Rack-Mount Receiver Analyzer 101

A Decade's Worth of Innovation

What's In the Box

Receiver Analyzer

Quasonix Supplied
RA Laptop

HP Power Cable

USB 2.0 6' AtoB Cable

Laptop Power Cable

(2) RF Cables
(with labels
showing cable loss)

(6) 75 ohm BNC Cables
for clock and data

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Hardware Setup

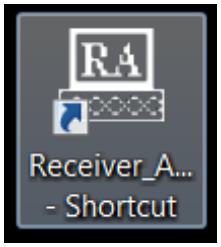
Connection to Quasonix 3rd Gen Receiver

- Connect RF cable labeled “Channel 1” to Tx1 RF Out on RA and Channel 1 RF In on Receiver
- Connect RF cable labeled “Channel 2” to Tx2 RF Out on RA and Channel 2 RF In on Receiver
- Connect the six (6) 75 ohm BNC cables to Ch1, Ch2, and Combiner Clock and Data between the Receiver and Receiver Analyzer

Ready to Run

1. Plug Receiver Analyzer into wall socket
2. Power on the Quasonix supplied RA Laptop
3. Connect USB from Receiver Analyzer to Laptop
4. It is preferred to *always* use the left front USB port. While not required, this will prevent Windows from installing multiple copies of drivers.
5. Power on the Receiver Analyzer
6. Power on the Receiver under test
7. Run the Receiver Analyzer Windows application

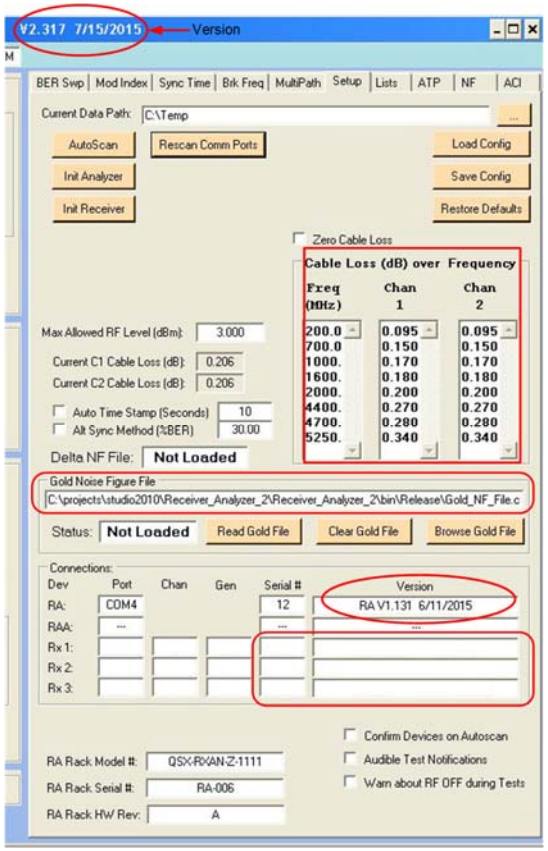
   Click on the desktop icon or use file Receiver_Analyzer_2.exe.

RA Desktop Icon 

RA WinApp

Normal Customer Use

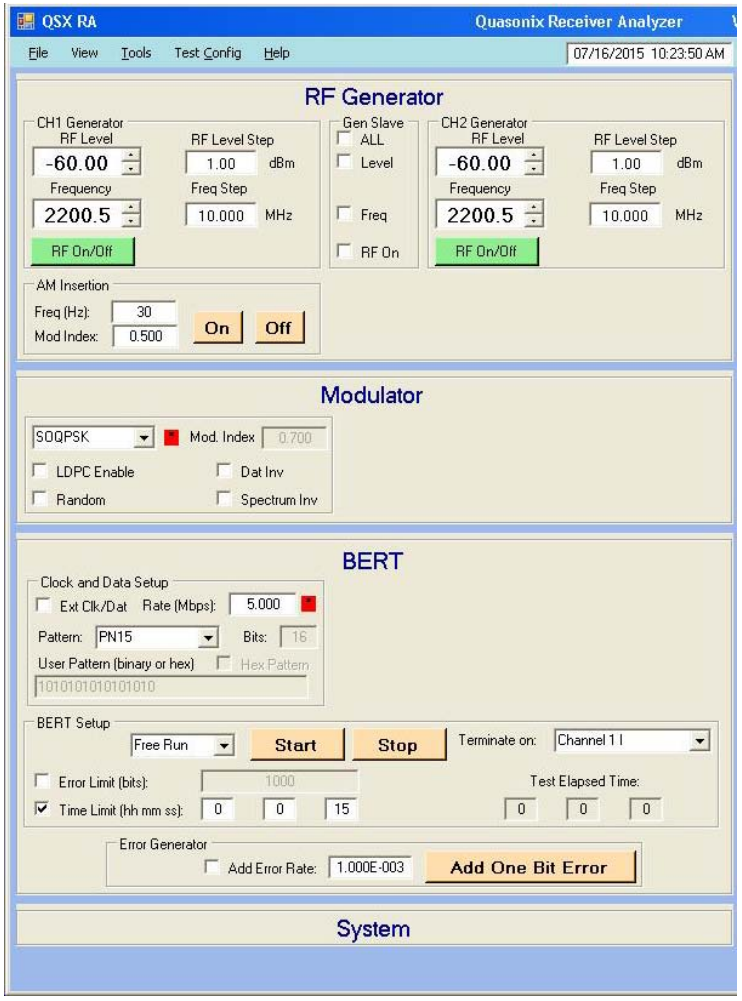
Quasonix technicians should look at five (5) items on startup:



1. RA Winapp version (at top of screen). The RA Winapp version should be the most recently released
2. Check Cable Losses and match to the actual cabled connected
3. File loaded for Gold Noise Figure File
4. RA embedded code should be RA V1.131 6/11/2015
5. Rx 1, Rx 2, and Rx 3 should be blank to use the RA the way the customer will—No serial ports

Customers only need verify that the Receiver Analyzer was detected and check cable losses.

RA WinApp



The left side of the main window contains:

RF Generator

Modulator

BERT

System level settings.

They are used to control the Dual RF signal sources in the Receiver Analyzer and the built-in BERTs.

Menu bar:

Quick access to load and save settings, window displays, and Help.

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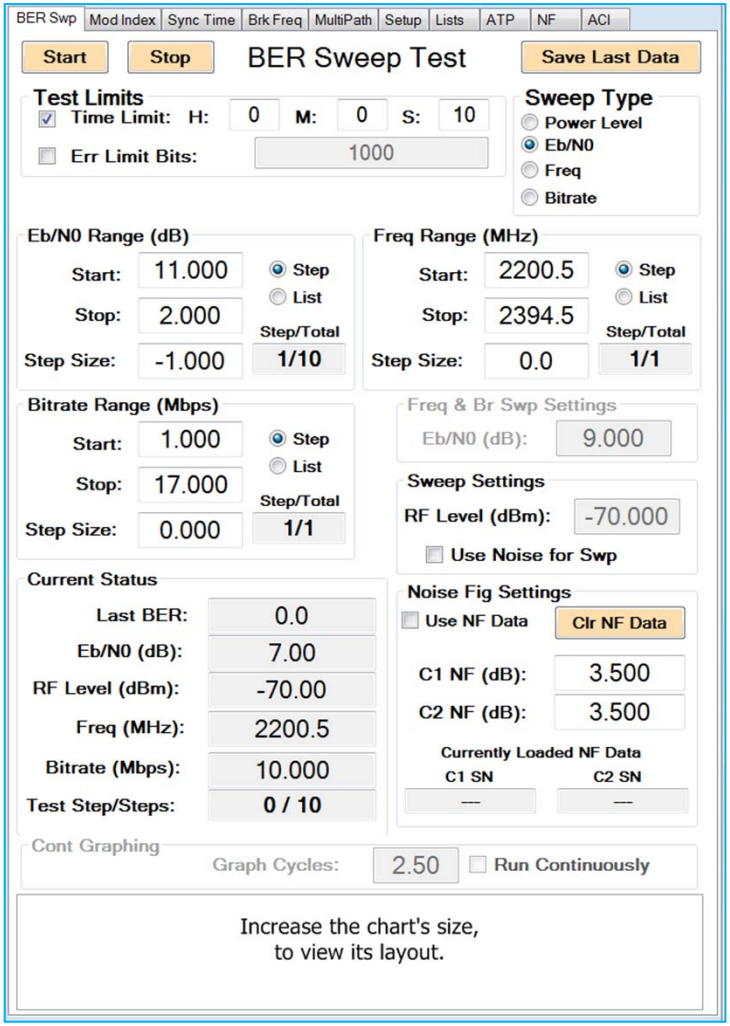
RA WinApp

The right side of the main window contains test tabs. Each tab is intended to set up one specific type of test.

More on these later.



Changing Settings

What happens when…

- Buttons
- Combo box/drop down selections
- Check boxes
- Up/down arrows on text boxes

} Actions happen immediately

- Changing text in a box – Nothing happens until the user clicks outside the box or presses the Enter key

- Left side sections (RF Generator, Modulator, BERT, System) can be opened or closed to allow more features to fit on the screen. Clicking on the section name toggles the open/closed state.

Saved Configs

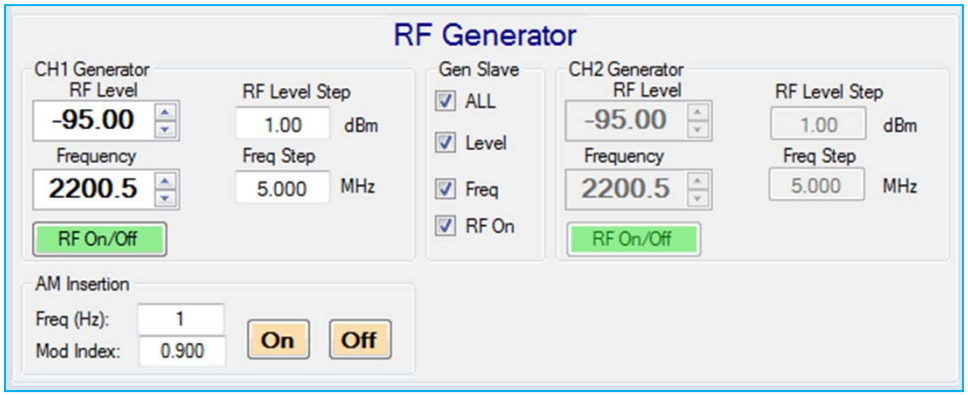
What is Saved:

- State of Signal Generator side including RF On/Off, Mode, Frequency, etc.
- Window Positions
- Enabled channels on Rx Status Window
- Selected Ref Channel (on BERT section) – “Terminate on” box
- Open/Closed state of left side sections (RF Generator, Modulator, etc.)
- Settings in all test tabs
- State of Multipath tab (running or not since this is just an extended signal CFG)

What is Not Saved:

- No test will ever come up running
- ATP will NOT have a file loaded and will not be running
- Advanced tools will NEVER be enabled

RF Generator

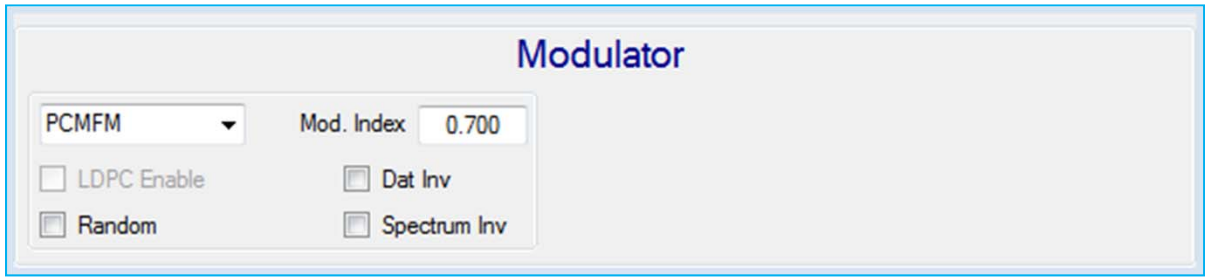


- Lets the user set RF Level and Frequency of the two RF outputs on the Receiver Analyzer
- RF Level Step and Frequency Step may be set for quick stepping between levels or frequencies
- RF On/Off control
- AM output at a given frequency and amplitude can be added to the RF outputs

  Frequency Range for AM is 1 Hz to 5 MHz

  Modulation Index is 1E-6 to 2.0

Modulator



- Lets the user select from the following modes:
  - PCM/FM
  - SOQPSK
  - MhCPM
  - BPSK
  - QPSK
  - Carrier
  - OQPSK

- LDPC is available in SOQPSK mode
- Modulation Index may be changed in PCM/FM mode

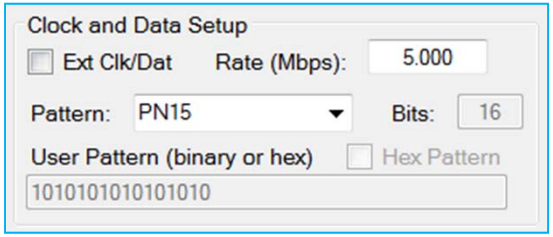
Available in all modes:

- Data Inversion
- Spectral Inversion
- Randomization

BERT – Clock and Data Setup

The BERT section has three parts:

- Clock and Data Setup
- BERT Setup
- Error Generator



Clock and Data Setup lets the user set data rates from 0.001 Mbps (1 kbps) to 46 Mbps.

Data Patterns include Mark, Space, alternating 01, eight standard PN sequences, and user patterns of 1 to 32 bits.

External clock selection is possible by clicking on the box and adding an external clock input to the back of the Receiver Analyzer, but this is rarely used.

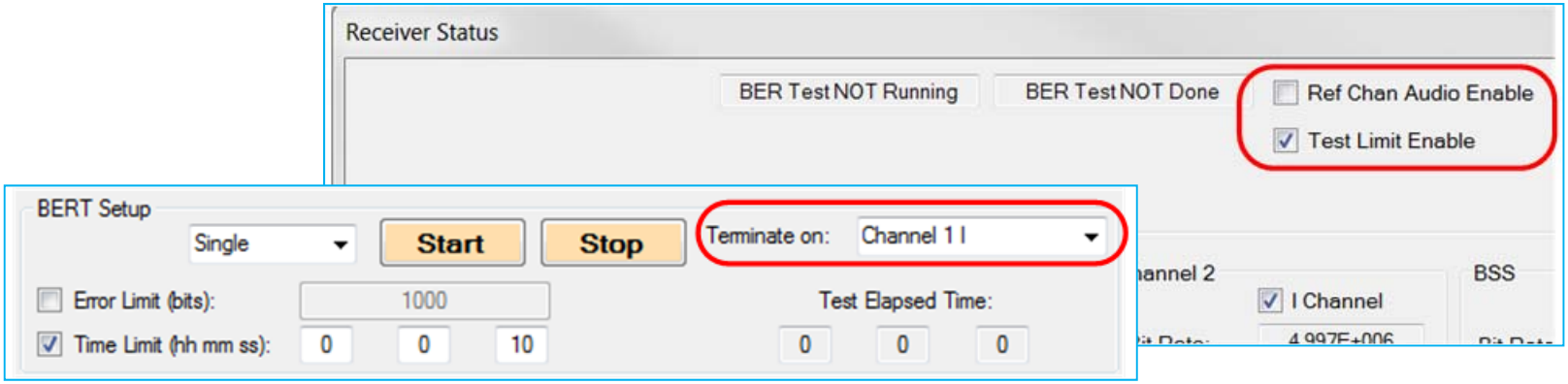
BERT – BERT Setup

This is the heart of the Receiver Analyzer test capability.

- Tests can be set up and run AND results can be viewed on the Rx Status or BER Status windows.
- Tests can be limited by time or detected errors. If errors are used, then the "Terminate on" Channel decides which channel errors are looked at.
- Test choices are:
  - Single – Runs until time or error limit is reached or the user clicks on the Stop button
  - Repeat – Same as Single but at the *end* of the test, the Error Rate is updated on the Rx Status and a new test starts; Continues to start new tests until the user clicks on Stop
  - Free Run – Test runs until the user clicks on the Stop button; User can click on Restart during the test to restart the test with cleared statistics

BER Testing

The channels listed in the “Terminate on” drop down menu are determined by the enabled channels on the Rx Status window. The selected channel is called the Ref Channel.



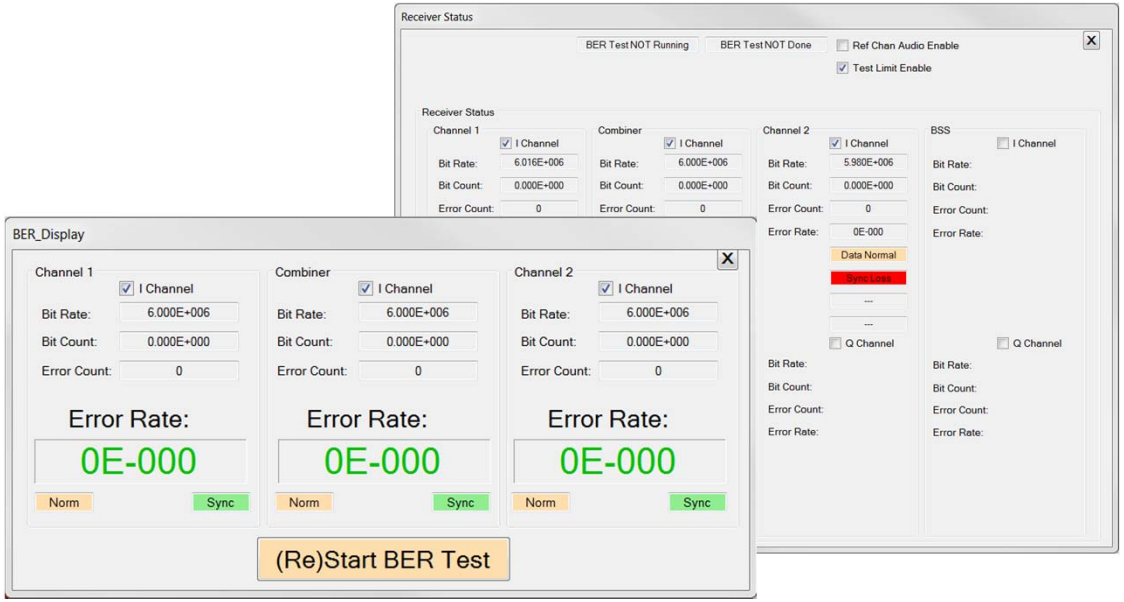
- In general, data is saved for enabled channels only.
- The Reference Channel Audio Enable check box (on the Receiver Status screen) causes the Receiver Analyzer to generate tones based on the bit error rate of the Ref Channel.
- The Test Limit Enable check box adds a test limit line to certain graphs. This and the graphing are being changed/expanded in future versions.

BER Testing

During a BER test:

- Start button changes to green
- Rx Status and BER Status windows update
- Test Elapsed Time updates on the BERT window

This is the basic test used by many of the more involved test tabs.



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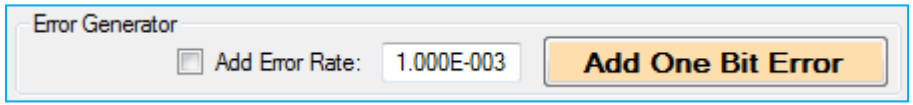
BERT – Error Generator



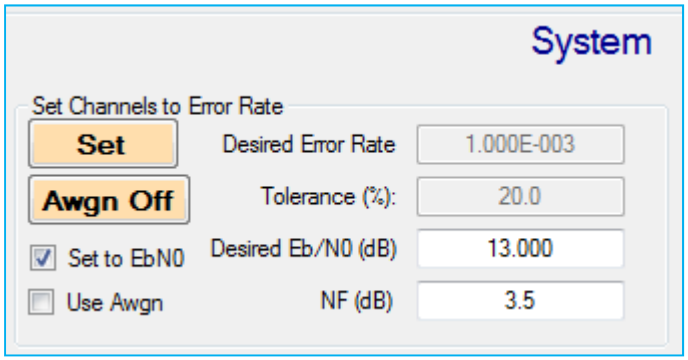
The third part of the BERT section is the Error Generator.

- The Error Generator allows the user to insert single bit errors into the data stream or to introduce a constant bit error rate in the stream.

System

The System section allows the user the use GOOD outgoing data from the Receiver Analyzer but set the received error rate to a specific value. This can be done in two ways:

1. Lower the RF level until the desired error rate is achieved, or
2. Leave the RF level alone and add noise to the outgoing RF



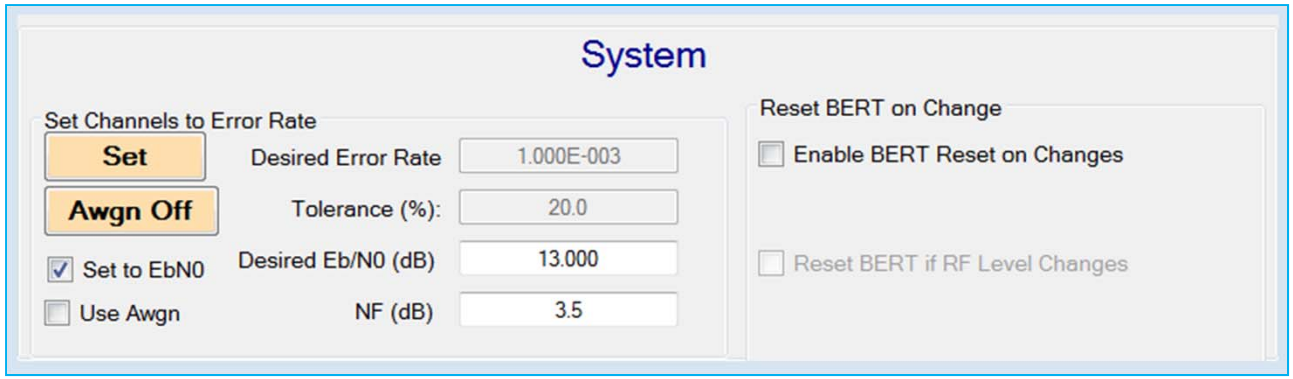
Currently, set to Eb/N0 is the only option.

- Specify the desired Eb/N0 and the current receiver noise figure, then click on the Set button.

If Use Awgn is **not** checked, this will calculate the desired RF level and set it.

If Use Awgn is checked, the RF level is not changed but noise (Additive White Gaussian Noise) is added to achieve the desired Eb/N0.

System – Reset BERT on Chg



- Reset BERT on Change (if enabled) lets the user select conditions under which the test will automatically restart. The only currently active option is Reset BERT if RF Level Changes.

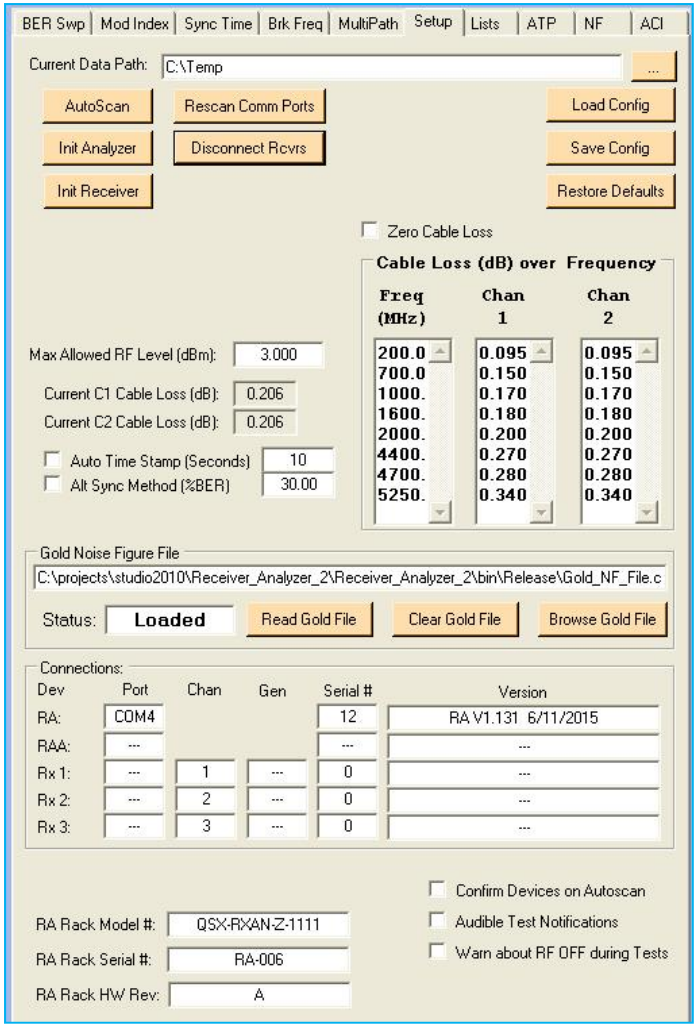
- Options for Frequency Change, Mode Change, and RF On/Off Change are still on the drawing board.

More About the Setup Tab

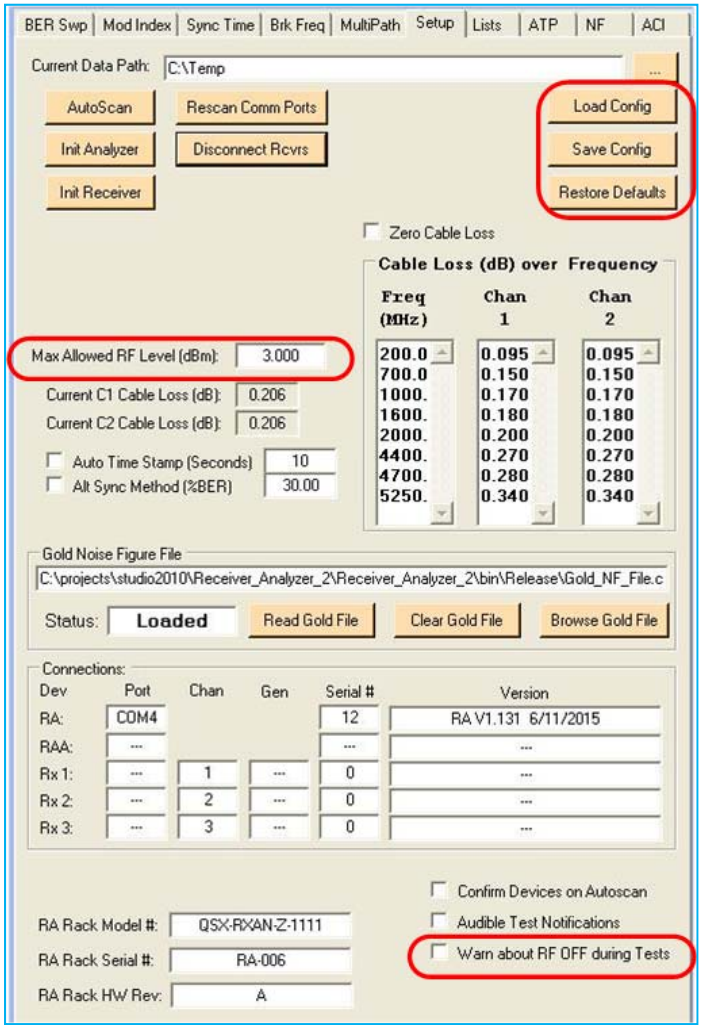
Setup contains a number of items that are important for normal operation.

- Current Data Path – This determines where all of the generated test data will be stored on the hard drive.
- Cable Loss – If the user chooses to supply their own cables, best results will be obtained if they measure and enter the cable losses here. Clicking on the Zero Cable Loss check box sets the loss to zero (0) everywhere (perfect cables).

Note that at any given time, the actual cable losses being used are displayed here (Current C1 and C2 Cable Loss (dB).)



Still More About the Setup Tab



The user also has the ability to limit the maximum output power of the Receiver Analyzer to protect equipment.

- Max Allowed RF Level (dBm) – Will prevent any test or user change to RF level that would exceed the given limit
- Warn about RF OFF during Tests – This check box gives the user a prompt if they attempt to start (most) tests with RF turned off
- Setup tab has buttons for the following:
  - Load Config Alt-L
  - Save Config Alt-S
  - Restore Defaults Alt-D

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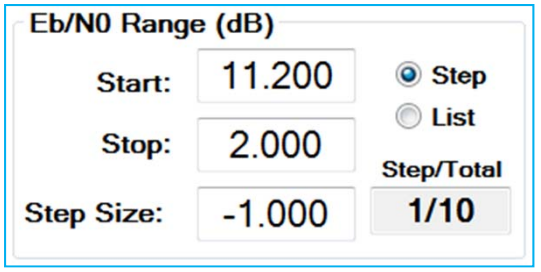
Setup Tab Items To Ignore

…For Now:

- Rescan Comm Ports button
- Disconnect Rcvrs button
- Init Analyzer button
- Init Receiver button
- Auto Time Stamp (Seconds)
- Alt Sync Method (%BER)
- Confirm Devices on Autoscan (check box)
- Audible Test Notifications (check box)

Lists and Start/Stop/Step

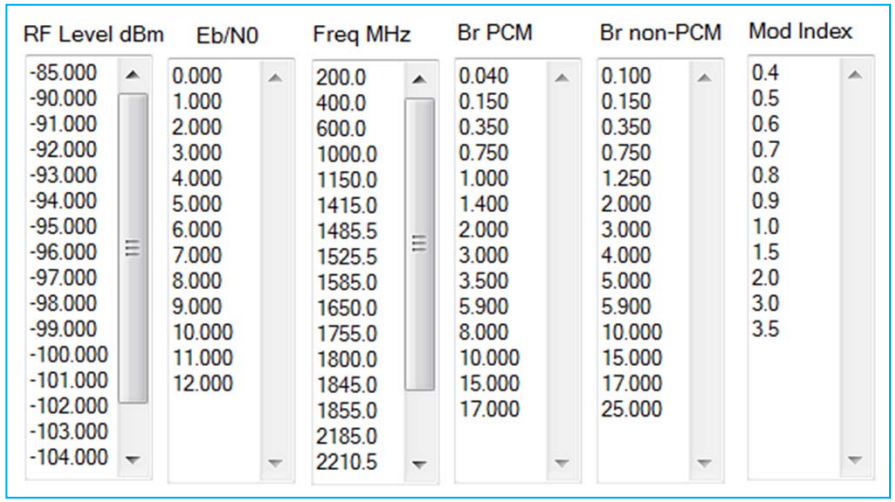
Almost everywhere that tests can be run over ranges, the user has a choice between a simple Start/Stop/Step loop or a List.



List

List lets the user choose the points to run the test at. If List is chosen, then the currently loaded list corresponding to the test type is used for the test. On the Lists tab there are separate lists for:

- RF Level
- Eb/N0
- Frequency
- Bit Rate (PCM/FM)
- Bit Rate (non-PCM/FM)
- Modulation Index

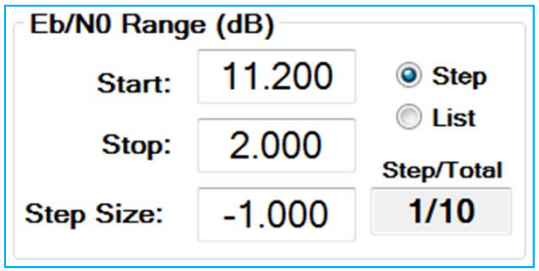


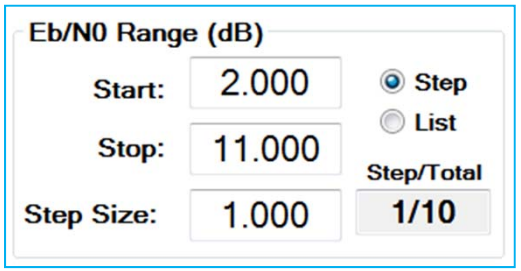
Lists and Start/Stop/Step

Step

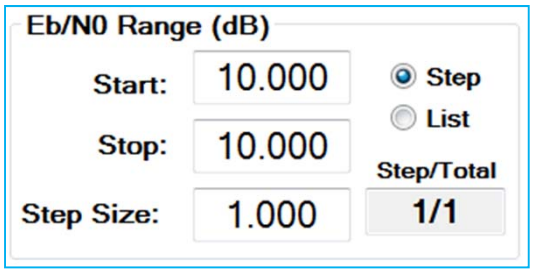
If Step is chosen, then generally the user can determine the order of the items by placing the first desired value in the Start field and the ending value in Stop.

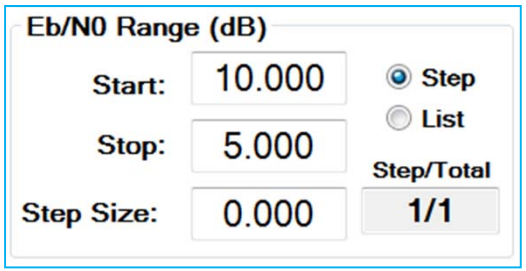
The sign of the step is adjusted accordingly.





If the user wants to run only one value, they either set Start and Stop to the same value OR set Step to zero (0).





Tests (Yea!!!)

At this time, the Receiver Analyzer supports the following tests:

- BER Sweeps over
  - RF Level
  - Eb/N0
  - Frequency at an Eb/N0
  - Bit Rate at Eb/N0
- Modulation Index Testing of PCM/FM
- Sync Time Testing
- Break Frequency Testing
- Multipath Signal Generation for use on equalizer tests
- Noise Figure Testing ONLY on Quasonix receivers with the optional serial port interface board and (1-3) USB serial ports added to the RA laptop

BER Sweep Test

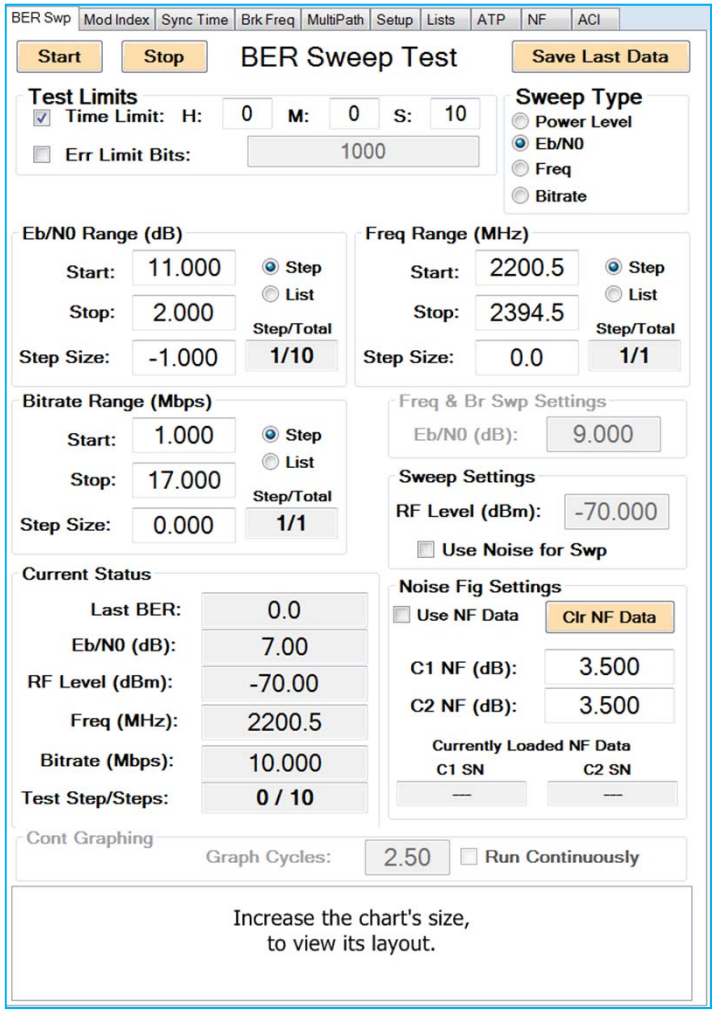
1. Choose the type of sweep (RF Level, Eb/N0, Frequency, Bit Rate)
2. Set the test limit type and value (Time Limit, Err Limit Bits)
3. Set Range to run over – For Power Level sweep, this is one Step/List window; for Eb/N0 sweeps, there may be nested loops over Frequency and Bit Rate (easy on a Quasonix receiver with serial interface, tedious on anything else)
4. Enable the desired channels on the Rx Status window
5. Click on the Start button and wait for the test to finish

   Current status information and Rx Status update during the test.

In general, the Start button turns green and changes to Pause when the test is running. The User can click on Pause and the button turns yellow and changes to Cont to let the user know the test is waiting.

When the test is finished, the user is prompted to save the data. If the user clicks on No, the data can still be saved by clicking on the Save Last Data button until a new test starts.

BER Sweep Tab



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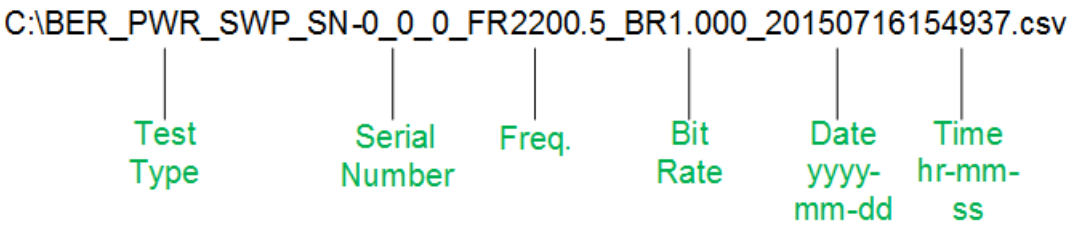
Saved Data Files

- Data files are saved as .CSV files, which can be directly entered into Excel for graphing
- Data files are named with Test_Type, Receiver Serial Numbers, test specific settings like frequency and bit rate, and a date/time stamp

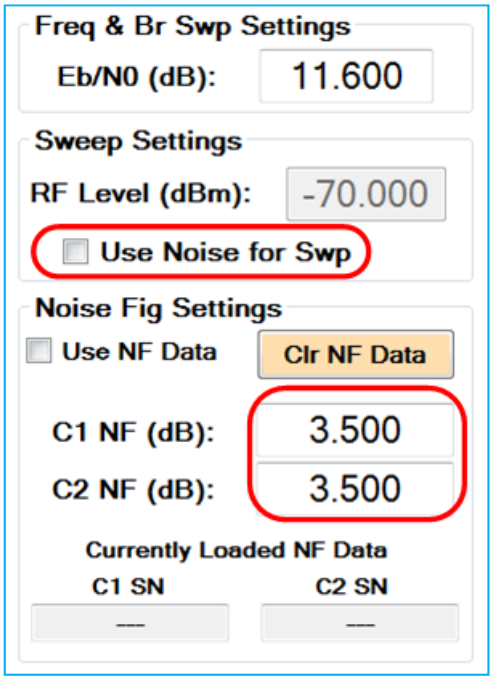


- Information including filename, serial numbers, mode, frequency, bit rate, etc. are included in the file as appropriate for the test

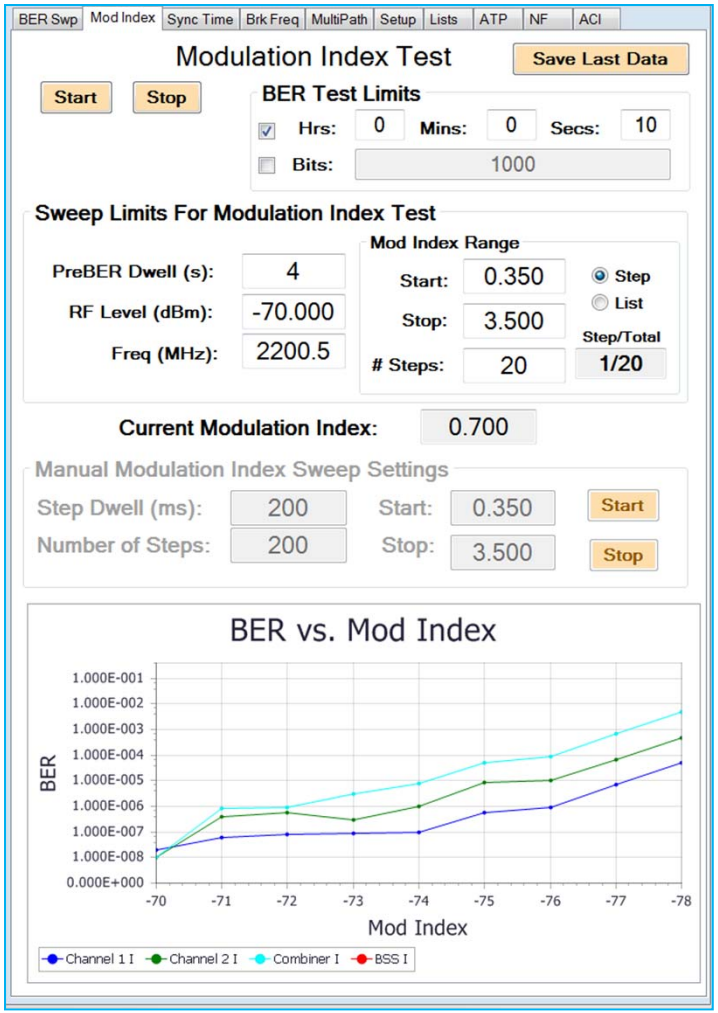
BER Sweeps

- Frequency/Bit Rate sweeps allow the user to choose an Eb/N0 to target (typically set near 10^{-5} BER for the current mode) which can be set either by dropping the RF level or by using a fixed RF level and adding AWGN (refer to System page, setting channels to Eb/N0)

- Channel 1 and 2 noise figures shown in the Noise Fig Settings window are used for this calculation. Fixed RF and AWGN is selected by clicking on the Use Noise for Swp check box



Modulation Index Tab



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Modulation Index Test

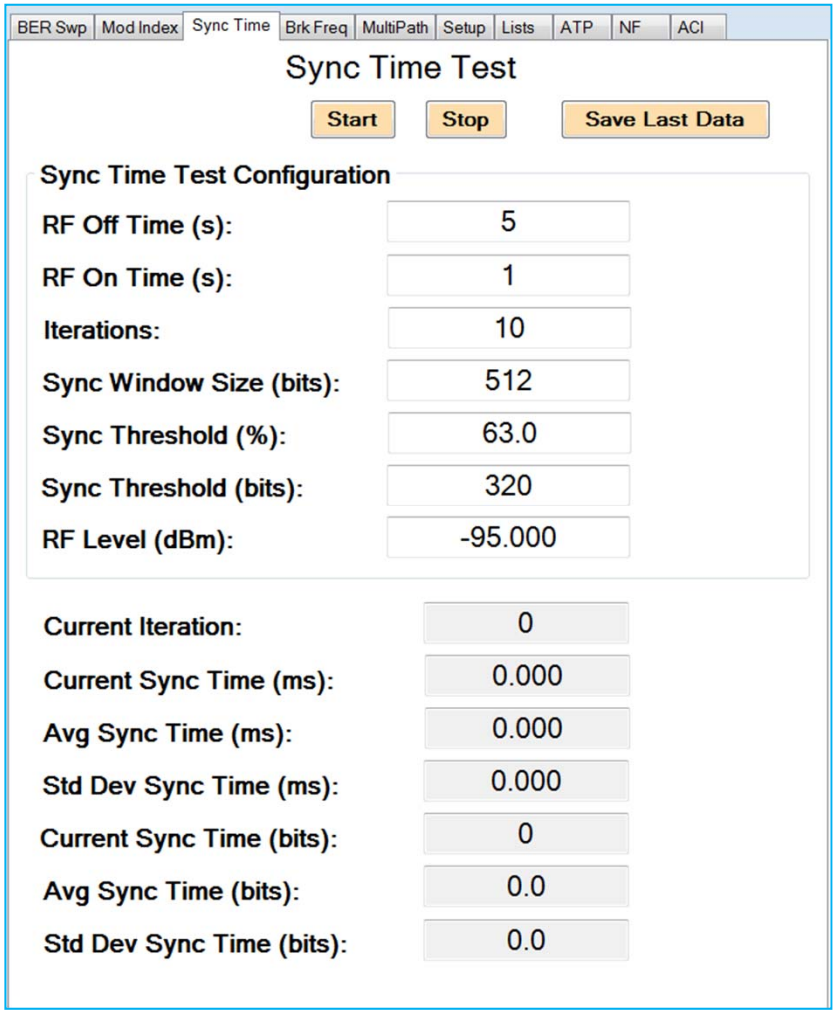
1. Set test limit type and value (time limit/bit error limit)
2. Set Range of indices (List or Step)

   Note in this case only, Step works by calculating exponential steps from Start to Stop—not linear steps. Here it is “# Steps”—number of steps rather than Step Size.
3. Set PreBER Dwell in seconds
4. Set Frequency (MHz) and RF Level (dBm) – the mode will switch to PCM/FM automatically
5. Enable desired channels on the Rx Status window
6. Click on the Start button and wait for the test to finish

   Current stats and Rx Status window update during the test.

The Pause/Cont/Stop buttons and Save File functionality are the same as those explained in BER Sweeps.

Sync Time Test Tab



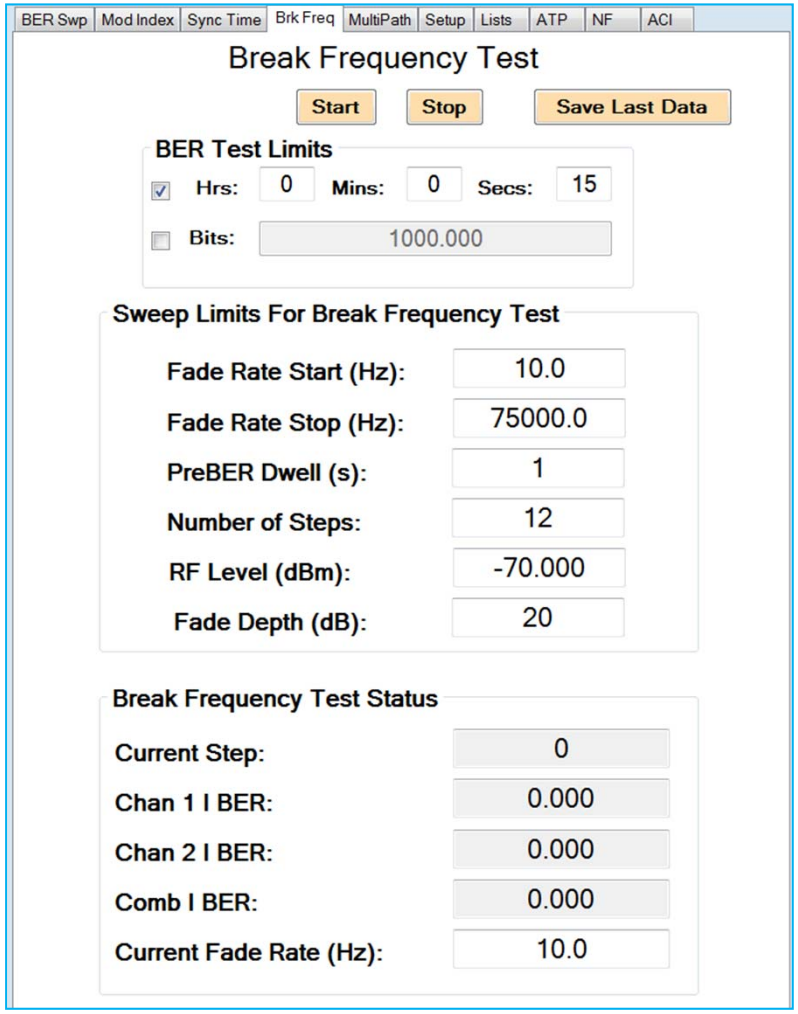
Sync Time Test

1. Set parameters as desired
2. Enable channels on the Rx Status window
3. Click on the Start button and wait for the test to finish

   Current statistics and Rx Status window update during the test.

The Pause/Cont/Stop buttons and Save File functionality are the same as those explained in BER Sweeps.

Break Frequency Test Tab



Break Frequency Test

1. Set test limit types and values
2. Set sweep parameters
3. Enable channels on the Rx Status window
4. Click on the Start button and wait for the test to finish

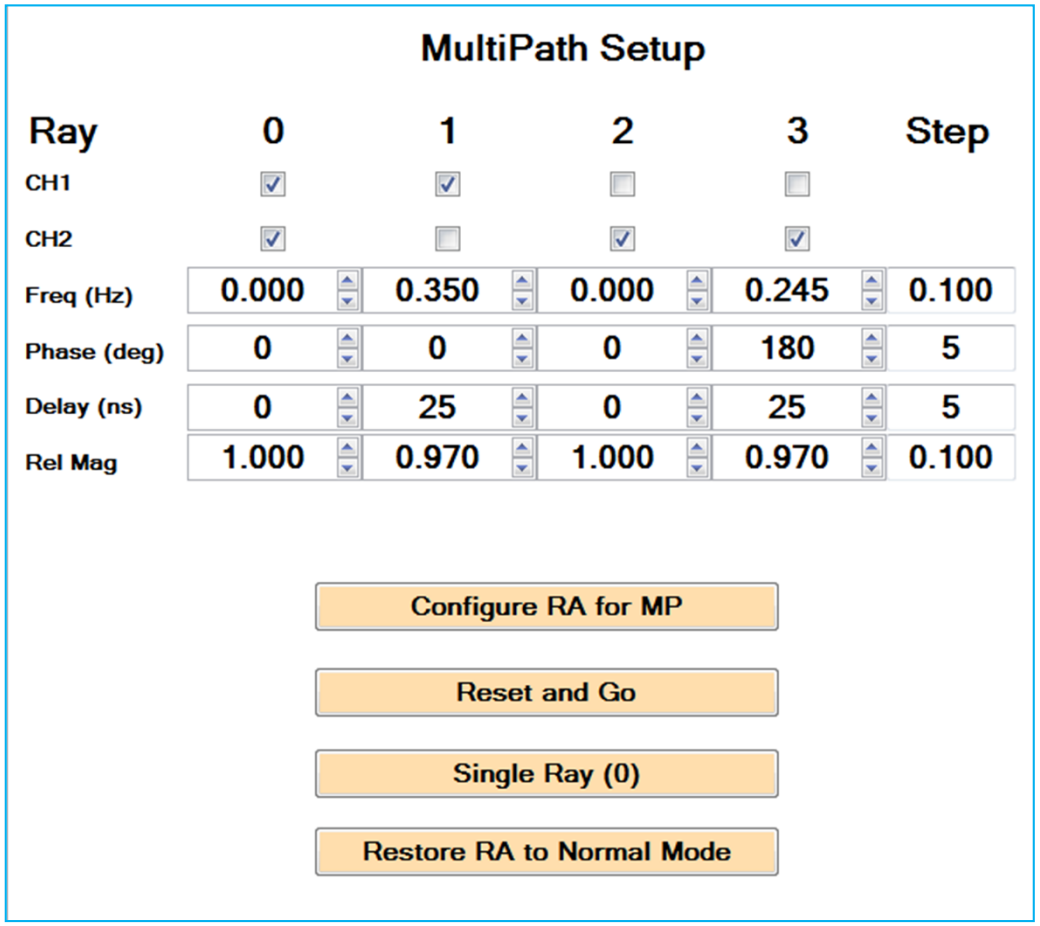
   Current statistics and Rx Status window update during the test.

The Pause/Cont/Stop buttons and Save File functionality are the same as those explained in BER Sweeps.

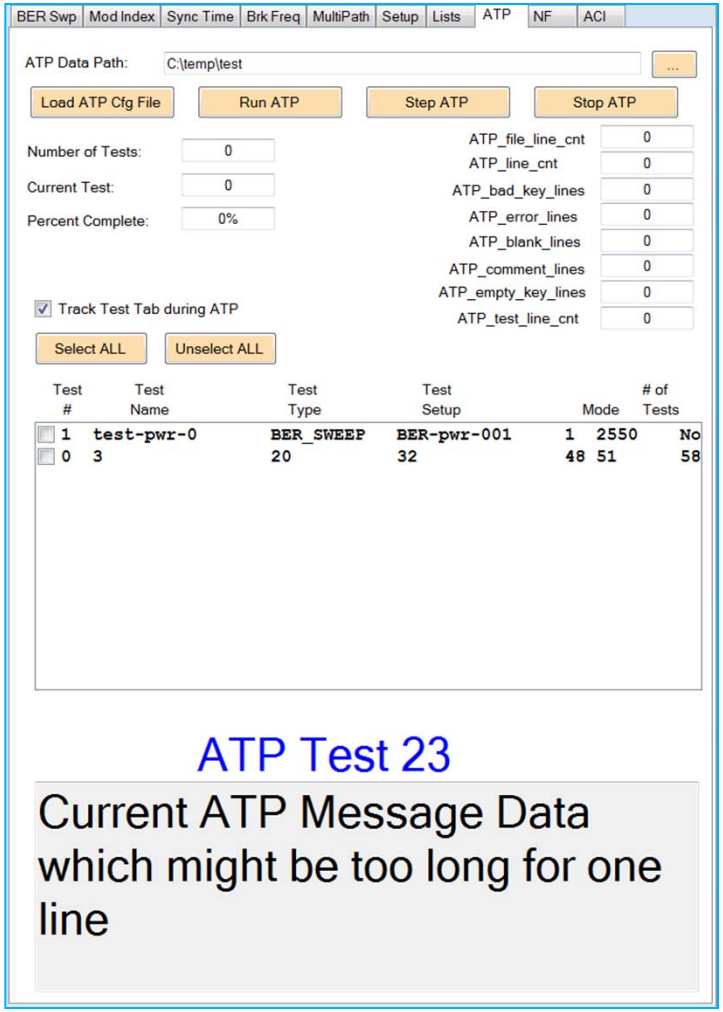
MultiPath Setup

If you know what you're doing, this tab can generate some realistic multipath RF outputs that could be prime material for testing an equalizer.

Note that the RA Laptop comes preinstalled with Bob Schumacher's Equalizer Demo App which has the same knobs but is helpful for simulating and visualizing what is happening here.



ATP Tab


BER Swp
Mod Index
Sync Time
Brk Freq
MultiPath
Setup
Lists
ATP
NF
ACI
ATP Data Path:
C:\temp\test
...
Load ATP Cfg File
Run ATP
Step ATP
Stop ATP
Number of Tests:
0
Current Test:
0
Percent Complete:
0%
ATP_file_line_cnt
ATP_line_cnt
ATP_bad_key_lines
ATP_error_lines
ATP_blank_lines
ATP_comment_lines
ATP_empty_key_lines
ATP_test_line_cnt
Track Test Tab during ATP
Select ALL
Unselect ALL
Test #
Test Name
Test Type
Test Setup
Mode
# of Tests
1 test-pwr-0 BER_SWEEP BER-pwr-001 1 2550 No
0 3 20 32 48 51 58
ATP Test 23
Current ATP Message Data which might be too long for one line

ATP

In order to facilitate in-house testing of Quasonix Receivers, the Quasonix Receiver Analyzer 2 supports an extensive ATP capability.

A test file (master in .xls, working file saved as *.csv) contains definitions for lists, test setups, and finally, actual tests to run.

In addition to system testing, there are basic RA Winapp commands which let the user configure the Receiver Analyzer as desired from a test file. This might be seen as an alternative to loading and saving multiple config files.

An example file is included “Customer_ATP_Example_File_2015-7-15.xls and .csv.

Troubleshooting Problems - 1

- RA Winapp starts up, displays on the Taskbar but no window is visible

1. Click on RA on the Taskbar and press CTRL-F9.

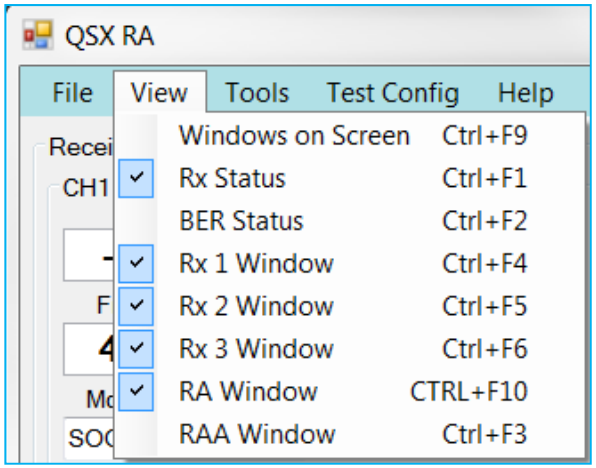
   This moves all windows onto the main screen, regardless of where they were saved.

   Alternately, close the application, go to the Receiver_Analyzer_2.exe directory and rename or delete the rx_test_app.cfg file. This forces the program to use default values.

   Restart the application.

Troubleshooting Problems - 2

- RA Winapp is running, but even though some windows have check marks by them, some are not visible
    1. Click on the View menu, “Windows on Screen” menu item or press CTRL-F9



- RA Power Output appears to be wrong
    1. Be sure the correct RF cables are being used and that the cable losses entered on the Setup page are correct

Troubleshooting Problems - 3

- Can't get output power above xx dBm but it should go up to 0 dBm
  1. Check the Setup page Max Allowed RF Level and adjust if needed.

- RA Winapp starts but Setup shows no Receiver Analyzer connected
  1. Is the Receiver Analyzer plugged into a live outlet?
  2. Is the Receiver Analyzer powered On?
  3. Is the USB cable connected from the Receiver Analyzer to the RA laptop?
  4. Use Alt-A or Autoscan on the Setup tab to try to find the Receiver Analyzer again. Sometimes windows takes a long time to resolve USB devices and it may not have been ready when RA Winapp started

Extras

- RA laptop includes Excel for graphing and data visualization
- Pico scope is a four (4) channel oscilloscope which is internally connected to the clock out from the Receiver Analyzer and from three (3) clock inputs from Channel 1, Channel 2, and Combiner. This provides a visual feel for “lock”.
- Equalizer Demo from Bob Schumacher

Summary

Quasonix

Thank You!