading for receiver Channel 2



#### 5.3.3.10.2.1 Buttons

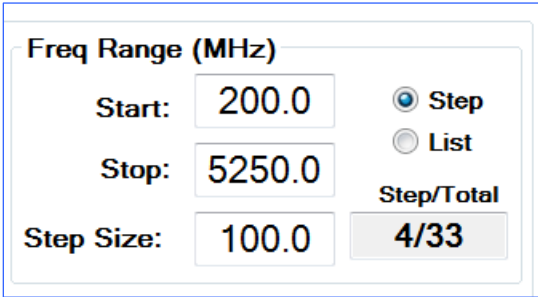
- Run Sweep – The Run Sweep button is used to start a new Receiver Gain sweep test. This button always causes the test to start over at the beginning.
- Pause - After clicking on the Run Sweep button, it changes to a green Pause button. This indicates the test is running and may be paused by clicking on this button.
- Cont - When a test is paused, the button changes to a yellow Cont button. This indicates that the test is in a paused state and is waiting for the user to take action. The test is continued by clicking on the Cont button. When the test is continued, the button changes back to a green Pause button.
- Stop Sweep – The Stop Sweep button immediately terminates a test.

**Table 4: Run Sweep Button States**

		
Run Sweep - Starts the test	Pause – Test running	Cont – Test running but paused

#### 5.3.3.10.3 Frequency Range (MHz)

- Freq Range - Selects the transmitter start, stop, and step frequencies, in MHz, as shown in Figure 134; the user may also select List instead of the Step parameter, in which case the values in the appropriate list (on the Lists screen) are used instead (Figure 135)



**Freq Range (MHz)**

Start: 200.0      ☒ Step

Stop: 5250.0      ☐ List

Step Size: 100.0      Step/Total: 4/33

**Figure 134: Frequency Range Window**

- Step/Total - Shows the current step in the Receiver Gain sweep test along with the total number of steps in the test

RF Level dBm	Eb/NO	Freq MHz	Br PCM	Br non-PCM	Mod Index
-85.000	0.000	200.0	0.040	0.100	0.4
-90.000	1.000	250.0	0.150	0.150	0.5
-91.000	2.000	270.0	0.350	0.350	0.6
-92.000	3.000	270.5	0.750	0.750	0.7
-93.000	4.000	300.0	1.000	1.250	0.8
-94.000	5.000	350.0	1.400	2.000	0.9
-95.000	6.000	400.0	2.000	3.000	1.0
-96.000	7.000	450.0	3.000	4.000	1.5
-97.000	8.000	500.0	3.500	5.000	2.0
-98.000	9.000	500.5	5.900	5.900	3.0
-99.000	10.000	550.0	8.000	10.000	3.5
-100.000	11.000	600.0	10.000	15.000	
-101.000	12.000	639.5	15.000	17.000	
-102.000		640.0	17.000	25.000	
-103.000		650.0			
-104.000		700.0			

Figure 135: Sample List Table

5.3.3.10.4 Power vs. Frequency Graph

The graph illustrates power versus frequency with a known reference level, as set in the RF Level field. Ideally, the channel 1 and channel two point distribution should be close to a flat line.

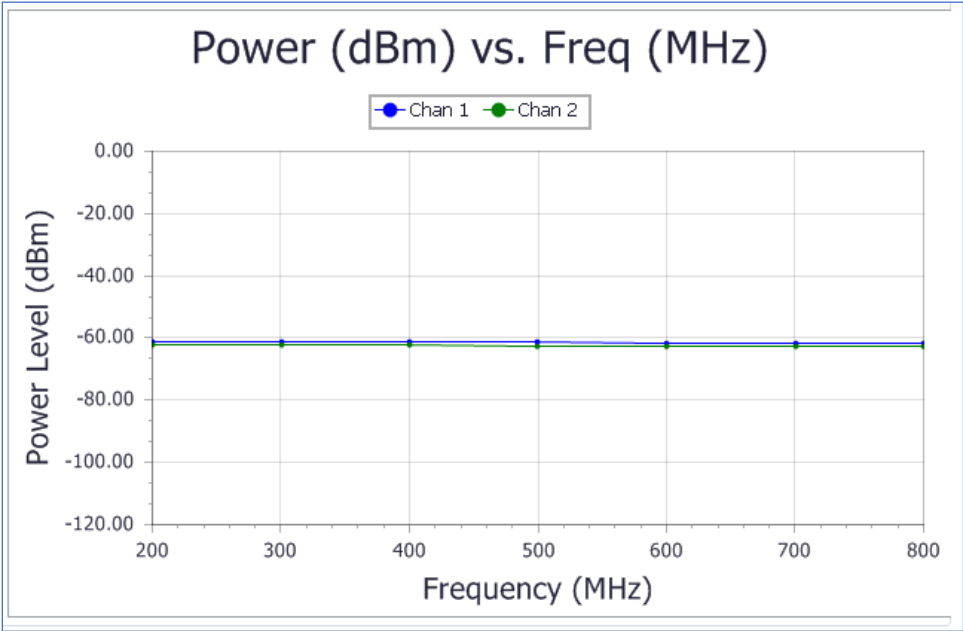


Figure 136: Power vs. Frequency Sample Graph

### 5.3.3.10.5 Saved Sweep Test Results

The Receiver Gain sweep test results are automatically saved to a file. Files are always saved to the data path set on the Setup screen. The file name, shown in Figure 137, is determined based on the test type, current settings, and the current date and time. It is slightly different for every test type.

C:\RX\_RG\_Swp\_SN-1234\_5678\_-60.0dB\_20180920125533.csv

Test	Sweep	Serial	RF	Date	Time
Type	Type	Numbers	Level	yyyy-	hr-mm-
		1_2_3		mm-dd	ss

Figure 137: Example of Saved Receiver Gain Sweep Test File Name Format

If a default location was not specified (in the Setup screen), the file is saved in the root directory (C:/). An invalid default directory message displays as shown in Figure 138.

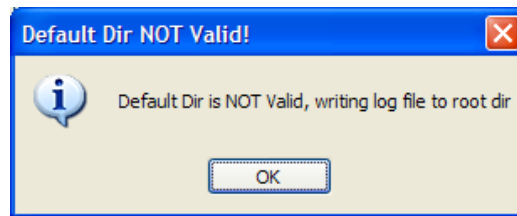


Figure 138: Default Directory Not Valid Message

### 5.3.3.11 Adjacent Channel Interference Test (Currently Unavailable)

The Adjacent Channel Interference Test is currently unavailable.

The Adjacent Channel Interference Test screen is shown in Figure 139.

## Adjacent Channel Interference Test

Start
Stop
Save Last Data

**Test Limits**

☒ Time Limit: Hrs:  Mins:  Secs:

☐ Err Limit Bits:

**Test Parameters**

Test Method

☒ IRIG118 Normal
☐ Alternate Fast

Parameter	Victim	Interferer1	Interferer2
Mode	<input type="text" value="SOQPSK"/>	<input type="text" value="SOQPSK"/>	<input type="text" value="SOQPSK"/>
Start Freq (MHz):	<input type="text" value="2220.500"/>	<input type="text" value="2230.500"/>	<input type="text" value="2210.500"/>
Interferer Freq Step (MHz):		<input type="text" value="5.000"/>	<input type="text" value="5.000"/>
Bitrate (Mbps):	<input type="text" value="5.000"/>	<input type="text" value="5.000"/>	<input type="text" value="5.000"/>
Interferer Delta Power (dBm):		<input type="text" value="20.000"/>	<input type="text" value="20.000"/>
Start RF Level (dBm):	<input type="text" value="-70.000"/>		
Stop RF Level (dBm):	<input type="text" value="-120.000"/>		
RF Step Size (dBm):	<input type="text" value="1.000"/>		
			Target BEP: <input type="text" value="1.000E-005"/>

**Current Test Status**

Parameter	Victim	Interferer1	Interferer2
Freq (MHz):	<input 3"="" text"="" type="text" value="---&lt;/input&gt;&lt;/td&gt; &lt;/tr&gt; &lt;tr&gt; &lt;td&gt;Victim Error Rate:&lt;/td&gt; &lt;td colspan="/> <input 328="" 667="" 811="" 829"="" data-label="Caption" type="text" value="---&lt;/input&gt;&lt;/td&gt; &lt;/tr&gt; &lt;/tbody&gt; &lt;/table&gt; &lt;/div&gt; &lt;/div&gt; &lt;/div&gt; &lt;div data-bbox="/> <p>Figure 139: Adjacent Channel Interference Test</p>		

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#### 5.3.3.11.1 Adjacent Channel Interference Test Buttons (Currently Unavailable)

The Adjacent Channel Interference Test screen contains three buttons: Start, Stop, and Save Last Data, as shown in Figure 140.



Figure 140: Adjacent Channel Interference Test Screen Buttons

- Start – The Start button is used to start a new Adjacent Channel Interference test.
- Stop – The Stop button immediately terminates a test.
- Save Last Data – The Save Last Data button saves the current Adjacent Channel Interference test information. A Save File message displays. Click on YES to save the file. Files are always saved to the data path set on the Setup screen. The file name is determined based on the test type, current settings, and the current date and time. It is slightly different for every test type.

If a default location was not specified (using the Setup screen), the file is saved in the root directory (C:/). An invalid default message displays as shown in Figure 141.

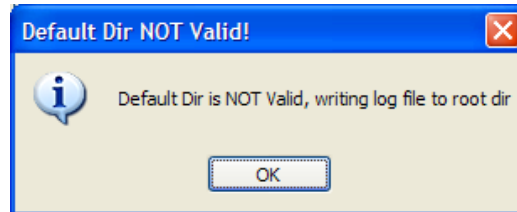


Figure 141: Default Directory Not Valid Message

#### 5.3.3.11.2 Test Limits (Currently Unavailable)

Test Limits, shown in Figure 142, is used to set up time and/or bit rate limits for a particular Adjacent Channel Interference test. One or both of the check boxes may be checked. Fields are greyed out when a box is not checked.

Figure 142: Adjacent Channel Interference Test, Test Limits

- Time Limit – When this box is checked, the test is set to run for the length of time specified in the hours, minutes, and seconds boxes.
- Error Limit Bits – When this box is checked, the test runs up to the number of bits specified.

If both Test Limits boxes are checked, the test will run until either the test time elapses or the number of errors specified are detected, whichever comes first.

### 5.3.3.11.3 Test Parameters (Currently Unavailable)

Test Parameters, shown in Figure 143, is currently unavailable.

Test Parameters

Test Method

☒ IRIG118 Normal
 ☐ Alternate Fast

Parameter	Victim	Interferer1	Interferer2
Mode	SOQPSK	SOQPSK	SOQPSK
Start Freq (MHz):	2220.500	2230.500	2210.500
Interferer Freq Step (MHz):		5.000	5.000
Bitrate (Mbps):	5.000	5.000	5.000
Interferer Delta Power (dBm):		20.000	20.000
Start RF Level (dBm):	-70.000		
Stop RF Level (dBm):	-120.000		
RF Step Size (dBm):	1.000		
			Target BEP: 1.000E-005

Figure 143: Adjacent Channel Interference Test, Test Parameters Window

- Test Method - Two test methods are available – IRIG 118 Normal and Alternate Fast
  - IRIG 118 Normal - Standard IRIG Adjacent Channel Test with interferers above and below
  - Alternate Fast - Under development
- Parameters (currently unavailable)
  - Mode -
  - Start Frequency (MHz) -
  - Interferer Freq Step (MHz) –
  - Bitrate (Mbps) –
  - Interferer Delta Power (dBm) -
  - Start RF Level (dBm) -
  - Stop RF Level (dBm) -
  - RF Step Size (dBm) –

- Target BEP -

5.3.3.11.4 Current Test Status (Currently Unavailable)

The Current Test Status window, shown in Figure 144, is currently unavailable.

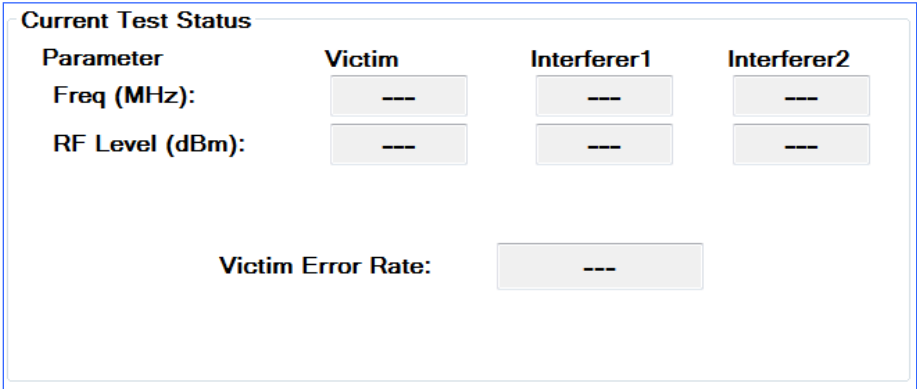


Figure 144: Adjacent Channel Interference Test, Current Test Status Window

- Frequency (MHz) – Current frequency for .....
- RF Level (dBm) – Current power level for.....
- Victim Error Rate –

## **6 Maintenance Instructions**

The Receiver Analyzer requires no regular maintenance, and there are no user-serviceable parts inside.



## 7 Product Warranty

The Receiver Analyzer 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.**

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## **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 – Sync Time Test Setup and Theory

### 9.1 Introduction

Receiver synchronization time is a key parameter of receiver performance. It is laborious to measure manually, and it is virtually impossible to characterize statistically by hand (namely, generating sync time histograms).

The Receiver Analyzer (RA) provides accurate and automated sync time measurements. However, these measurements may not reflect intended performance (or lack thereof) unless the test and its parameters are well understood.

### 9.2 How It Works

The RA starts sync time measurement with RF Off, to ensure the receiver under test has lost synchronization. The RA then transmits a known data pattern and measures how long it takes the receiver to output matching data. This process repeats over and over, alternating between RF Off and RF On, to measure several instances of synchronization time.

The key to sync time measurement is the RA's ability to distinguish between the expected data pattern and random or incorrect data.

#### 9.2.1 Pattern Matching

Pattern matching is based on the same principle as the IRIG 106 derandomizer. When receiver output data matches the expected pattern, the pattern matcher self-synchronizes and outputs all '1' bits. A single bit error from the receiver results in three '0' bits output from the pattern matcher amongst the stream of '1' bits. Random data from the receiver results in random '0' and '1' bits output from the pattern matcher.

#### 9.2.2 Sync Detection

Sync detection works by simply discerning the difference between mostly '1' bits out of the pattern matcher and random '0' and '1' bits out of the pattern matcher. In this way, the RA is able to measure sync times even when the steady-state receiver bit error rate is non-zero.

The sync detector counts the number of '1' bits (or matches) in the most recently received  $n$  bits (the sync window). When this count exceeds a threshold (the Sync Threshold), synchronization is declared.

#### 9.2.3 Sync Time Measurement

Figure 145 illustrates how the pattern matcher and sync detector work to measure sync time. Suppose we want to measure the sync time of a receiver at low SNR when it has a 90% match rate. Note, because pattern matching has an error-multiplying effect, the match rate is not  $1 - \text{BER}$ , where BER is the bit error rate.

For PN test patterns, the match rate is  $(1 + (1 - 2 * \text{BER})^3) / 2$ . In this example, the BER would be approximately  $3.5e-2$ .

Assume the Sync Window is 100 bits and the Sync Threshold is 80 bits; the RA starts transmitting at bit time 0 and the receiver synchronizes and starts outputting valid (but still occasionally errored) data at bit time 2500.

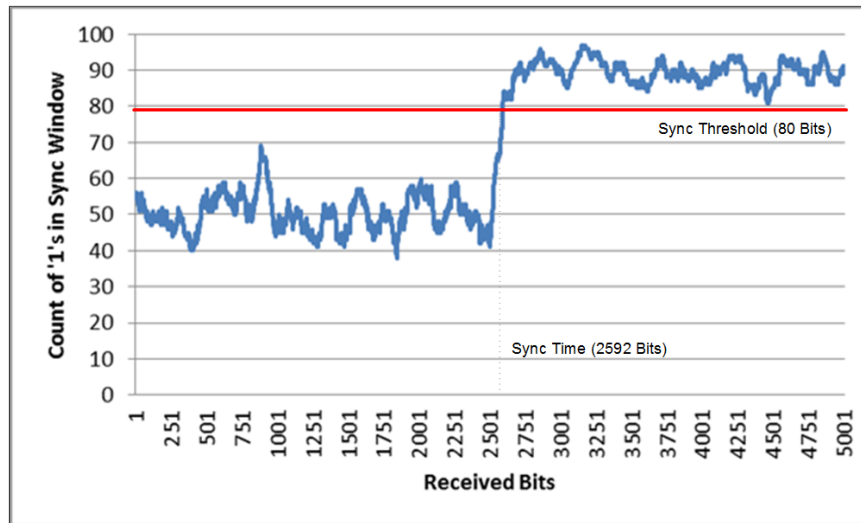


Figure 145: Synchronization Detection and Sync Time Measurement

Prior to bit time 2500, the receiver data is random, so the count of ‘1’ bits in the sync window is also random, averaging 50%. After synchronization, the receiver data has a 90% match rate, so the count of ‘1’ bits in the sync window is still random, but now averages 90%. In-between, the count of ‘1’ bits in the sync window transitions from the average of 50% to the average of 90%, crossing the sync threshold of 80 bits (in other words, 80% of the sync window) at bit time 2592.

So, the measured sync time would be 2592 bits. The actual sync time in this example is 2500 bits. The difference—and a way to correct for it—are explained below.

### 9.3 Sync Time Test Configuration

Proper selection of parameters for the sync time test affect the quality of sync time test results.

Sync Time Test Configuration	
RF Off Time (s)	2
RF On Time (s)	1
Iterations:	100
Sync Window Size (bits):	250
Sync Threshold (%):	90.0
Sync Threshold (bits):	225
RF Level (dBm):	-50.000

Figure 146: Sync Time Test Configuration Window

#### 9.3.1 RF Off Time

This time period should be set according to the synchronization scenario being tested. To emulate flat fading, a short RF Off time is appropriate. To emulate initial acquisition, the RA frequency offset should be time-varying (as

described below), or the RF Off time must be long enough to ensure the receiver has fully lost lock and its acquisition loops have drifted to be essentially random.

### **9.3.2 RF On Time**

This time period should be longer than the worst-case anticipated sync time.

### **9.3.3 Iterations**

The iteration count should be set high enough to get a valid statistical sampling of sync times. This count needs to be high (perhaps 100 or more) if the variance of sync time measurements is large, such as for low SNR testing or for block-based coding like STC or LDPC.

The standard deviation status displayed during a sync time test run indicates the variance for the selected scenario and parameter settings.

### **9.3.4 Sync Window Size**

Two factors determine the optimal setting for sync window size.

Fundamentally, the sync window size affects the period over which the determination of sync is measured. A simple example illustrates why this may be important. Consider the case in which the sync threshold is 100% and two receivers have the same sync time, but the second receiver experiences bit sync slips that cause errors 200 bits after initial acquisition. If the sync window is 100 bits, both receivers will have the same sync time measurement. If the sync window is 1000 bits, the second receiver will have a longer sync time measurement because synchronization (in this case) is defined as 1000 perfect bits in a row, which will not occur until after the bit sync slips.

Also, the sync window size affects the statistics of the match count before and after acquisition. To understand this, consider that the match count is a binomially distributed random variable. The distribution of counts gets wider as the sync window increases, but the distribution of counts as a percentage of the sync window decreases as the sync window increases, as shown in Figure 147.

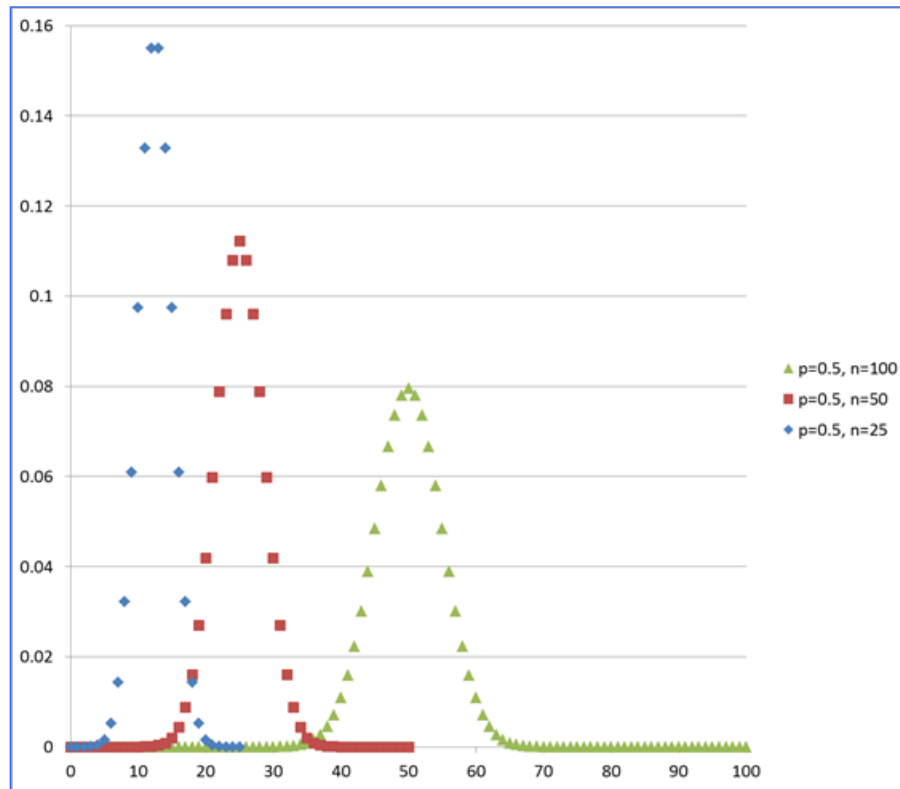


Figure 147: Match Count Distribution Prior to Sync—Sync Window = 25, 50, and 100 Bits

These two effects have different implications.

First, a larger sync window increases the variance of measured sync times. This is because the measured sync time is directly affected by the random count of matches in the sync window when synchronization occurs. The result is that more sync time test iterations are required to achieve a stable sync time average.

Second, a larger sync window allows a lower sync threshold—as a percentage of the sync window—without false sync detection. The result is that sync time can be measured under conditions that cause high error rates in the receiver.

Therefore, the sync window should be large enough to encompass the observation span of interest and to yield negligible probability of false sync based on the selected sync threshold, but no larger.

### 9.3.5 Sync Threshold

The sync threshold should be set between 50% (as noted above) and the expected bit match rate when the receiver is synchronized. Note, the RA will not allow a sync threshold setting below the level that would give a false sync probability exceeding  $1e-6$  (each bit time). Ideally the sync threshold would be set at the point where the probability of false sync and probability of false sync loss are equal, that is, where the tails of the pre-sync and post-sync count distributions cross. However, in common cases where the bit error rate after synchronization is low (less than  $1e-3$ ), the sync threshold can simply be set at a percent or two below perfection. Refer to Figure 148.

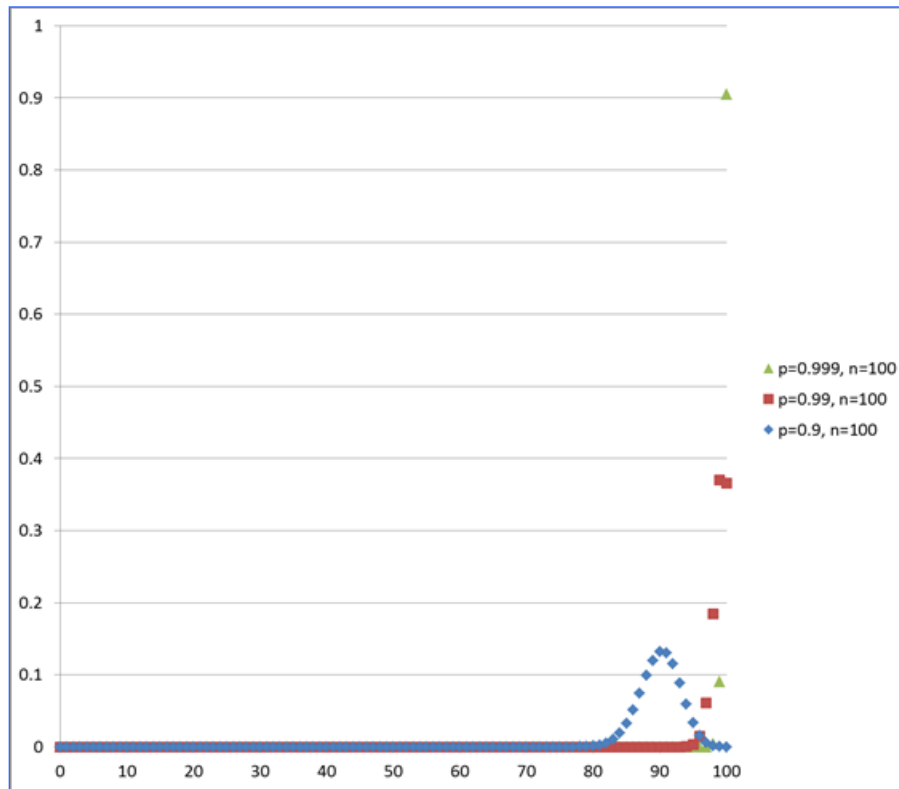


Figure 148: Match Count Distribution After Sync—Different Match Probabilities, Sync Window = 100 Bits

Table 5 lists some possible settings for Sync Window Size and Sync Threshold across a number of different test scenarios.

Table 5: Sample Settings for Different Sync Time Test Scenarios

Scenario	Sync Window Size (bits)	Sync Threshold (%)
General-purpose, for synchronized BER up to 10%	500	62.5
Slow/"unclean" synchronization or block codes, for synchronized BER up to 10%	4000	62.5
Slow synchronization or block codes, for synchronized BER below 1e-3	4000	97.5
Fast synchronization, for synchronized BER below 1e-3	250	97.5
Fast synchronization, for synchronized BER below 1e-3 and "forgiving" spurious bit errors following initial acquisition	250	90
Fast synchronization, for synchronized BER of 0 and penalizing spurious bit errors following initial acquisition	250	100



Scenario	Sync Window Size (bits)	Sync Threshold (%)
Fast synchronization, for synchronized BER of 0 and penalizing spurious bit errors even long after initial acquisition	4000	100

### 9.3.6 RF Level

The RF level should be set according to the desired synchronization conditions. A high level (well above the receiver noise floor) is useful if error-free post sync performance is desired, or if AWGN generation is enabled. RF is completely disabled out of the RA during the RF off portion of sync time tests. Note that this turns off additive noise as well as the desired signal.

A low level (approaching the receiver noise floor) can be used to test synchronization under errored conditions. This level is used for the RF on portion of sync time tests independent of the “normal” RF Generator RF Level settings for CH1 and CH2.

## 9.4 Test Type

Traditionally, synchronization time has been measured from RF into the receiver to bits out of the receiver. As long as the latency in the receiver is small, this is a very reasonable approach. However, modern technologies such as trellis demodulation, STC, and especially LDPC require processing delay in the receiver to achieve optimal performance. It is unfair to count this delay as sync time, since it does not affect the number of good bits received, only the time it takes to get them out of the receiver.

Figure 149: Sync Time Test, Test Type Window

### 9.4.1 Sync Time

Selecting Sync Time configures the RA to measure the time from RF in to good bits out of the receiver, as described previously. These measurements include receiver latency in addition to actual synchronization time.

### 9.4.2 Sync Loss Time

Selecting Sync Loss Time configures the RA to measure the time from loss of RF-in to bad bits-out of the receiver. Clearly, the receiver cannot manufacture good bits without an input signal. The time it takes from when the signal is removed until the receiver outputs errored bits is a good measure of receiver latency.

Sync loss time measurements are analogous to sync time, but in reverse. First, RF is applied long enough to ensure the receiver is firmly locked. Then, RF is removed and the RA measures how long it takes the match count in the shift register to fall below the sync threshold. The same considerations for sync time parameters also apply to sync loss time configuration.

While end-to-end latency of a transmitter/receiver system is a constant value, it is important to note that receiver-only RF-in to bits-out latency will vary in block-coded systems like STC and LDPC, depending on which bit in the block is the first one received. Therefore, latency (and sync time) measurements in these systems have a high variance and many iterations may be required to achieve an accurate average measurement.

## 9.5 Sync Time Adjustments

The selection of sync window size and sync threshold affects the measured sync time, even if actual sync time is invariant. For example, suppose a perfect receiver has a sync time of 0 bits. With a threshold of 100%, the sync time measures as 100 bits if the window is 100 bits and 1000 bits if the window is 1000 bits. This is why the measured sync time in Figure 145 is longer than the actual sync time.

Figure 150: Sync Time Test, Adjust for Sync Window Delay

### 9.5.1 Adjust for Sync Window Delay

The RA allows the user to adjust measurements to account for sync window delay. This adjustment accounts for the time it takes to shift “good” bits into the sync window and shift “bad” bits out of the sync window, keeping in mind that half of the “bad” bits randomly match. The adjustment is  $2 * \text{threshold\_bits} - \text{window\_bits}$ . When enabled, this adjustment is subtracted from the measured sync time to get a “true” measure of the sync time.

Just like sync time, the sync window size and sync threshold affect the sync loss time measurement. Similarly, the RA allows the user to adjust for sync window delay in the sync loss case. The adjustment for sync loss is  $2 * (\text{window\_bits} - \text{threshold\_bits})$ . When enabled, this adjustment is subtracted from the measured sync loss time to get a “true” measure of the sync loss time.

However, corrected measurements are only “true” in a statistical sense, since the count of actual matches in the sync window prior to synchronization is a random variable and therefore so is the measured sync time. Average sync time is unbiased but not individual measurements. The effect is generally small since the binomial distribution is tightly grouped with small tails. Nevertheless, this is one reason for making the sync window size no larger than necessary because it reduces the variance of measured results.

Quasonix published sync time results account for the window correction.

### 9.5.2 Subtract Average Latency

After average latency has been measured using the sync loss time test, the RA can subtract it from sync time measurements. This adjustment, in conjunction with adjustment for the sync window delay, allows the RA to provide the most realistic measure of actual bits lost due to synchronization.

Quasonix published sync time results *do not* presently account for receiver latency.

## 9.6 Frequency Offset During Sync Time Test

There are two primary scenarios in which synchronization generally occurs: flat fading, and initial acquisition. The RA allows static or time-varying offsets to emulate these two scenarios.

Freq Offset During Sync Time Test			
<input type="radio"/> Static Offset:	(kHz)	10.000	
<input type="radio"/> Random Offset:	(kHz max)	40.000	
<input checked="" type="radio"/> Swept Offset:	(kHz max)	25.000	(rate kHz/s): 8.750
<input type="radio"/> No Offset:			
			Current Freq Offset (kHz): 0.000

Figure 151: Sync Time Test, Freq Offset During Sync Time Test Window

### 9.6.1 Static Offset

Static Offset allows the user to test synchronization at a fixed frequency offset relative to the selected carrier frequency. Since the frequency offset does not change, this selection emulates flat fading.

### 9.6.2 Random Offset

Random Offset allows the user to test synchronization at a random frequency each sync time measurement. Since the frequency changes while RF is Off and is unknown to the receiver, this selection emulates initial acquisition.

The random frequency offsets are uniformly distributed in a range from carrier minus the maximum specified offset to carrier plus the maximum specified offset. The actual frequency offset for each sync time test is recorded in the results file for later analysis.

### 9.6.3 Swept Offset

Swept Offset allows the user to test synchronization at a continuously changing frequency. Since the frequency changes at all times, including while RF is Off, this selection emulates initial acquisition.

The swept frequency offset varies linearly in a range from carrier minus the maximum specified offset to carrier plus the maximum specified offset, changing direction at each endpoint and then sweeping toward the other endpoint. The rate of change is constant, as specified by the user.

Note that swept frequency offsets test not only synchronization at changing frequencies but also tracking across the full specified frequency range.

### 9.6.4 No Offset

No Offset allows the user to test synchronization at exactly the carrier frequency. This option is provided in addition to Static Offset so that a “standard” non-zero Static Offset can be saved and restored as part of the RA configuration.

## 10 Appendix B - Currently for Quasonix Factory Use Only

The following sections are used in development and/or internal testing and are only for Quasonix factory reference at this time. Some sections may be available for customer use at a later date.

### 10.1 Rx Terminal Windows

The Rx Channel window, shown in Figure 152, provides a terminal interface to a connected Quasonix receiver, if there is one. This includes showing all of the automatic activity going on between the Receiver Analyzer and the receiver during automated testing. The terminal includes a logging function to capture all terminal I/O. In this example, a 3<sup>rd</sup> Generation receiver was connected to receiver channel 1.

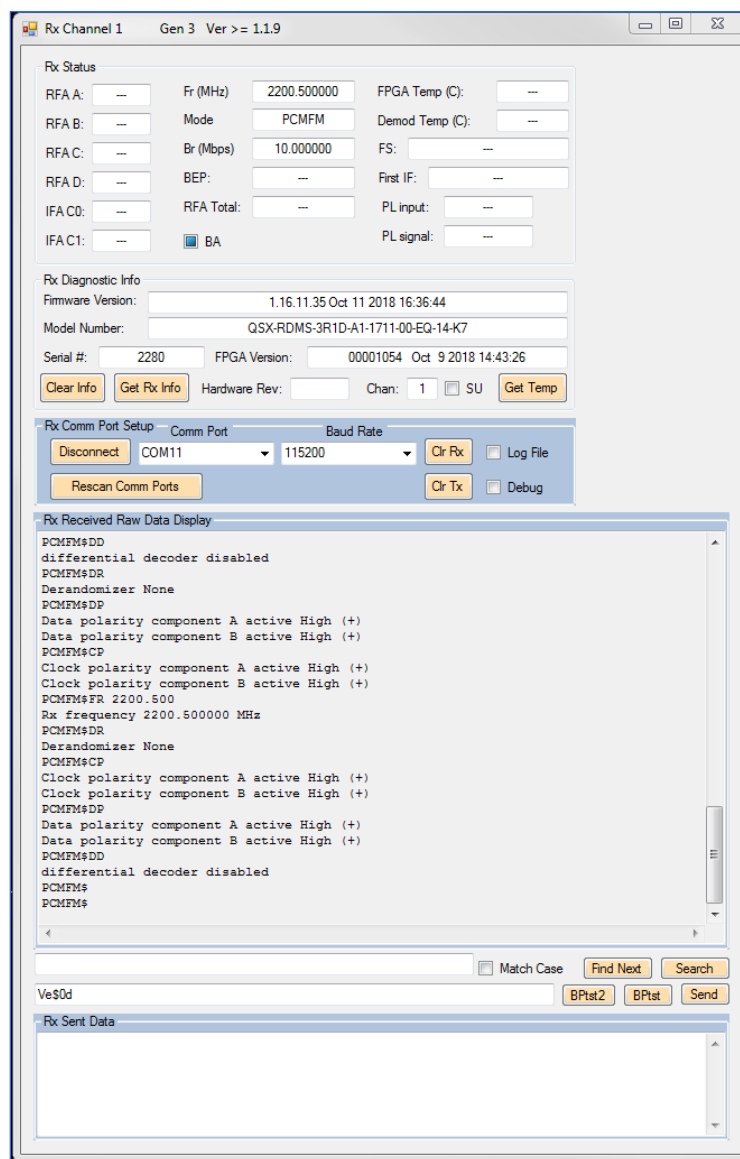


Figure 152: Receiver Terminal Window

### 10.1.1 Rx Status on the Terminal Window

The top most section on the Rx Terminal Window is Rx Status, as shown in Figure 153. It provides the current status for the detected receiver.

Rx Status			
RFA A:	---	Fr (MHz)	2200.500000
RFA B:	---	Mode	PCMFM
RFA C:	---	Br (Mbps)	10.000000
RFA D:	---	BEP:	---
IFA C0:	---	RFA Total:	---
IFA C1:	---	<input checked="" type="checkbox"/> BA	
		FPGA Temp (C):	---
		Demod Temp (C):	---
		FS:	---
		First IF:	---
		PL input:	---
		PL signal:	---

Figure 153: Receiver Status

Check box:

- BA – Bulk Attenuator – Indicates whether bulk attenuator is in or not

If the Receiver Analyzer cannot determine the status, the check box is blue.

Display fields:

- RFA A through D - Receiver Attenuator Alignment
- IFA A C0 and C1 - Attenuator Alignment for combiner (demodulator brick)
- Fr (MHz) - Current receiver frequency setting in megahertz
- Mode - Current receiver mode (waveform)
- Br (Mbps) - Current receiver bit rate setting in Mbps
- BEP – Bit Error Probability – An estimate of what the bit error rate should be
- RFA Total - Total of values from Receiver Attenuator Alignment A through D
- FPGA Temp (C) – Current temperature of the FPGA in degrees Celsius
- Demod Temp (C) – Current Demod (3<sup>rd</sup> Generation Receivers) temperature in degrees Celsius
- FS – Filter Select – Displays FS 0 Bandwidth 10
- First IF – First IF Filter – In (12 MHz) or Bypassed
- PL Input (dBm) - Input power level
- PL Signal (dBm) - Power level measurement signal only

### 10.1.2 Rx Diagnostic Info

The Rx Diagnostic Info displays details retrieved from the detected Quasonix receiver, as shown in Figure 154. This information is helpful should the user require assistance from Quasonix Technical Support.

Figure 154: Receiver Diagnostic Info

- Firmware Version - Describes enabled modes and hardware options as well as the firmware revision with date/time stamp
- Model Number - Quasonix product model number
- Serial # - Quasonix product serial number of the internal receiver brick
- FPGA Version - FPGA version installed in the receiver
- Hardware Rev - Hardware revision
- Chan - Channel number
- SU check box - Reserved for Quasonix superuser access

#### Buttons

- Clear Info – Deletes information currently displayed in all of the diagnostic fields
- Get Rx Info button – Displays all current version and revision information for the receiver
- Get Temp – Reads the latest FPGA and MAX1619/Demod temperatures and redisplayes them in the appropriate fields

### 10.1.3 Rx Comm Port Setup

Rx Comm Port Setup may be used to change the receiver communication port settings.

Figure 155: Receiver Comm Port Setup

#### Buttons

- Connect/Disconnect – Connects or disconnects comm port
- Rescan Comm Ports – Detects available comm ports that are not in use and updates the list in the Comm Port field
- Clr Rx – Clears the receiver log
- Clr Tx – Clears the transmitter log

#### Drop down menus

- Comm Port - Use the drop down menu to select a new communications port
- Baud Rate - Use the drop down menu to select the baud rate; Default should always be 115,200

#### Check boxes

- Log File – When checked, continuously logs receiver activity
- Debug – When checked, provides debug information – Quasonix factory use only

### 10.1.4 Rx Received Raw Data Display

The Rx Received Raw Data Display shows receiver response data.

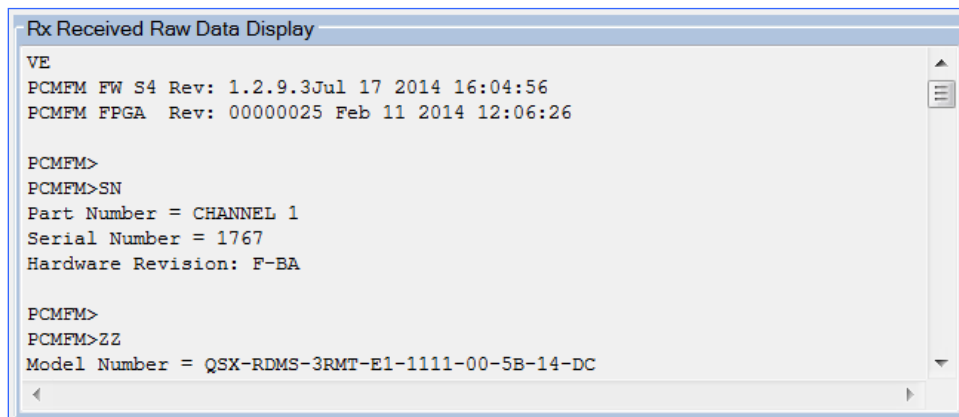


Figure 156: Rx Received Raw Data Display

### 10.1.5 Rx Find/Search Field

This field is used to search the Received Raw Data Display for specific words or characters. The search examines all of the information still in the data buffer. Older data drops off of the display when the buffer threshold is reached.

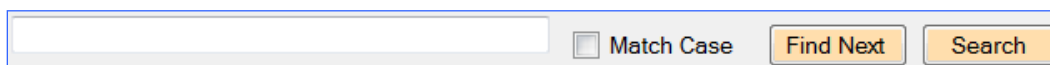


Figure 157: Rx Find/Search Field

### 10.1.6 Rx Send String Field

This field is used to send a string to the communications port. The whole string is sent at once (\$0d is interpreted as a carriage return) when the Send button is clicked. This is useful for sending the same string over and over without retyping it every time (such as a power level reading command).

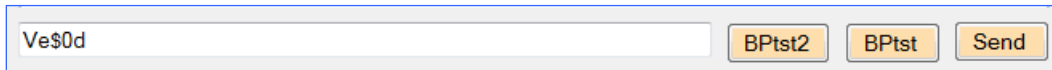


Figure 158: Rx Send String

The BPtst2 and BPtst keys send two different, hardcoded, binary protocol tests to the receiver. The hexadecimal bit strings and checksums are displayed as shown in Figure 159. This is a regression test functionality for Quasonix factory use.

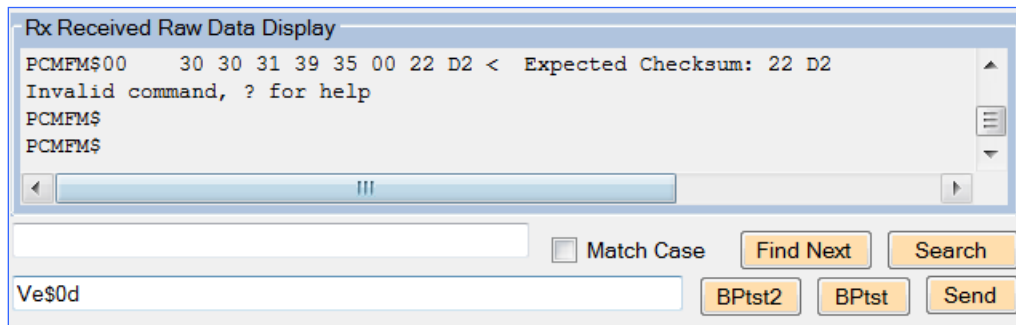


Figure 159: Rx Send Binary Protocol Tests with Data Displays

### 10.1.7 Rx Sent Data Display

Rx Sent Data is an interactive field that lets the user type commands directly to a receiver as though they were talking directly—one character at a time.



Figure 160: Receiver Sent Data



## 10.2 RA Window (Currently Quasonix Factory Use Only)

The RA Terminal screen provides status information for receiver analyzer channel 1 and channel 2, RA Diagnostic Info, RA Comm Port Setup, RA Received Raw Data Display, and RA Sent Data displays. *This screen is currently available only for Quasonix factory use.*

The screenshot shows the RA Terminal window with the following sections:

- RA Chan 1 Status:**

IC	5.000	MODE	1
RF	---	FR	2200.500
QC	---	AT	30.0
FO	0.000	FA	6
MS	---	EA	1
LDF	1.000	DL	10957
CEF	1.000	OP	-59.79
AM adj	0.000	MPadj	0.000
- RA Chan 2 Status:**

IC	5.000	MODE	1
RF	---	FR	2200.500
QC	---	AT	30.0
FO	0.000	FA	6
MS	---	EA	1
LDF	1.000	DL	12057
CEF	1.000	OP	-59.79
AM adj	0.000	MPadj	0.000
- RA Diagnostic Info:**

Firmware Version: RA V1.205 5/10/2018 Log

Model Number: QSX-RXAN-281D-A1-1111

Serial #: 96470002 FPGA Version: 000h 017h 0

Hardware Rev: A SU State Get Temps
- RA Comm Port Setup:**

Comm Port: COM6 Baud Rate: 2000000 Log File

Disconnect Stop Tx Updates (Re)Start Tx Updates Clr Rx Clr Tx
- RA Received Raw Data Display:**

```

Bert CMBI CC: 00000001h RF1-1 RF2-1 BS: 00000000h FC: 460175030 SY:1 BC:
Bert CMBQ CC: 00000001h RF1-1 RF2-1 BS: 00000000h FC: 0 SY:0 BC:
Bert BSSI CC: 00000001h RF1-1 RF2-1 BS: 00000000h FC: 0 SY:0 BC:
Bert BSSQ CC: 00000001h RF1-1 RF2-1 BS: 00000000h FC: 0 SY:0 BC:
RA>
Bert CH1I CC: 00000001h RF1-1 RF2-1 BS: 00000000h FC: 460175085 SY:1 BC:
Bert CH1Q CC: 00000001h RF1-1 RF2-1 BS: 00000000h FC: 0 SY:0 BC:
Bert CH2I CC: 00000001h RF1-1 RF2-1 BS: 00000000h FC: 460175030 SY:1 BC:
Bert CH2Q CC: 00000001h RF1-1 RF2-1 BS: 00000000h FC: 0 SY:0 BC:
Bert CMBI CC: 00000001h RF1-1 RF2-1 BS: 00000000h FC: 460175030 SY:1 BC:
Bert CMBQ CC: 00000001h RF1-1 RF2-1 BS: 00000000h FC: 0 SY:0 BC:
Bert BSSI CC: 00000001h RF1-1 RF2-1 BS: 00000000h FC: 0 SY:0 BC:
Bert BSSQ CC: 00000001h RF1-1 RF2-1 BS: 00000000h FC: 0 SY:0 BC:
RA>
Bert CH1I CC: 00000001h RF1-1 RF2-1 BS: 00000000h FC: 460175030 SY:1 BC:
Bert CH1Q CC: 00000001h RF1-1 RF2-1 BS: 00000000h FC: 0 SY:0 BC:
Bert CH2I CC: 00000001h RF1-1 RF2-1 BS: 00000000h FC: 460175085 SY:1 BC:
Bert CH2Q CC: 00000001h RF1-1 RF2-1 BS: 00000000h FC: 0 SY:0 BC:
Bert CMBI CC: 00000001h RF1-1 RF2-1 BS: 00000000h FC: 460175030 SY:1 BC:
Bert CMBQ CC: 00000001h RF1-1 RF2-1 BS: 00000000h FC: 0 SY:0 BC:
Bert BSSI CC: 00000001h RF1-1 RF2-1 BS: 00000000h FC: 0 SY:0 BC:
Bert BSSQ CC: 00000001h RF1-1 RF2-1 BS: 00000000h FC: 0 SY:0 BC:
RA>
Bert CH1I CC: 00000001h RF1-1 RF2-1 BS: 00000000h FC: 460175030 SY:1 BC:

```
- RA Sent Data:**

Ve\$0d Send

Figure 161: RA Terminal Screen

### 10.2.1 RA Channel 1 and Channel 2 Status

The top most sections on the RA Terminal screen are RA Channel 1 and Channel 2 Status, as shown in Figure 162.

RA Chan 1 Status				RA Chan 2 Status					
	IC	5.000	MODE:	1		IC	5.000	MODE:	1
<input checked="" type="checkbox"/> RF	ID	---	FR	2200.500	<input checked="" type="checkbox"/> RF	ID	---	FR	2200.500
Tmp (C)	QC	---	AT	30.0	Tmp (C)	QC	---	AT	30.0
43.23	FO	0.000	FA	6	43.83	FO	0.000	FA	6
AWGN	MS	---	EA	1	AWGN	MS	---	EA	1
0.000	LDF	1.000	DL	11054	0.000	LDF	1.000	DL	12163
	CEF	1.000	OP	-59.79		CEF	1.000	OP	-59.79
AM adj	0.000	MPadj	0.000		AM adj	0.000	MPadj	0.000	

Figure 162: RA Channel 1 and Channel 2 Status

Check box

- RF - RF Output; When checked, RF output state is On

Display fields

- TMP (C) - Temperature of the receiver analyzer in degrees Celsius
- AWGN - Current Additive White Gaussian Noise correction factor (applies to both channels)
- IC - I Clock bit rate (Mbps)
- ID - I Data pattern
- QC - Q Clock bit rate (Mbps)
- FO – Frequency offset
- MS - Modulation Index value; PCM/FM only
- LD - Low Density Parity Check (LDPC) factor
- CEF – Convolutional Encoding (CE) factor
- AM Adj – Current AM correction factor (applies to both channels)
- MODE – Waveform modulation currently selected
- FR – Frequency (MHz)
- AT – Attenuation (dB)
- FA –Fixed Attenuator
- EA – External Attenuator
- DL – DAC Level
- OP – Output Power (dBm)
- MPadj – Current MP correction factor

### 10.2.2 RA Diagnostic Info

RA Diagnostic Info displays details about the receiver analyzer, as shown in Figure 163. This information is helpful should the user require assistance from Quasonix Technical Support.

RA Diagnostic Info

Firmware Version: RA V1.203 4/10/2018

Model Number: QSX-RXAN-281D-A1-1111

Serial #: 96470002 FPGA Version: 000h 017h 0

Clear Info Get Info Hardware Rev: A ☐ SU State Get Temps

ZS log

Figure 163: RA Diagnostic Info

- Firmware Version – Describes the firmware revision with date/time stamp
- Model Number – Quasonix product model number
- Serial # - Quasonix product serial number
- FPGA Version – FPGA version installed in the receiver analyzer
- Hardware Rev – Hardware revision
- SU State – Reserved for Quasonix superuser access

#### Buttons

- Clear Info – Deletes information currently displayed in all of the diagnostic fields
- Get Info button – Requests all current version and revision information for the receiver analyzer
- ZS log – Sends ZS command and logs information to a separate file (different from the regular log file)
- Get Temps – Reads the latest FPGA temperatures for Channel 1 and Channel 2 and redisplayes them in the appropriate fields

### 10.2.3 RA Comm Port Setup

RA Comm Port Setup, shown in Figure 164, may be used to change the receiver analyzer communication port settings.

RA Comm Port Setup

Comm Port: COM6 Baud Rate: 2000000

Disconnect (Re)Start Tx Updates Clr Rx Clr Tx Log File

4046 1245

Stop Tx Updates

Figure 164: RA Comm Port Setup

#### Buttons

- Connect/Disconnect – Connects or disconnects comm port
- Stop Tx Updates – Stops all transmitter updates (Quasonix use only)

- (Re)Start Tx Updates – Starts or restarts transmitter updates (Quasonix use only)
- Clr Rx – Clears the received data log
- Clr Tx – Clears the sent data log
- Top white box – Maximum receive buffer in use
- Bottom white box – Current receiver buffer in use

Check box

- Log File – When checked, continuously writes Receiver Analyzer activity to a log file

Drop down menus

- Comm Port – Use drop down menu to select a new communications port
- Baud Rate – Use drop down menu to select the baud rate

#### 10.2.4 RA Received Raw Data Display

The RA Received Raw Data Display shows receiver analyzer command activity.

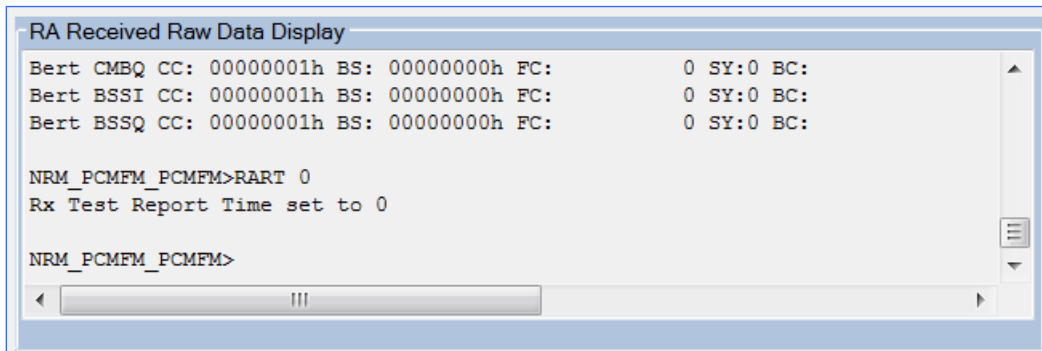


Figure 165: RA Received Raw Data Display

#### 10.2.5 RA Find/Search Field

This field is used to search the Received Raw Data Display for specific words or characters. The search examines all of the information still in the data buffer. Older data drops off of the display when the buffer threshold is reached.

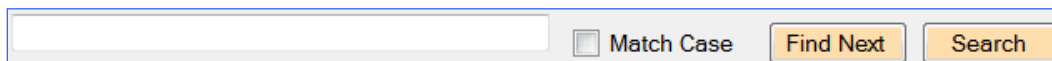


Figure 166: RA Find/Search Field

#### 10.2.6 RA Send String Field

The RA Send String field is used to send a string to the communications port. The whole string is sent at once (\$0d is interpreted as a carriage return) when the send button is clicked. This is useful for sending the same string over and over without retyping it every time (such as a power level reading command).

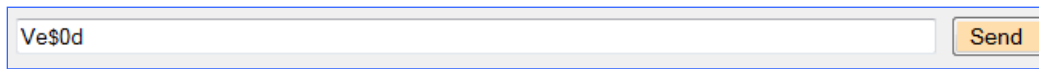
A screenshot of a software interface showing a text input field with the text "Ve\$0d" and a "Send" button to its right. The input field has a light gray border and the text is in a standard monospace font. The "Send" button is a small, rectangular button with a light orange background and a thin border.

Figure 167: RA Send String Field

### 10.2.7 RA Sent Data Display

The RA Sent Data display is an interactive field that lets the user type commands directly to the Receiver Analyzer—one character at a time.

A screenshot of a software interface showing a text area titled "RA Sent Data". The text area is empty and has a light gray border. To the right of the text area is a vertical scrollbar with up and down arrows.

Figure 168: RA Sent Data Display

### 10.3 RAA Window (Quasonix Factory Use Only)

The Receiver Analog Analyzer screen provides status information for the receiver analog analyzer as well as RAA Diagnostic Info, RAA Comm Port Setup, RAS Received Raw Data Display, and RAA Sent Data displays. *This screen is currently available only for Quasonix factory use.*

The screenshot shows the 'RAA Terminal (No RAA detected)' window. It contains several sections:

- RAA Status:** A grid of input fields for Ports 1 through 8. To the right are checkboxes for 'C1 Locked', 'C2 Locked', 'Comb Locked', 'SDI 1 Lock', 'SDI 2 Lock', and 'SDI 3 Lock'. Further right are checkboxes for 'C1 Ones Det', 'C2 Ones Det', and 'Comb Ones Det'. Below these are 'SDI Threshold Ext' and 'Int' fields. A 'Poll' button and a 'Poll time ms' field (set to 1000) are on the right.
- RAA Diagnostic Info:** Fields for 'Firmware Version' and 'Model Number'. Below are buttons for 'Clear Info', 'Get Info', 'Read Ports', and 'Last SDI'. To the right are fields for 'Serial #' and 'Hardware Rev'.
- RAA Comm Port Setup:** A section with 'Comm Port' (set to COM1) and 'Baud Rate' (set to 115200) dropdowns. It includes buttons for 'Connect', 'Rescan Comm Ports', 'Clr Rx', and 'Clr Tx'. Checkboxes for 'Log File' and 'Debug' are also present.
- RAA Received Raw Data Display:** A large text area labeled 'RAA Recvd Data display:'.
- RAA Sent Data:** A text input field with a 'Send' button.
- Right Panel:** A vertical stack of buttons: 'SNON' (green), 'SANA' (blue), 'STTL' (orange), 'S422' (orange), 'SVID' (orange), and 'SDIS' (orange). Each button has a corresponding dropdown menu.

Figure 169: RAA Terminal Screen

## 10.4 ATP (Currently Quasonix Factory Use Only)

The ATP screen allows the user to read in a configuration test file and then run a whole series of tests automatically without further intervention. Detailed ATP testing, regression testing, etc., can all be set up to run automatically and unattended. ATP also allows for quick, direct set up of the RA Generator, Modulator, BERT, and System settings. *This screen is currently available only for limited customer use. There is an example configuration file with formatting and syntax information included in the executable directory on the CD. This file is suitable for modification by the customer if they so desire.* The ATP window is shown in Figure 170.

ATP Data Path:  ...

Load ATP Cfg File

Run ATP

Step ATP

Stop ATP

Number of Tests:

ATP\_file\_line\_cnt

Current Test Number:

ATP\_line\_cnt

Current Test Index:

ATP\_bad\_key\_lines

Percent Complete:

ATP\_error\_lines

ATP\_blank\_lines

☒ Track Test Tab during ATP

ATP\_comment\_lines

Select ALL

Unselect ALL

ATP\_empty\_key\_lines

ATP\_test\_line\_cnt

Test Index	Test Name	Test Type	Test Setup	Mode	# of Tests	Msg
<input type="checkbox"/> 1	test-pwr-0	BER_SWEEP	BER-pwr-001	1	2550	No Message
<input type="checkbox"/> 0	4	21	33	49	52	59

### ATP Test 23

Current ATP Message Data which might be too long for one line

Figure 170: ATP Screen

## 11 Appendix C – Acronym List

Acronym	Description
AGC	Automatic Gain Control
AM	Amplitude Modulation
AQPSK	Variant of Quadrature Phase Shift Keying
ARTM	Advanced Range Telemetry
AUQPSK	Variant of Quadrature Phase Shift Keying
AWGN	Additive White Gaussian Noise
BER	Bit Error Rate
BNC	Bayonet Neill-Concelman Connector (RF Connector)
BPSK	Binary Phase Shift Keying
CD	Compact Disk
CPM	Continuous Phase Modulation
DB-9	D-subminiature 9 pin Serial Connector
dBm	Decibels referenced to one milliwatt; A 0 dBm signal is equal to 1 milliwatt
DC	Diversity Combiner
DHCP	Dynamic Host Configuration Protocol
DPM	Digital Phase Modulation
$E_b/N_0$	Energy per bit divided by noise; ratio of bit energy to noise
FPGA	Field Programmable Gate Array
IF	Intermediate Frequency
IP	Internet Protocol
kbps	Kilobits per second
KHz	Kilohertz
LCD	Liquid Crystal Display
mbps	Megabits per second
MCX	Snap on subminiature connector
MHCPM	multi-h Continuous Phase Modulation
MHz	Megahertz
N	(connector type) Threaded RF connector



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