ISO 9001:2015
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Installation and Operation Manual

Best Source Selector Analyzer

Quasonix, Inc.
6025 Schumacher Park Dr.
West Chester, OH 45069
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Specifications subject to change without notice.

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1 Introduction

1.1 Description

This document describes the installation and operation of the Quasonix Best Source Selector Analyzer (BSSA™).

The Quasonix BSSA™ has 12 independent data generators capable of emulating a multitude of best source selection challenges such as channel delay, Doppler effects, variable bit error probability, receiver sync loss, and more. Twelve PCM I/O and twelve TMoIP I/O are independently configurable as input or output, with the ability to monitor and report results for up to four simultaneous channel groups.

Tests are precisely repeatable, so it's easy to make valid comparisons of any equipment across a wide variety of scenarios. Evaluate strengths and weaknesses, focusing on the signal impairments most likely to occur on your range. By including DQE framing with the exact DQM based on dynamic error probability, it's possible to know with certainty how your BSS is performing not only in the absolute but also relative to theory.

The BSSA™ can help you to test and optimize your own specific BSS parameters, such as those you may be using for receiver data correlation and realignment. Refine and improve your system with no actual data lost.

The Quasonix Best Source Selector Analyzer is manufactured by:

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

1.2 Nomenclature

The Quasonix Best Source Selector Analyzer is available in a single configuration, QSX-BSSA, which includes twelve (12) PCM channels, 12 TMoIP channels, 12 simultaneous source outputs, and four (4) groups.

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

1.2.1 Standard Package Contents

The contents of the shipment include the following:

- 1U BSSA™
- Power Cord
- Four (4) rubber feet with adhesive for lab bench use

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

2 Specifications

Characteristic	Specification
Core	
Data Rate	24 Kbps (100 Kbps for TMoIP) to 46 Mbps per channel (TMoIP max aggregate rate of all channels limited depending on specific user settings.)
Physical Input/Output Channels	12 PCM and 12 TMoIP available
Logical Output Channels	12 available (Each logical output is assignable to one source.)
Channel Groups	4 available
BERT	Bit error rate test capability using pre-defined patterns on each output and input channel
EBERT	Estimated BER based on DQM allows evaluating BSS combined DQE/DQM output
Programmable Channel Settings	Base delay (at least 1 second) Variable delay/Doppler (at least equivalent to Mach 20) Variable bit error rate Receiver sync loss emulation (random bit rate offset within settable limits at least +/-1%)
PCM I/O	
Channels	12, each independently configurable as output or input for BSS channel groups
BNC Clock and Data Pairs	12 (75 ohm, TTL)
MDM-25 Ports	2 RS-422
Clock/Data Polarity User	User Selectable
Auto Clock Edge Detection	Yes
TMoIP I/O	
Channels	12, each can be an output or input for BSS channel groups
Packet Format	IRIG 218-20 TMoIP
First Bit Timestamping	Based on Network Time Protocol (NTP) or Precision Time Protocol (PTP) time, via Ethernet
Network	
Network Interface	1000 BASE-T
Number of Interfaces	2, separate ports for configuration and TMoIP data
User Interfaces	
Local Front Panel Interface	Four (4) displays for health and status monitoring
Browser Interface	Command, Control, Health, and Status
Integrated Status Reporting	Yes
Easy Field Updates	Yes
Physical	
Size	1U rack unit, depth 14 inches
Weight	7.4 lbs
Power	90-264 V-RMS, 47-63 Hz

3 Installation Instructions

3.1 Mechanical

The Best Source Selector Analyzer enclosure fits in a standard 19” rack, occupying just 1U of rack space. Mechanical layouts are provided in Figure 1, Figure 2, and Figure 3.

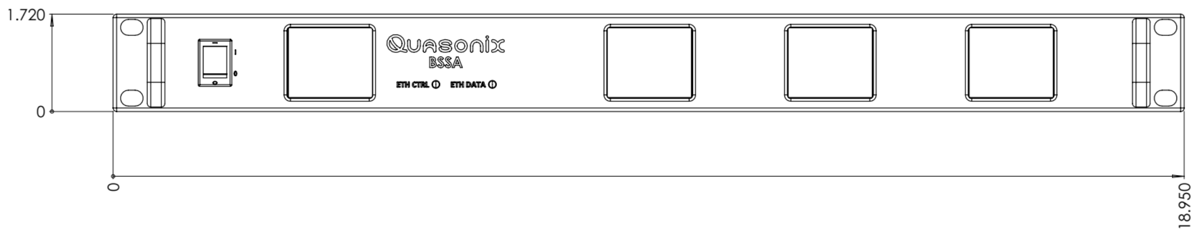


Figure 1: Mechanical Drawing – 1U Front View

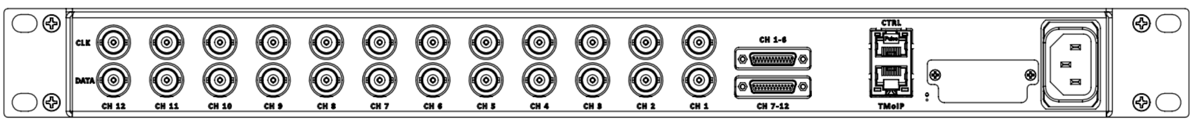


Figure 2: Mechanical Drawing – 1U Back View

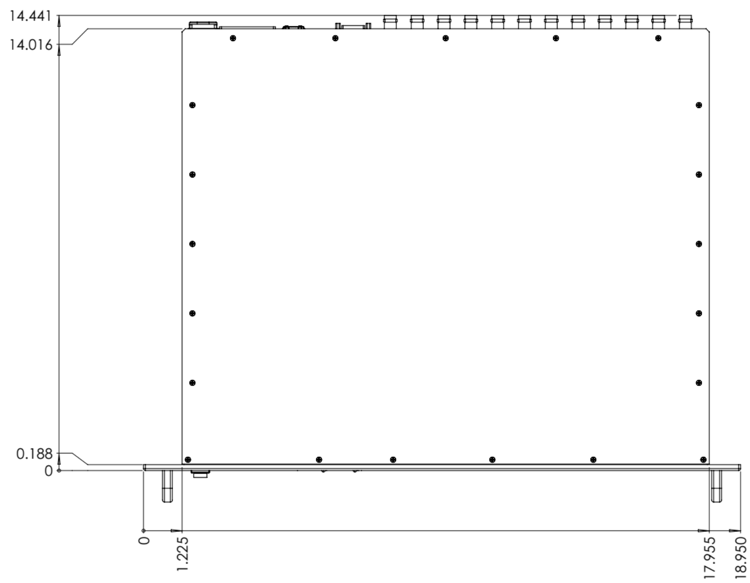


Figure 3: Mechanical Drawing – 1U Top View

3.2 Environmental

The storage temperature of the BSSA™ is rated for -20°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 unit features cooling vents on both sides of its aluminum chassis. These vents must be kept entirely unobstructed in order to allow for maximum airflow through the system. Whenever feasible, it is helpful to leave an open rack space above and below the 1U unit for additional heat dissipation.

3.3 Electrical

The power switch is located on the front panel, as shown in Figure 4. All pertinent electrical connections are on the rear panel.

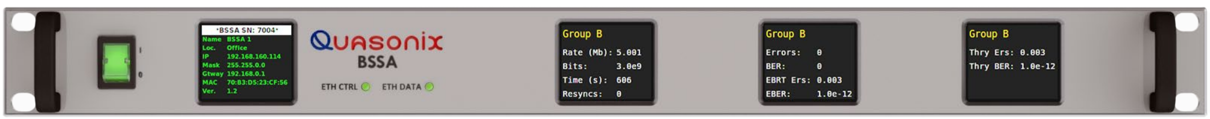


Figure 4: BSSA™ Front Panel

3.3.1 Rear Panel Connections

The BSSA™ has twelve (12) PCM channels available via twelve (12) BNC clock and data pairs or two MDM-25 connectors. Additionally, twelve (12) TMoIP channels are available via a TMoIP Ethernet port.

Rear panel connectors are the same for all configurations. Connectors are present whether the feature is ordered or not. The electrical interface connectors are shown in Figure 5.

Figure 5: Rear Panel

The stacked MDM connector contains two male MDM-25 connectors. The MDM connectors must be cabled to source or destination equipment via a twisted pair shielded cable, such as a Glenair cable starting with 177-740-2-25-S, as described in the following document: https://www.glenair.com/micro-d/pdf/b/shielded-cable-assembly.pdf.

Functional descriptions and electrical characteristics for each connector located on the rear panel are described in Table 1.

Table 1: 1U Rear Panel Connectors

Name	Description
CLK (1-12)	TTL 75 Ohm PCM Clock signals for channels 1-12 Input or Output depending on software configuration
DATA (1-12)	TTL 75 Ohm PCM Data signals for channels 1-12 Input or Output depending on software configuration
CH 1-6	MDM-25 RS-422 clock/data signals for channels 1-6 Input or Output depending on software configuration
CH 7-12	MDM-25 RS-422 clock/data signals for channels 7-12 Input or Output depending on software configuration
CTRL	10/100/1000Base-T Ethernet connection for configuration of unit AKA Control Ethernet
TMoIP	10/100/1000Base-T Ethernet connection for TMoIP data packets AKA Data Ethernet
'Dot'	Hole for accessing Reset to Defaults button
Power	Supplies AC power to the unit

3.3.1.1 MDM-25 D-Sub Pinout Ch 1-6

The pinout for the Ch 1-6, an MDM-25 D-sub connector, is shown in Table 2. Pin locations are illustrated in Figure 6.

Table 2: MDM-25 D-Sub Pinout (Ch 1-6)

Pin	Electrical Char.	Pin	Electrical Char.
1	CH1 CLK 422 P	14	CH1 CLK 422 N
2	CH1 DATA 422 P	15	CH1 DATA 422 N
3	CH2 CLK 422 P	16	CH2 CLK 422 N
4	CH2 DATA 422 P	17	CH2 DATA 422 N
5	CH3 CLK 422 P	18	CH3 CLK 422 N
6	CH3 DATA 422 P	19	CH3 DATA 422 N
7	CH4 CLK 422 P	20	CH4 CLK 422 N
8	CH4 DATA 422 P	21	CH4 DATA 422 N
9	CH5 CLK 422 P	22	CH5 CLK 422 N
10	CH5 DATA 422 P	23	CH5 DATA 422 N
11	CH6 CLK 422 P	24	CH6 CLK 422 N
12	CH6 DATA 422 P	25	CH6 DATA 422 N
13	GND		

3.3.1.2 MDM-25 D-Sub Pinout Ch 7-12

The pinout for the Ch 7-12, an MDM-25 D-sub connector, is shown in Table 3. Pin locations are illustrated in Figure 6.

Table 3: MDM-25 D-Sub Pinout (Ch 7-12)

Pin	Electrical Char.	Pin	Electrical Char.
1	CH7 CLK 422 P	14	CH7 CLK 422 N
2	CH7 DATA 422 P	15	CH7 DATA 422 N
3	CH8 CLK 422 P	16	CH8 CLK 422 N
4	CH8 DATA 422 P	17	CH8 DATA 422 N
5	CH9 CLK 422 P	18	CH9 CLK 422 N
6	CH9 DATA 422 P	19	CH9 DATA 422 N
7	CH10 CLK 422 P	20	CH10 CLK 422 N
8	CH10 DATA 422 P	21	CH10 DATA 422 N
9	CH11 CLK 422 P	22	CH11 CLK 422 N
10	CH11 DATA 422 P	23	CH11 DATA 422 N
11	CH12 CLK 422 P	24	CH12 CLK 422 N
12	CH12 DATA 422 P	25	CH12 DATA 422 N
13	GND		

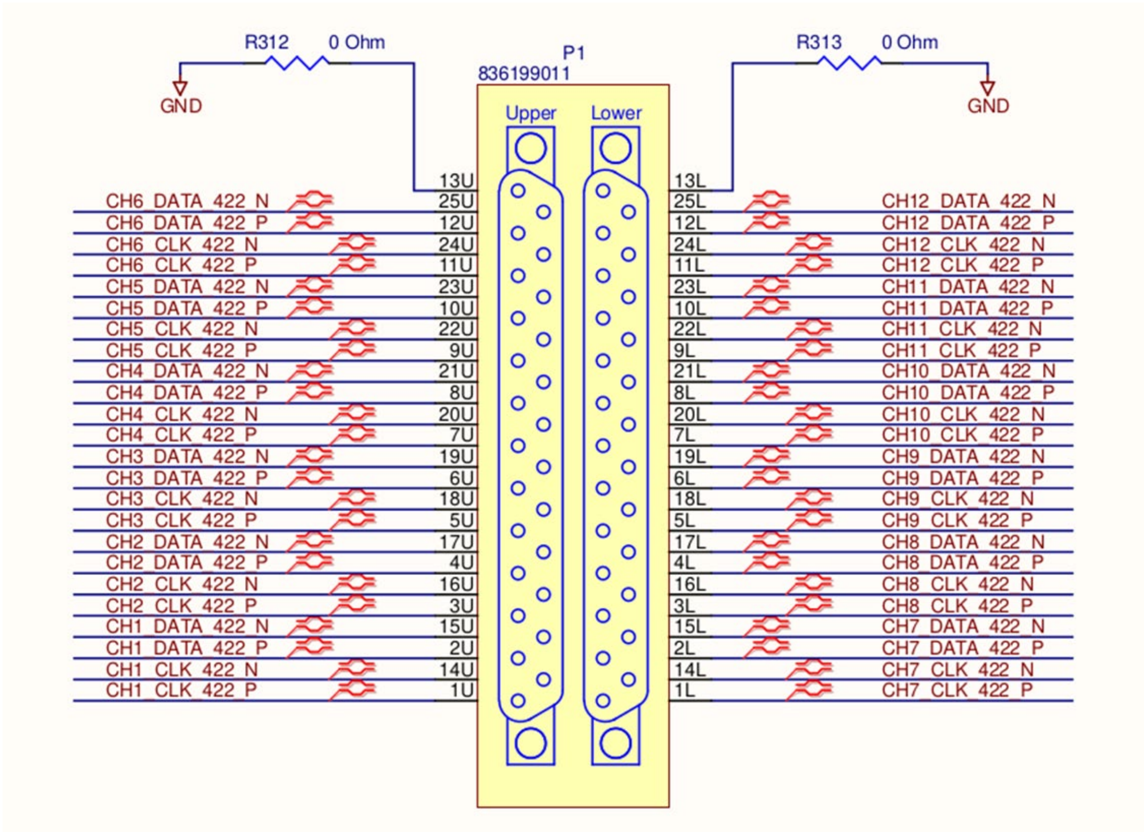


Figure 6: MDM-25 D-Sub Pin Locations for Ch 1-6 and Ch 7-12

3.3.1.3 RJ-45 Ports

The Ethernet connectivity to the BSSA™ unit is established through the use of one RJ-45 port on the back panel, labeled CTRL. The port accepts 10/100/1000 BASE-T links. The CTRL Ethernet port is used exclusively for configuring, monitoring, and updating the BSSA™, as well as for network time.

Figure 7: Back Panel RJ-45 CTRL and TMoIP Ports, LEDs

Figure 8: CTRL and TMoIP Ports, Example Green and Orange LEDs

The LEDs on the RJ-45 connectors convey the following information:

- Left LED
  - Off – There is no active network connection.
  - Green – There is an active 10/100/1000 BASE-T Ethernet connection.
  - Flashing – There is activity on the network connection.
- Right LED
  - Orange – There is a 1000 BASE-T Ethernet connection.
  - Off – If the Left LED is green, then this connection is a 10/100 BASE-T link. If the Left LED is Off, there is no Ethernet connection.

3.3.1.4 Network Segmentation

The BSSA™ operates two distinct Ethernet interfaces, one for Control traffic (CTRL), and one for Data traffic (TMoIP). This design decision was made to reduce the potential for traffic disruption to the TMoIP data streams from ancillary network traffic and to isolate TMoIP data streams from potential security concerns. For these reasons, Quasonix recommends that two distinct, non-overlapping networks and LANs be allocated to the BSSA™, one for Control traffic and one for TMoIP/Data traffic. For example:

- **Control Network:** 10.1.1.123/24 – IP address of 10.1.1.123 with subnet mask of 255.255.255.0, giving a network of 10.1.1.X. Any devices wanting to access the BSSA™ for configuration and monitoring would also be on this network, or could access this network through a router.
- **TMoIP/Data Network:** 10.1.2.1/24 – IP address of 10.1.2.1 with subnet mask of 255.255.255.0, giving a network of 10.1.2.X. Any devices receiving TMoIP traffic from the BSSA™, or sending TMoIP traffic to it, would also be on this network, or could access this network through a router.

Note: While not recommended by Quasonix, in the case where two separate LANs cannot be deployed to support Control and TMoIP independently, it is possible to configure Control and Network on separate interfaces as described above, but run them over a single LAN.

3.3.1.5 Reset to Defaults Button

Immediately to the right of the RJ-45 ports is a printed 'dot' with a small hole above it. This hole provides access to the reset to defaults button.

Figure 9: Back Panel Reset Button Access

To set the unit back to factory defaults, including the IP addresses, insert a small paperclip straight into this hole until it makes contact with a button. Depress the button and hold it for 10 seconds. When this 10 second threshold is reached, listen for the system fans to power off momentarily, then power itself back on. When the power is back on, the paperclip can be removed. The unit stops passing TMoIP data, resets all settings to factory defaults, and reboots.

After the system fully boots, all settings are set back to factory defaults. The control IP address is set back to 10.1.1.123 with a netmask of 255.255.255.0.

3.3.1.6 Electrical Signals

Figure 10 shows the relative timing of clock and data signals. Note, only NRZ-L signaling is supported at this time.

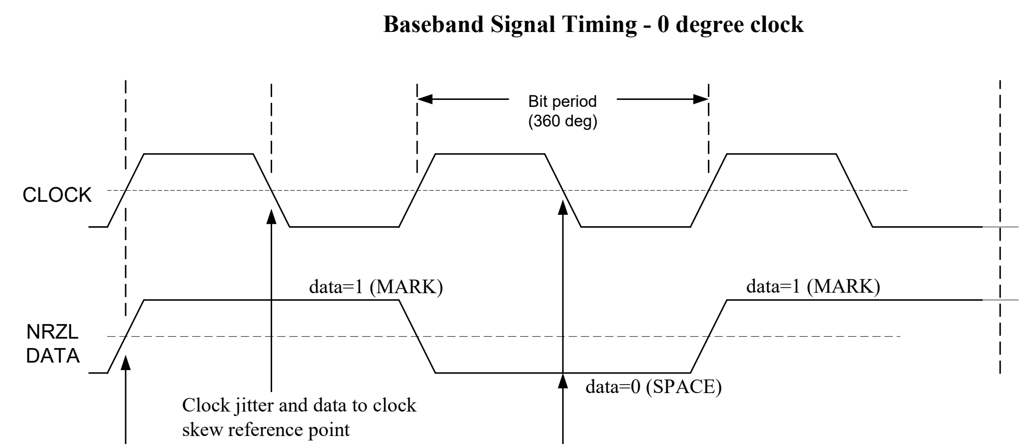


Figure 10: NRZ-L Signal Timing

The BNC Clock and Data connectors are 75 Ohm BNC and utilize TTL signaling.

The MDM-25 connectors use RS-422 signaling.

3.4 Browser Interface

The Quasonix BSSA™ contains a built-in web server. The system's browser-based graphical user interface (GUI) enables configuration and monitoring of the device on the user's IP network. While the Browser Interface works with most modern browsers, the latest version of Chrome, Firefox, or Edge is recommended. The Browser Interface (BI) provides easy-to-read, real-time status information to the user, thus eliminating the need for direct access to the front panel.

Browser Interface is laid out intuitively with all primary control and monitoring functionality for the entire system in one window.

To access the Browser Interface:

1. Plug a network cable into the BSSA™ Control RJ-45 connector.
2. Apply power to the system, and flip the power switch up, to '|'.
3. Open a browser on the PC.
4. The unit has a control IP address assigned to it when the user sets it up. The default control IP address is 10.1.1.123 with a netmask of 255.255.255.0. This address can be changed by the operator through the Browser Interface. The operator needs to know this IP address. Type the Control IP address into the browser as:

   http://XXX.XXX.XXX.XXX

   where the Xs represent the Control IP address of the BSSA™.

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

For issues that occur during installation, call Quasonix Technical Support at 513-942-1287 or email support@quasonix.com.

3.5 Theory of Operation

The BSSA™ sources PCM telemetry data to test and analyze Best Source Selectors (BSS), such as the Quasonix MLSC. This data emulates the output from multiple ground station receivers, including telemetry link and ground station network effects.

This PCM data can be sourced from the BSSA™ via PCM serial cabling (BNC TTL or MDM-25 RS-422) or via TMoIP. After this data is processed by the BSS, the BSS output can be input back into the BSSA™ via PCM serial cabling or TMoIP.

Twelve (12) PCM serial channels and twelve (12) TMoIP channels are available for use as inputs to, or outputs from, the BSSA™.

The BSSA™ provides four groups for sourcing test streams. Each group can synchronize a set of test streams that are then output to a BSS under test. Each group then analyzes the resulting output from the BSS.

3.6 Setup

When configuring the BSSA™, it can be helpful to follow the steps below:

1. Configure System (refer to section 4.2.4)
    a. Assign an IP address, netmask, and gateway to be used for configuration and control of the system.
    b. Provide a name and location for the system.
    c. Choose how time is supplied to the system (manual, PTP, or NTP). Time is used for TMoIP timestamping, as well as for group logging.
2. Configure PCM Channels (refer to section 4.2.5)
    a. Enable the channels for which you would like to output PCM serial data (to a BSS) or input data (from a BSS).
    b. Set the direction for each channel – either Input or Output.
    c. Set the PCM interface type – TTL or RS-422.
3. Configure TMoIP Channels (refer to section 4.2.6)
    a. Enable the channels for which you would like to output TMoIP data (to a BSS) or input data (from a BSS).
    b. Set the direction for each channel – either Input or Output.
    c. Configure the Network and Advanced settings.
4. Configure Sources (refer to section 4.2.9)
    a. Enable each source that you would like to have available for outputting test data.
    b. Choose the physical Output Channel (PCM or TMoIP) to output that particular source test data to.
    c. Set the base bit rate and sweeping parameters for the source.
    d. Set the base Q value and sweeping parameters for the source.
    e. Set the source delay for the source data.
5. Configure Groups (refer to section 4.2.10)
    a. For each BSS group under test, enable one of the Groups.

b. Choose a BSS Mode for each group. This allows the BSSA™ to generate a 'theory' output from the sources it is generating. This output can be compared against the output coming back from the BSS under test.

c. Select the Input Channel that the BSS under test output will come back on.

d. Select the Output Sources to include in each group.

e. Configure additional settings as needed.

6. Access the Monitor page (refer to section 4.2.11)

a. Ensure that the Q plot of each input matches the Q value at the sourcing BSS for that input.

b. Analyze the input BERT and EBERT results against the Theory.

4 Operating Instructions

The BSSA™ can be configured solely through the web-based browser interface, while the front panel interface provides a variety of status information. The Browser Interface is capable of configuring, monitoring, and updating the device while on the Control network.

4.1 Front-Panel Display

The BSSA™ front panel contains a power switch for turning the unit On or Off, as well as two Ethernet status LEDs and four LCD screens, as shown in Figure 11.

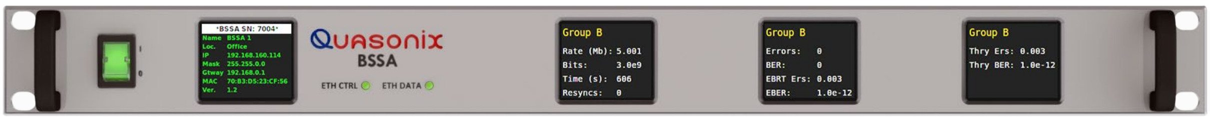


Figure 11: BSSA™ Front Panel Display

4.1.1 Ethernet Status LEDs

The two LEDs labeled ETH CTRL and ETH DATA, shown in Figure 12, indicate the status of the two respective Ethernet network connections on the back panel. These LEDs both share the following behavior:

- Off – There is no active network connection.
- Green – There is an active 10/100/1000 BASE-T network connection.
- Flashing – There is activity on the network connection

Figure 12: Front Panel Ethernet Status LEDs

4.1.2 Front Panel LCDs

The leftmost front panel LCD, shown in Figure 13, displays a variety of system settings to help the user in identifying and communicating with the system.

Figure 13: Front Panel LCD Display

The front panel LCD shows the following:

- Serial Number (SN)
- Name – System name for the device
- Loc. – Location for the device
- IP – Control IP address
- Mask – Control subnet mask
- Gtway – Control network gateway
- MAC – Control network MAC address
- Ver. – System version number

All parameters except the MAC and Version can be modified through the Browser Interface.

The remaining three LCD screens display status information about each enabled BSSA™ group. The currently-displayed Group Letter is shown at the top of the display, in orange. The information displayed across the three screens include a variety of measurements on the input stream coming back from the BSS under test.

Rate (Mb) – Measured bit rate in megabits per second

Bits – Total number of bits received since last reset

Time (s) – Elapsed time since last reset

Resyncs – Number of BERT PN resyncs since last reset

Errors – Number of bit errors since last reset (based on selected PN pattern)

BER – Bit error rate (bit errors / Bits) since last reset

EBRT Ers – Number of estimated bit errors based on the DQM values received in the stream

EBER – Estimated bit error rate (EBRT Ers / Bits)

Thry Ers – Number of theoretical bit errors based on the selected BSS Mode

Thry BER – Theoretical bit error rate (Thry Ers / Bits) based on the selected BSS Mode

4.2 Browser Interface

The Browser Interface provides the operator with full configuration, control, and monitoring capabilities for a single BSSA™ device. For configuration management purposes, only one browser interface should configure a BSSA™ at a given time. However, multiple browser interfaces can monitor an individual BSSA's status at once.

Refer to section 3.4 for instructions on how to connect to the Browser Interface.

Figure 14 shows an example of the Configure System Page.

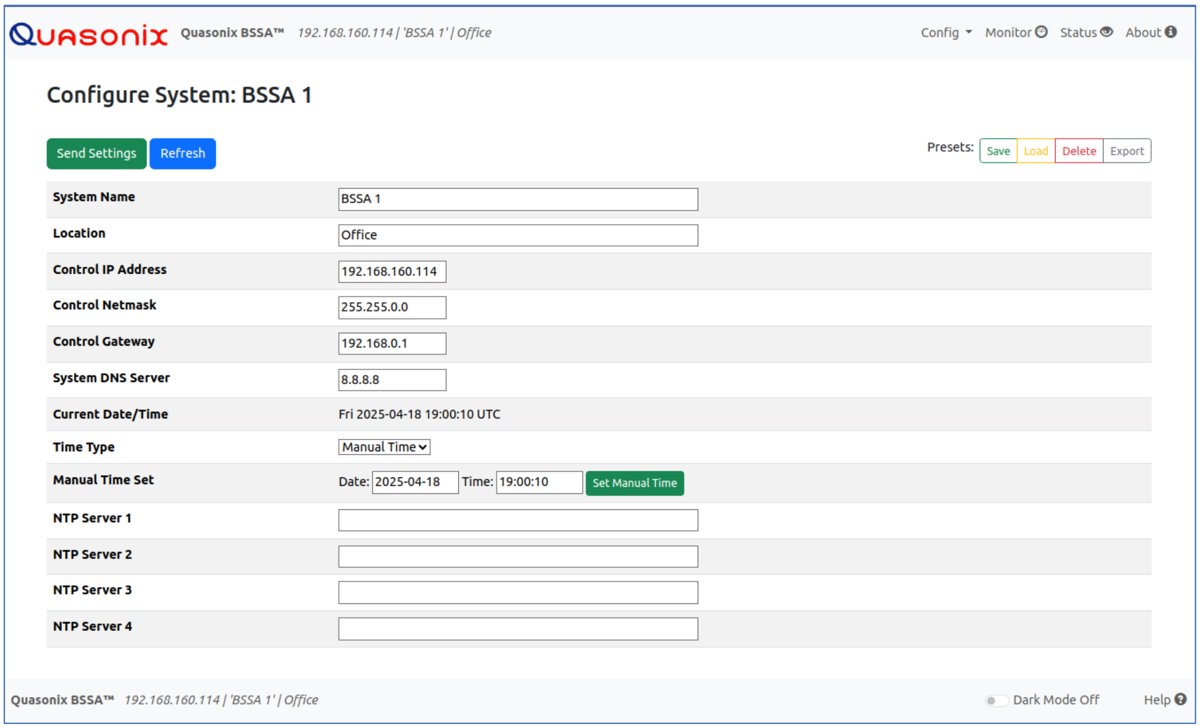


Figure 14: Browser Interface Configure System

Each page of the BSSA™ Browser interface consists of three main sections: the frame header at the top, the main content, and the frame footer at the bottom. The header and footer are the same from page to page, but the main content will change. The header and footer are described here, with the main content for each page described in the sections that follow.

4.2.1 Frame Header

The Frame Header, shown in Figure 15, provides identifying information about the system, as well as links to each page in the interface.

Figure 15: Browser Interface Frame Header

The left-hand portion of the Frame Header consists of:

- Quasonix Logo (with link to Monitor page)
- Product Type: Quasonix BSSA™
- IP Address
- System Name
- System Location

Figure 16: Browser Interface Frame Header, Left Side

The right-hand portion of the Frame Header, shown in Figure 17, consists of links to each page in the interface:

- Config – Configuration of system; Drop down menu provides links to System, PCM Channels, TMoIP Channels, Sources, and Groups configuration
- Monitor – Monitor page for viewing quality information about group input
- About – System information and firmware update

Figure 17: Browser Interface Frame Header, Right Side

4.2.2 Frame Footer

The Frame Footer, shown in Figure 18, provides identifying information about the system.

Figure 18: Browser Interface Frame Footer

The Frame Footer consists of:

- Product Type: Quasonix BSSA™
- IP Address
- System Name
- System Location
- Dark Mode Selection Switch
- Link to Help page

4.2.3 Help

The Help page provides a link for downloading this BSSA™ Installation and Operation Manual, as well as a link to the Quasonix web site. In addition, it provides the Quasonix mailing address and an email address for contacting Quasonix Support.

4.2.4 Configure System

The Configure System page is used for configuring the high-level properties of the BSSA™, as well as for saving, loading, deleting, and exporting configuration Presets.

There are two buttons above the system properties, as shown in Figure 19. The green Send Settings button is used to send (apply) settings to the system. After clicking on this button, any changed settings are sent to the device for validation and application.

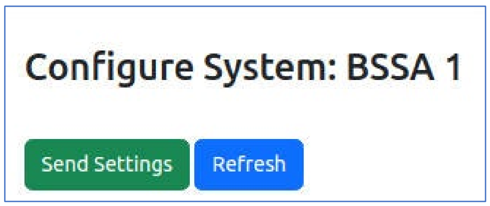


Figure 19: Browser Interface Configure System, Send Settings and Refresh Buttons

While the Send Settings process is executing, a message window displays, as shown in Figure 20.

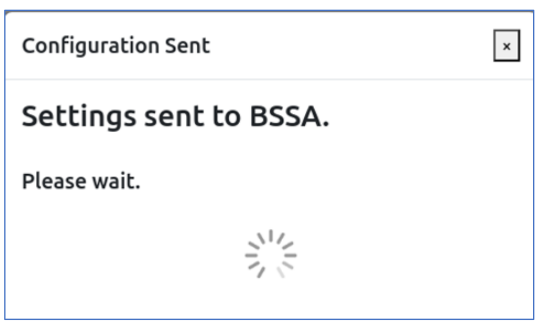


Figure 20: Browser Interface Configure System

If settings are valid and accepted, a message displays, as shown in Figure 21.

Figure 21: Example of Successful Configuration Message

If settings are not valid or another error occurs, a message will be displayed as in Figure 22.

Figure 22: Example of Error Message

In this case, correct the errors as indicated in the message, then click on the Send Settings button again.

Click on the blue Refresh button at any time to pull the current settings from the unit. Note that this resets any settings that have been changed on the page, but were not yet successfully submitted to the device.

4.2.4.1 System Name

The System Name is a text identifier given to the unit for identification purposes. It has a maximum of 100 characters. It is displayed in the browser window title.

4.2.4.2 Location

Location is a text identifier given to the unit for identification purposes. It has a maximum of 100 characters. It is displayed in the browser window title.

4.2.4.3 Control IP Address

The Control IP address is applied to the Control Ethernet interface, which is available to the user via the top RJ-45 connector labeled CTRL on the back panel. This interface is available for configuration and monitoring of the device.

When choosing an IP address for the Control interface, it is critical that the address is unique on its network, otherwise, the unit will not operate properly and may be inaccessible. It is strongly recommended that the user contact their network administrator to receive a reserved address for this purpose.

When an IP address change is applied via the Send Settings button, a message displays indicating that the new IP address will be opened in a new browser tab. Depending on browser settings, this new tab may be blocked and will require browser settings to be changed to allow the new tab to be opened.

If the Control IP Address is forgotten or incorrectly entered, the current address can be read from the front panel display. Alternatively, there is another method for regaining contact with the unit: reset the system to defaults (refer to section 3.3.1.4), then connect to the default Control IP address.

Note: DHCP is not available for the Ethernet interfaces on the BSSA™.

4.2.4.4 Control Netmask

The Control Netmask is used in conjunction with the Control IP Address to determine the Control Subnet to which the Control interface belongs. It is essential that any external devices that will be used to configure or monitor this unit are part of the same subnet (or can access it through a router). For example, if the Control IP and Netmask are 10.1.1.123 and 255.255.255.0, then any external devices that will communicate with the BSSA™ device should also be in the 10.1.1.X network.

4.2.4.5 Control Gateway

The Control Gateway should specify the router that allows the BSSA™ to access networks outside of the Control Subnet defined by the Control IP and Netmask. This gateway must be an address within the Control Subnet as determined by the Control IP and Netmask.

The Control Gateway may be needed if any external devices accessing the BSSA™ Browser Interface are not in the Control Subnet.

4.2.4.6 Current Date/Time

This displays the current system date and time, in UTC.

4.2.4.7 Time Type

The BSSA™ supports Manual Time, NTP (Network Time Protocol), and PTP (Precision Time Protocol, 1588, Version 2).

4.2.4.7.1 Manual Time

When the Time Type is set to Manual Time via the drop down menu, the system will not use any time server for setting the time. Instead, the user must provide a Date and Time in the corresponding boxes, as shown in Figure 23. These are initialized with the current system time, when the page is loaded or refreshed.

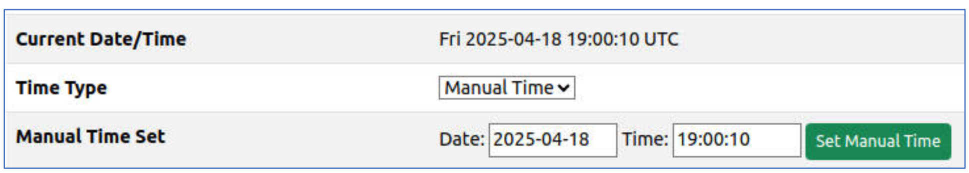


Figure 23: Configure System, Time Type Setting

If Manual Time is to be used, first, set the Time Type to Manual Time, then click on the Send Settings button. Wait for confirmation that the setting was applied.

Next, enter the UTC Date and Time adjacent to the Manual Time Set field, as described in section 4.2.4.7.1.1.

4.2.4.7.1.1 Manual Time Set

The Manual Time Set fields, Date and Time, are utilized only when Time Type is set to Manual Time.

The formats for the Date and Time fields are shown in Figure 24.

- Date
  - YYYY-MM-DD
    - YYYY – Year
    - MM – Month
    - DD – Day
- Time:
  - HH:MM:SS
    - HH – Hour (24-hour time)

- MM – Minute
- SS – Second

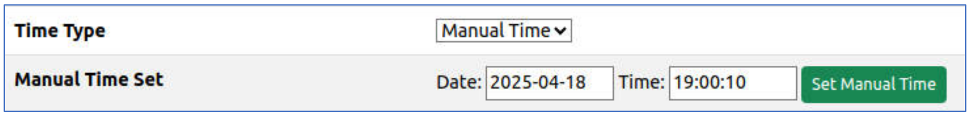


Figure 24: Example of Date/Time Parameters

After typing in the Date and Time, click on the Set Manual Time button to manually set the time. The Configure System page refreshes approximately one (1) second after clicking on the button. The new time should display in the Current Date/Time field.

4.2.4.7.2 NTP (Network Time Protocol)

The BSSA™ can automatically set its time based on communication with an NTP time server on the Control network. If automatic time setting is desired, choose NTP from the drop down menu labeled Time Type, fill in at least NTP Server 1, as described in section 4.2.4.8, then click on Send Settings.

When NTP setting is applied, the system immediately attempts to synchronize its time with the NTP server(s). This can take anywhere from 5 to 45 seconds, depending on the network and server. Click on the blue Refresh button to refresh the current Date/Time to check for sync.

If the NTP Servers are provided as hostnames as opposed to IP addresses, the System DNS, and likely the Control Gateway, must be provided.

If the NTP Server is not on the Control Subnet, the Control Gateway must be provided.

4.2.4.7.3 PTP (Precision Time Protocol)

The BSSA™ can automatically set its time based on communication with a PTP time server on the Control network. PTP utilizes multicast and can provide much greater precision in time syncing than NTP. To utilize PTP, select PTP from the drop down menu labeled Time Type, then click on Send Settings. No time server configuration is necessary in order to use PTP. However, a PTP grandmaster must be accessible on the Control network. Multicast traffic from the PTP grandmaster must traverse any intermediate networks in order to reach the BSSA™.

Note: When PTP is used, the TSR (Timestamp Source Reference) in the 218-20 TMoIP packets will be set to 1, indicating International Atomic Time, which is currently 37 seconds ahead of UTC time.

4.2.4.8 NTP Server 1-4

The four NTP Server fields are utilized only if the Time Type is set to NTP. These entries can be provided either as a hostname or as an IP address. For example:

- Hostname: xxx.pool.ntp.org
- IP Address: yyy.yyy.yyy.yyy

When NTP Time Type is used, only NTP Server 1 is required, though more servers can be added to improve time sync reliability and accuracy.

4.2.4.9 Presets

The Presets buttons are used to Save, Load, Delete, and Export system configuration settings. This is a convenient way to save settings for a particular test or operation, then reload those settings as needed.

Figure 26: Configure System, Preset Buttons

4.2.4.9.1 Save

Click on the green Save button to save the current settings to a preset JSON file. Enter a name for the Preset in the Save Preset message, shown in Figure 25, then click on the Save button. Figure 26 shows the Save Operation message indicating the completed save. Click on the OK button to close the window and proceed.

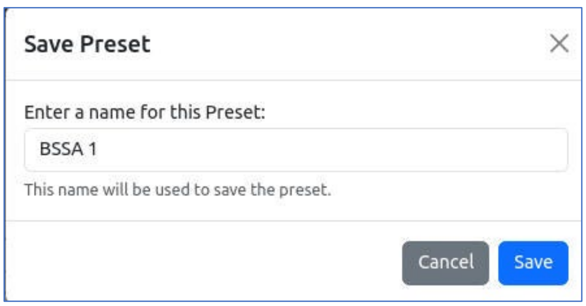


Figure 25: Save Preset Message

Figure 26: Save Operation Message, Save Complete

4.2.4.9.2 Load

Click on the yellow Load button to load a previously saved configuration. Select a preset to load using the drop down menu in the Load Preset message, shown in Figure 27. All settings on the system are overwritten by the preset settings, except for the System configuration settings. The Load Operation message displays when the load is complete, as shown in Figure 28.

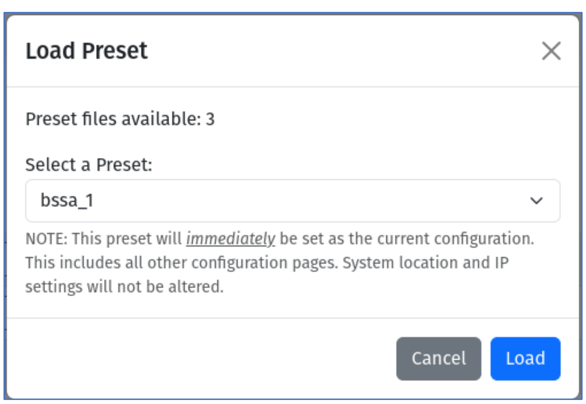


Figure 27: Load Preset Message

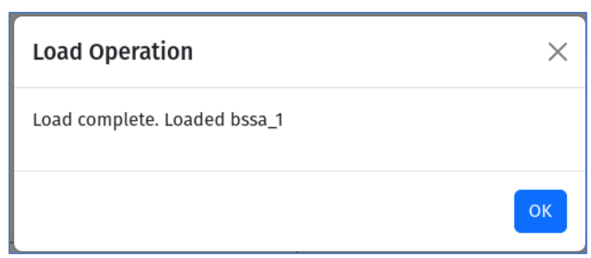


Figure 28: Load Operation Message, Complete

4.2.4.9.3 Delete

Click on the red Delete button to delete a previously saved configuration. Select a preset to delete using the drop down menu in the Delete Preset message, shown in Figure 29. The Delete Operation message displays when the delete is complete, as shown in Figure 30.

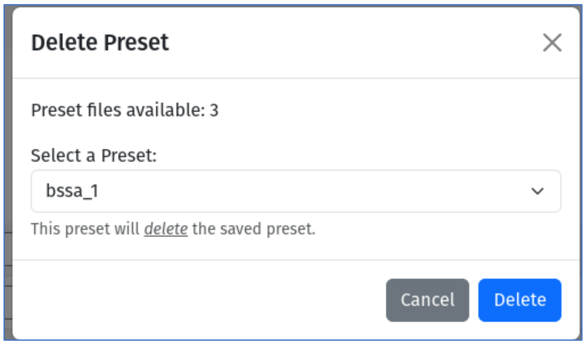


Figure 29: Delete Preset Message

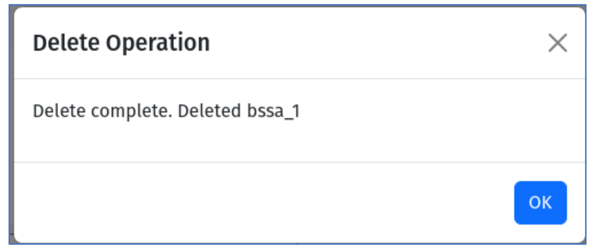


Figure 30: Delete Operation Message, Complete

4.2.4.9.4 Export

Exporting settings can be useful for creating an offline backup of the system configuration. Additionally, a future release will allow the importing of exported settings to the same, or different, systems.

Click on the gray button to export a previously saved configuration as a JSON file. Select a preset to export using the drop down menu in the Export Preset message, shown in Figure 31. The Export Operation message displays when the export is complete, as shown in Figure 32, and a file download occurs within the browser.

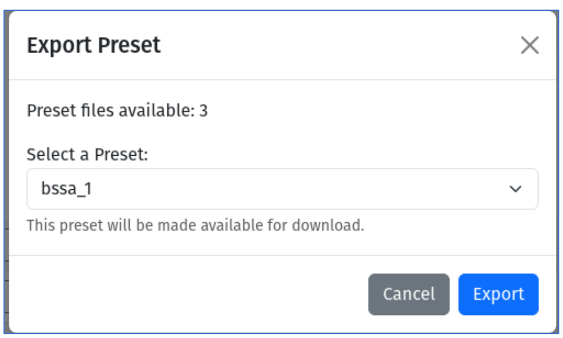


Figure 31: Export Preset Message

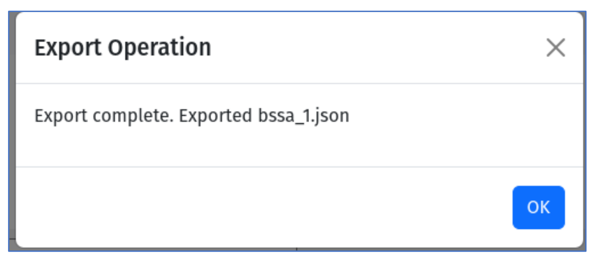


Figure 32: Export Operation Message, Complete

4.2.4.9.5 Dark Mode Switch

The Dark Mode Switch, shown in Figure 35, changes the browser interface color scheme to use a black background and darker colors. This theme may be preferred by some users, especially in low light environments.

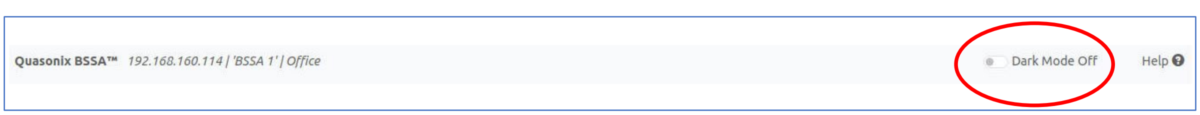


Figure 33: Frame Footer, Dark Mode Switch

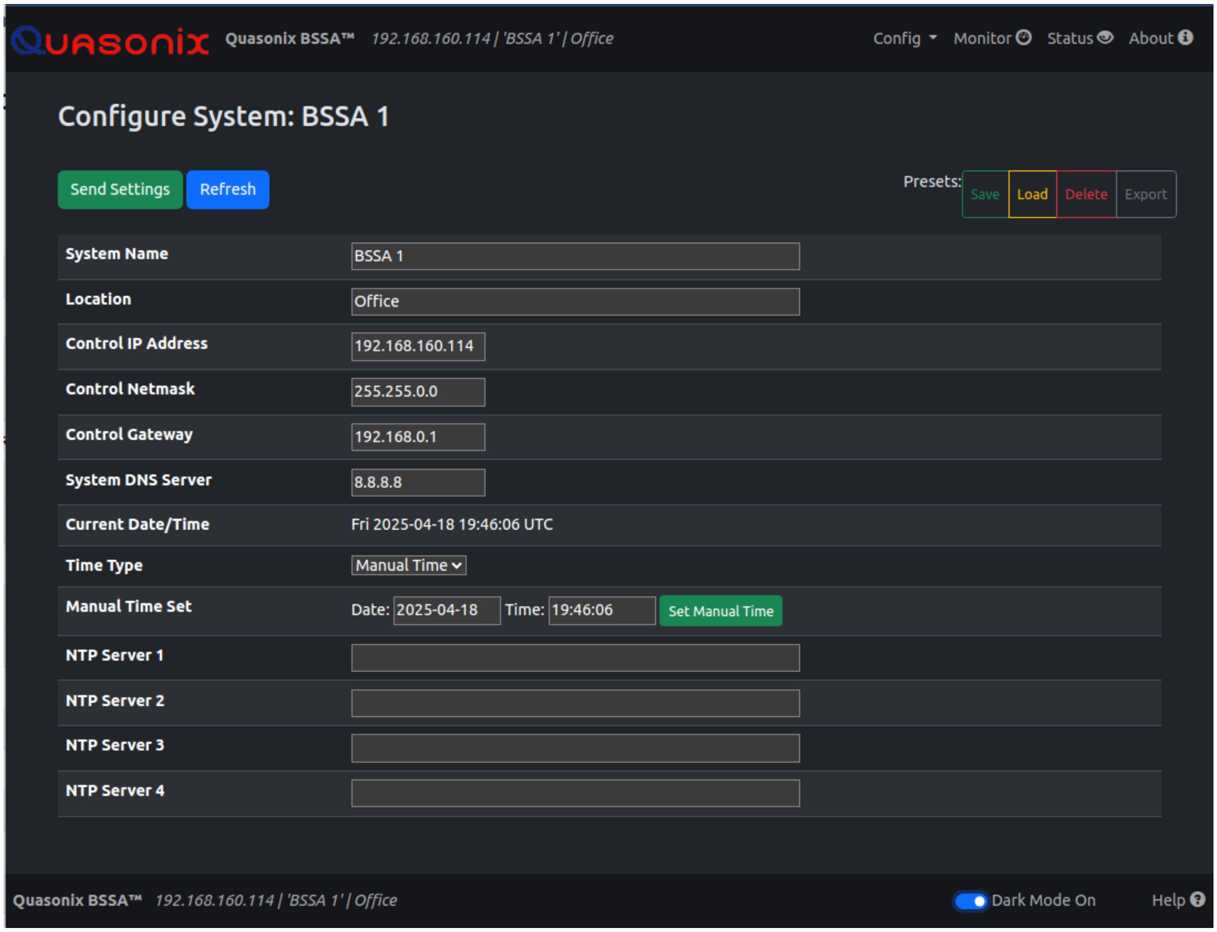


Figure 34: Dark Mode Example

4.2.5 PCM Channel Configuration

The PCM Channel Configuration page, shown in Figure 35, provides access to every channel-specific setting.

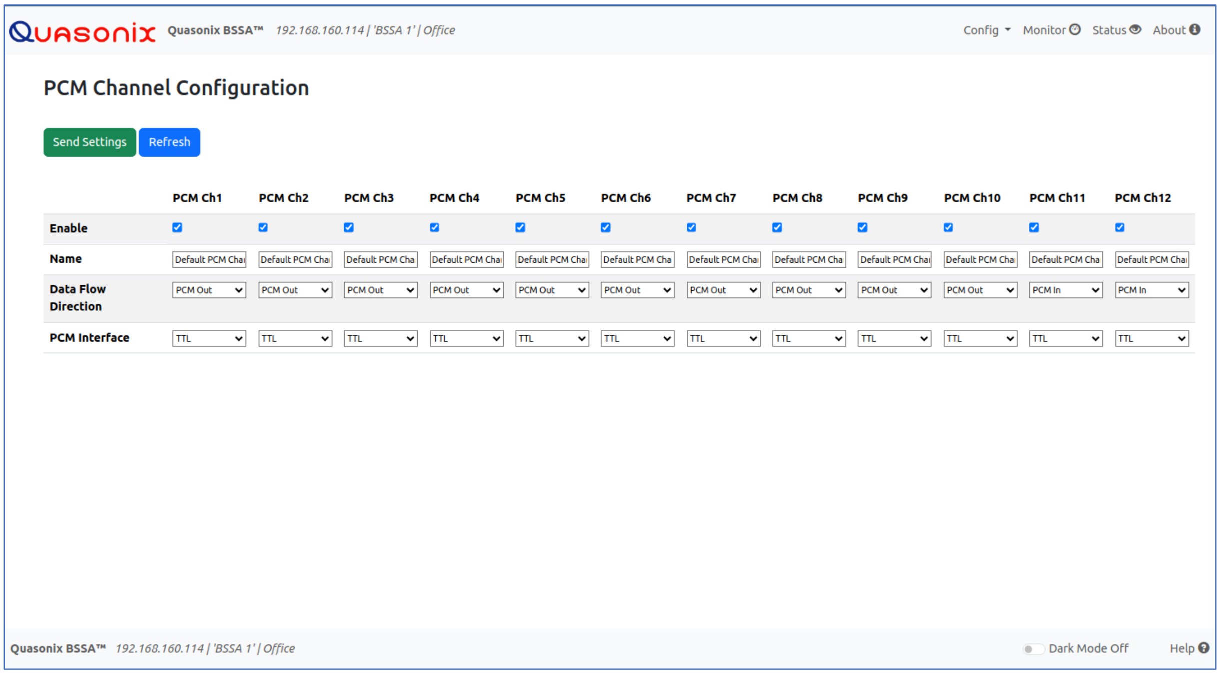


Figure 35: PCM Channel Configuration

The settings available in each group are described in the following sections.

As described for the Configure System page, the Channel Configuration page contains a Send Settings button and a Refresh button that behave similarly to those on the Configure System page. Here, the two buttons apply to all channels at once. After making changes to this page, click on the Send Settings button for the settings to be applied to the individual channels.

As all channel settings are in columns, under labels specifying Channel 1-12, settings in each column only apply to the channel specified at the top of the column.

Note: If a channel setting is changed, applying it causes the channel to stop and start again, likely resulting in lost data. If changes are required, it is recommended to make them prior to starting any test with critical data.

4.2.5.1 Enable

Check this box to enable the PCM channel via the back panel connections. When not checked, this channel is disabled. Disabled channels are not available for selection as outputs on the Source Configuration page or as inputs on the Group Configuration page.

4.2.5.2 Name

Enter a descriptive name here to enable easier identification on other configuration pages that reference PCM Channels. It has a maximum of 100 characters.

4.2.5.3 Data Flow Direction

Each channel of the BSSA™ can be independently configured to take PCM as an input or transmit it as an output. There are two settings available via the drop down menu. Choose either PCM In to use the channel as an input to the BSSA™ device or PCM Out to use the channel as an output from the BSSA™ device.

4.2.5.4 PCM Interface

The PCM Interface drop down menu allows the user to choose the electrical interface used for incoming/outgoing PCM telemetry on the back panel. This can be set to:

- TTL – PCM telemetry utilizes TTL signaling on the BNC clock and data connector assigned to the channel.
- RS-422 – PCM telemetry utilizes RS-422 signaling on the MDM-25 connector and pins assigned to the channel. Refer to section 3.3.1.1 for the MDM-25 pinout.

4.2.6 TMoIP Channel Configuration

The Channel Configuration page, shown in Figure 35, provides access to every channel-specific setting. Each Channel in the BSSA™ allows one stream of telemetry data to be packetized (PCM In) or depacketized (PCM Out), depending on the settings for that channel.

This page displays the settings for all channels in columns. This facilitates comparing settings between channels and ensuring correct configuration, but it can be a bit overwhelming. To reduce the amount of information displayed at one time, the settings are broken up into four groups: Default, Network, and Advanced. Each of these groups (aside from Default) has a Show link that shows or hides the group of settings when clicked on. Refer to Figure 36 for an example of this behavior.

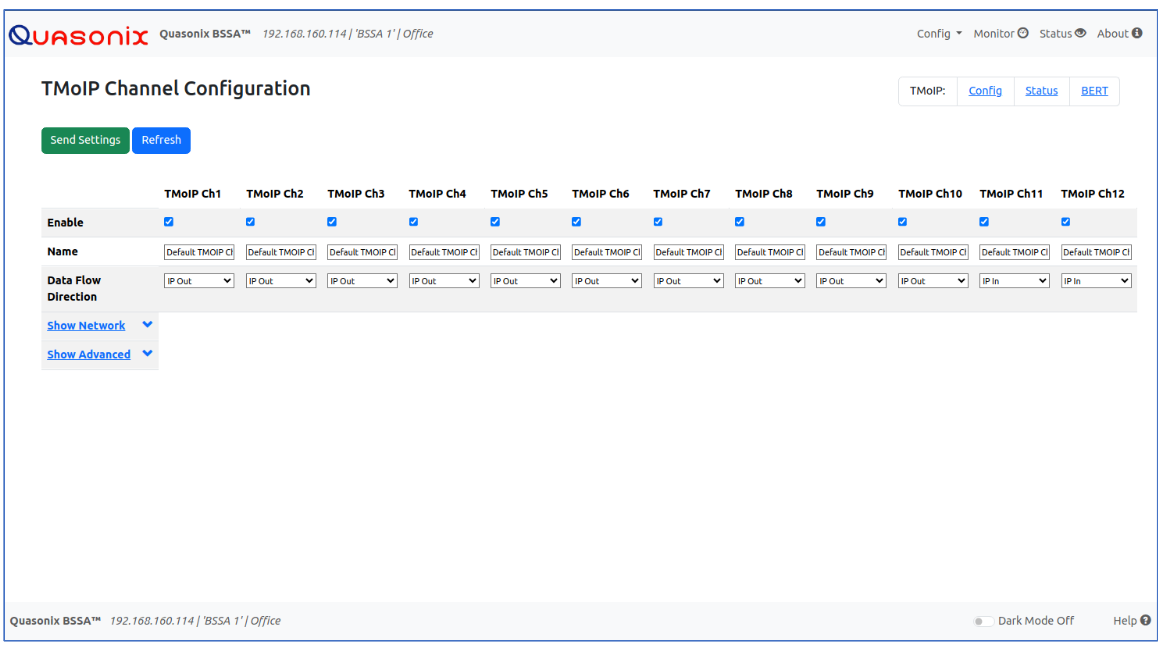


Figure 36: TMoIP Channel Configuration, Condensed

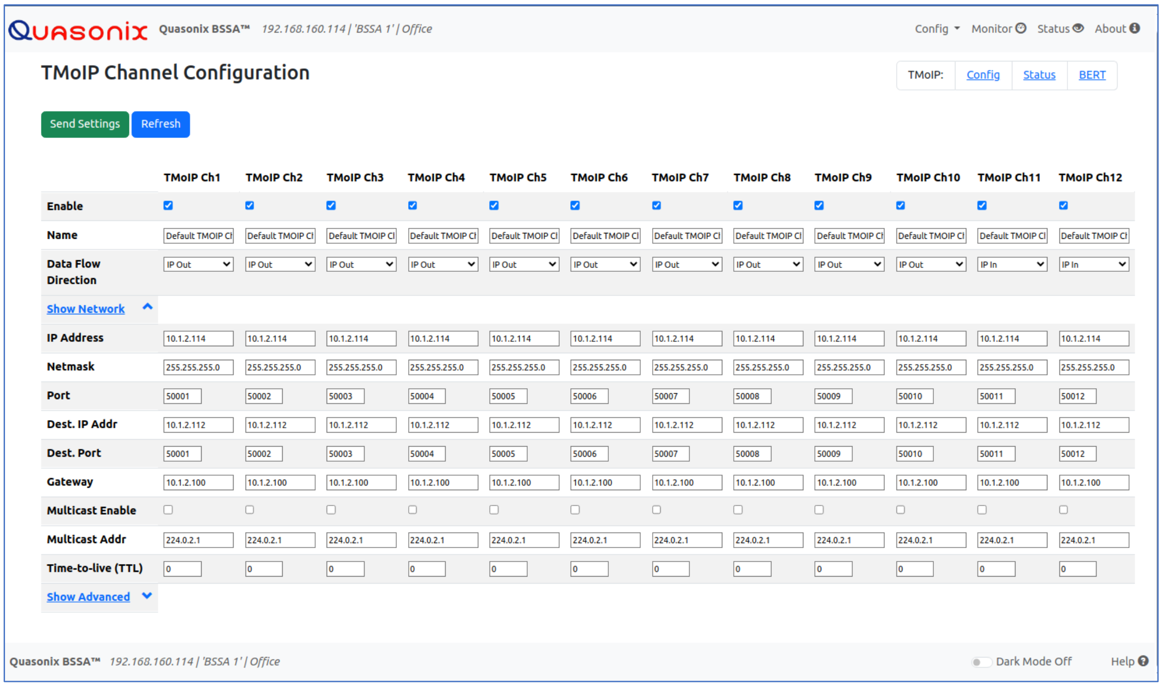


Figure 37: TMoIP Channel Configuration, Network Expanded

The settings available in each group are described in the following sections.

As described for the Configure System page, the Channel Configuration page contains a Send Settings button and a Refresh button that behave similarly to those on the Configure System page. Here, the two buttons apply to all channels at once. After making changes to this page, click on the Send Settings button for the settings to be applied to the individual channels.

As all channel settings are in columns, under labels specifying TMoIP Ch 1-12, settings in each column only apply to the channel specified at the top of the column.

Note: If any channel setting is changed, applying it causes all BSSA™ processes to stop and then restart again, likely resulting in lost data. If changes are required, it is recommended to make them prior to starting any test with critical data.

4.2.6.1 Default Group

The Default group is unlabeled and cannot be hidden, as shown in Figure 38. It contains high-level, critical settings, as described in the following sections.

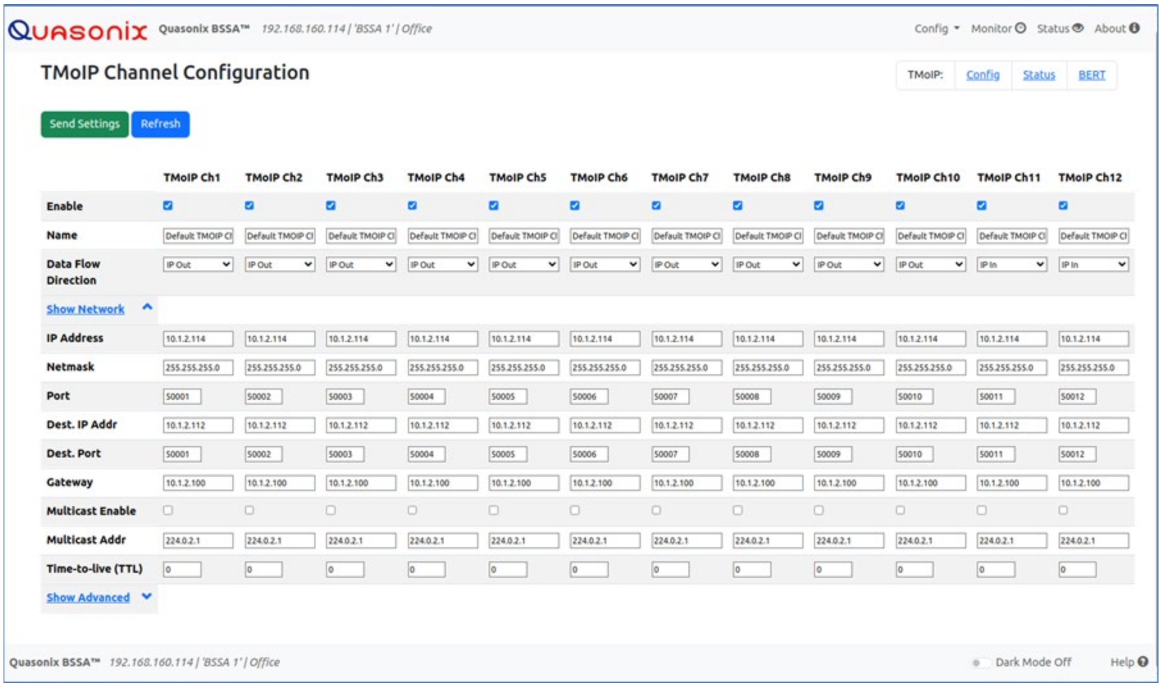


Figure 38: Channel Configuration, Default View

4.2.6.1.1 Enable

This check box enables the channel when checked. When not checked, this channel is disabled. Disabled channels are not available for selection as outputs on the Source Configuration page or as inputs on the Group Configuration page.

If a channel's settings are not valid, errors are generated when enabling the channel. It is best to make changes to the channel's settings, then check the Enable box before clicking on the Send Settings button.

4.2.6.1.2 Name

The Channel Name is a text identifier given to the channel for identification purposes. It has a maximum of 100 characters.

4.2.6.1.3 Data Flow Direction

Each channel of the BSSA™ can be independently configured to take TMoIP packets as input or transmit them as an output. There are two settings available via the drop down menu:

- IP In
  - In this mode, the BSSA™ receives TMoIP packets via the TMoIP data network, depacketizes them, and sends the resulting data to the BSSA™ core for processing in a group.
- IP Out
  - In this mode, the BSSA™ outputs data that is packetized in TMoIP packets to be sent out the TMoIP network interface.

4.2.6.2 Network Group

The Network Group settings pertain to the network settings for each individual channel, as shown in Figure 39.

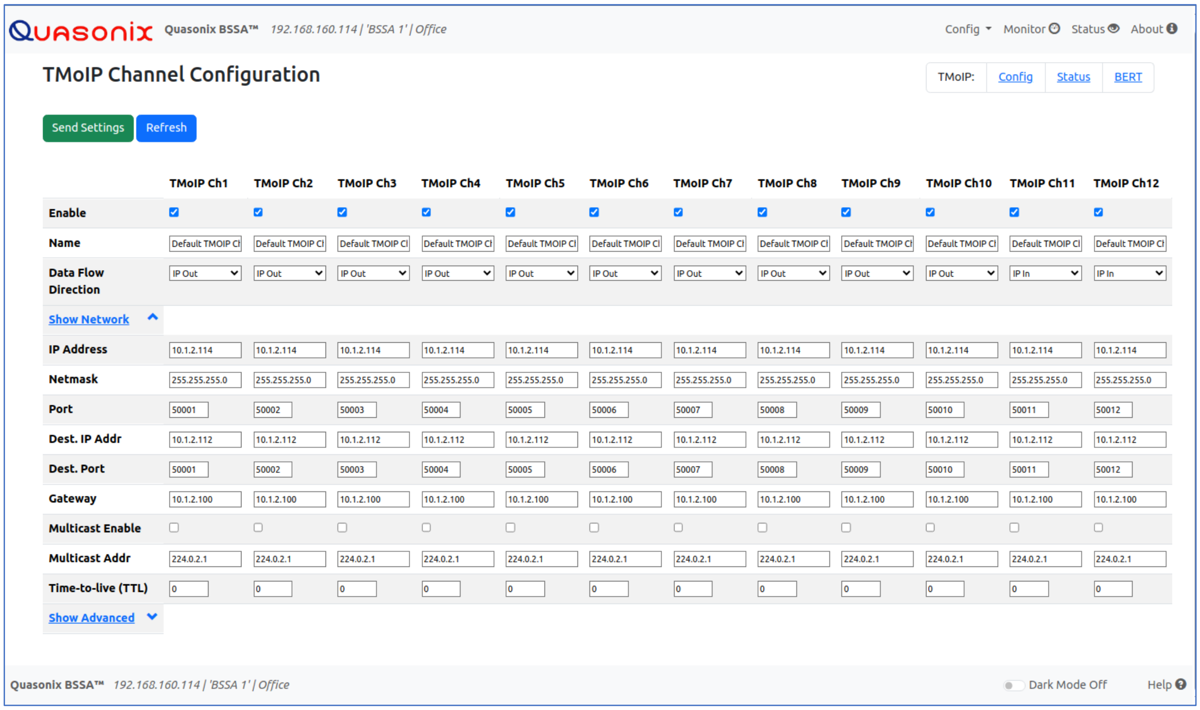


Figure 39: Channel Configuration, Network Expanded

4.2.6.2.1 IP Address

The IP Address setting sets the TMoIP network interface address for each channel. This address is used as follows in the two Data Flow Direction modes:

- In IP In mode, this address serves as the listening/destination address that receives TMoIP network packets from a packetizing device. This must match the IP packet header destination address field in incoming packets.
- In IP Out mode, this address serves as the sending/source address that generates TMoIP network packets to be sent to a depacketizing device. This address is put into the IP packet header source address field.

Note: All channel IP Addresses on a single BSSA™ device should be contained within the same subnet. For example, 10.1.2.1 through 10.1.2.12, all with Netmask 255.255.255.0. Additionally, all channels can share the same IP address, if desired, as long as they have unique Port numbers.

4.2.6.2.2 Netmask

The Netmask setting determines the network subnet for each channel.

4.2.6.2.3 Port

The Port setting is used as follows in the two Data Flow Direction modes:

- In IP In mode, this port serves as the listening/destination port that receives TMoIP network packets from a packetizing device. This port must match the UDP packet header destination port field in incoming packets.
- In IP Out mode, this port serves as the sending/source port that generates TMoIP network packets to be sent to a depacketizing device. This port is put into the UDP packet header source port field.

Note: The (IP Address, Port) pair for a particular channel must be unique on a single system to avoid ambiguity in packet addressing.

4.2.6.2.4 Dest. IP Addr.

The Destination IP Address setting is only used when the Data Flow Direction for this channel is set to IP Out. This address specifies the host to which the TMoIP packetized data will be sent. This address is put into the IP packet header destination address field.

4.2.6.2.5 Dest. Port

The Destination Port setting is only used when the Data Flow Direction for this channel is set to IP Out. This port specifies the UDP port to which the TMoIP packetized data will be sent. This port is put into the UDP packet header destination port field.

4.2.6.2.6 Gateway

The Gateway setting is only used when the Data Flow Direction for this channel is set to IP Out. Additionally, the Gateway is only needed when the Destination IP Address is not part of the Channel Subnet defined by the IP Address and Netmask for this channel, and the generated packets must be sent to a router on their way to the Destination IP Address.

The Gateway address must be part of the Channel subnet defined by the Channel IP Address and Netmask.

When the Gateway address is provided, and required as defined above, it is used as the destination for a host route for the channel as follows:

- IP packets are generated with telemetry payload and destination IP/port set to Dest. IP Addr. and Dest. Port. The packets are then sent to the Gateway address to be routed to their destination.

4.2.6.2.7 Multicast Enable

The BSSA™ is capable of both sending and receiving multicast-addressed 218-20 TMoIP payload packets, depending on the Data Flow Direction that each channel is configured for. Multicast enables the same telemetry data to be packetized and sent to more than one destination without broadcasting it to every device on a network.

Click on the Multicast Enable check box in order to enable multicast delivery of TMoIP network packets. The behavior is as follows:

- In IP In mode with Multicast Enable checked, this channel accepts multicast traffic sent to the Multicast Addr and Port specified for the channel. In addition, this channel sends out an IGMP Report (Join) message to indicate to all attached switches and routers that this device wants to receive multicast traffic destined for the Multicast Addr. These IGMP messages are required when working with certain multicast-enabled switches and routers (which typically use IGMP Snooping to determine to which ports to send certain multicast traffic).
- In IP Out mode with Multicast Enable checked, outgoing telemetry data from the BSSA™ is packetized and sent to the address entered in the Multicast Addr field. The port entered in Dest. Port is still used as the UDP destination port.

4.2.6.2.8 Multicast Addr

This setting indicates the address to use as the destination address when Multicast Enable is checked. The valid range is 224.0.0.1 to 239.255.255.255.

4.2.6.2.9 Time-to-live (TTL)

This setting indicates the time-to-live (TTL) value to be inserted in TMoIP UDP network packets when Multicast Enable is checked and the Data Flow Direction is set to IP Out.

The TTL value is used to limit how far the multicast packets can traverse outside of the immediate subnet. If the destination for the multicast traffic is in the immediate subnet (not through a router), then this TTL value should be set to 0 (zero). For every router that the multicast packets must traverse on their way to their destinations, this TTL value must be incremented by 1.

4.2.6.3 Advanced Group

The Advanced Group contains settings related to polarity, payload size, formatting, and alignment, as shown in Figure 40.

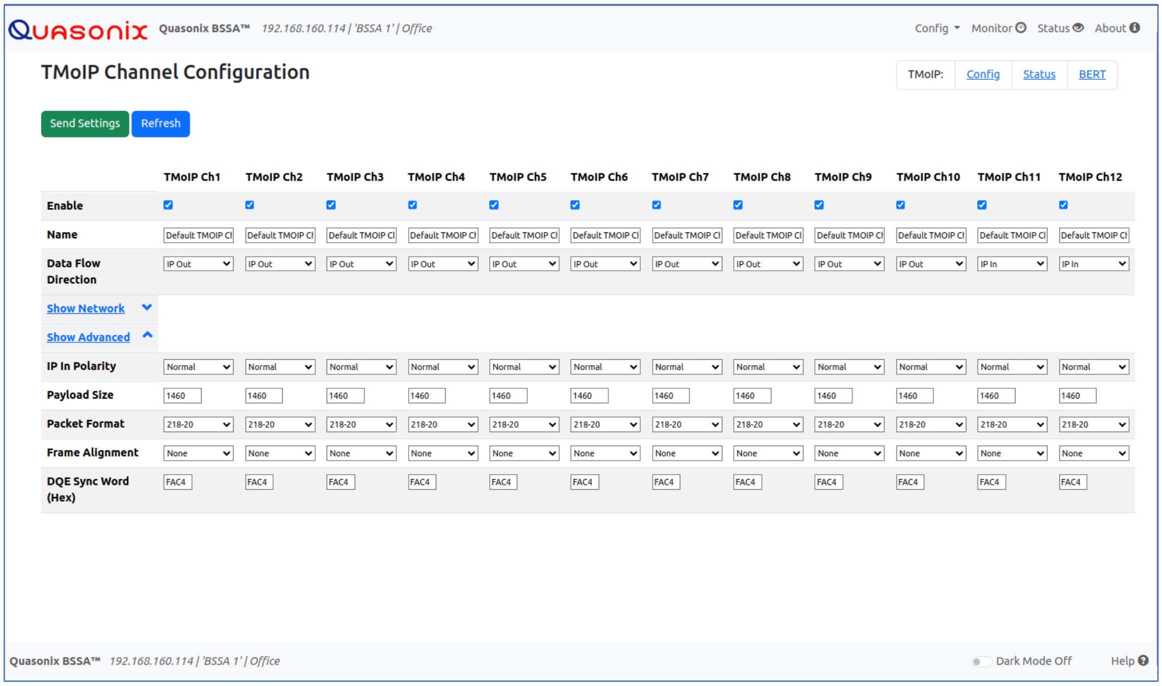


Figure 40: TMoIP Channel Configuration, Advanced Group

4.2.6.3.1 IP In Polarity

The IP In Polarity setting is only applicable when this channel is in IP In mode.

The IP In Polarity provides the ability to invert incoming data, if necessary. Two settings are available via the drop down menu:

- Normal – Incoming TMoIP packet data is not inverted.
- Inverted – Incoming TMoIP packet data is inverted after being read from the incoming TMoIP data packet.

4.2.6.3.2 Payload Size

The Payload Size setting specifies the number of payload bytes contained in the TMoIP packets being received or sent. One byte equals 8 bits.

- In IP In mode, this setting must match the number of PCM telemetry bytes that are packetized into each incoming TMoIP network packet.

- In IP Out mode, this setting determines how many incoming PCM telemetry bytes are packetized into each outgoing TMoIP network packet.

In general, at high data rates, larger packet sizes should be used in order to increase the efficiency of processing and network utilization. Likewise, at low rates, smaller packet sizes should be used to reduce the amount of time it takes to fill the packet and send it.

For instance, at 50 Mbps, a 1460 byte payload takes approximately 234 us to be filled. However, at 100 kbps, that same payload takes almost 117 ms to fill. This adds significantly to the overall latency of the data transmission from source to destination.

On the other hand, at 100 kbps, a 50 byte payload requires just 250 packets per second to be sent across the network. However, at 50 Mbps, that same payload requires 125,000 packets per second. That inefficiency deteriorates system and network efficiency significantly and leads to poor performance. Table 4 provides suggested payload sizes at various data rates to balance efficiency and latency.

Table 4: Suggested Payload Sizes and Data Rates

Rate (Mbps)	Payload Size (Bytes)
0.1	125
0.5	625
1	1250
5-50 Mbps	1460

Use of these payload sizes results in a packet fill time of no more than 10 ms, while also reducing CPU load at higher data rates.

Note: If DQE Frame Alignment is specified, the payload size must match the DQE frame size without header (refer to section 4.2.6.3.4 for details).

4.2.6.3.3 Packet Format

The Packet Format setting only applies when this channel is in IP Out mode. It determines the TMoIP control word format to use in outgoing TMoIP network packets. Two settings are available via the drop down menu:

- 218-20 – Outgoing packets are formatted according to the IRIG 218-20 specification with control word Version identifier bits set to “0010”.
- 218-10 – Outgoing packets are formatted according to the IRIG 218-10 specification with control word Version identifier bits set to “0000”.

Note: In IP In mode, only 218-20 TMoIP packets are processed. All other formats, including 218-10, are ignored.

4.2.6.3.4 Frame Alignment

The Frame Alignment setting indicates whether incoming and outgoing packets are aligned to PCM Data Quality Encapsulation (DQE) frames. Two settings are available:

- None – TMoIP payload data has no frame alignment.
- DQE – TMoIP payload data is aligned with PCM DQE frames. The first bit of the TMoIP packet payload is the first bit of a DQE frame header, and the packet contains just one DQE frame.

When this channel is in IP Out mode, the BSSA™ searches incoming PCM data from the BSSA™ core for the DQE Sync Word (refer to section 4.2.6.3.5). When regularly found at the proper interval, the BSSA™ indicates DQE Sync on the System and Channel Status page (refer to section 4.2.7). The DQE header and payload will then be packetized into one TMoIP network packet.

When DQE frame alignment is chosen, the Payload Size must be set to match the DQE Frame payload size.

Note: Frame Alignment is not required when the BSSA™ group is configured for Data Quality Encapsulation. The DQE frames are still contained in the TMoIP packets, but they are not aligned with the start of the packet. Frame Alignment is only required if the TMoIP destination that is receiving the TMoIP packets requires it.

4.2.6.3.5 DQE Sync Word (Hex)

The DQE Sync Word specifies the two-byte hex-formatted sync word to be used in searching for incoming PCM DQE frames. It is only used when the Frame Alignment setting is set to DQE.

The standard setting for this sync word is FAC4.

4.2.7 TMoIP Status

The TMoIP Status page, shown in Figure 41, is a one-stop-shop for status information on the system and all channels during operation.

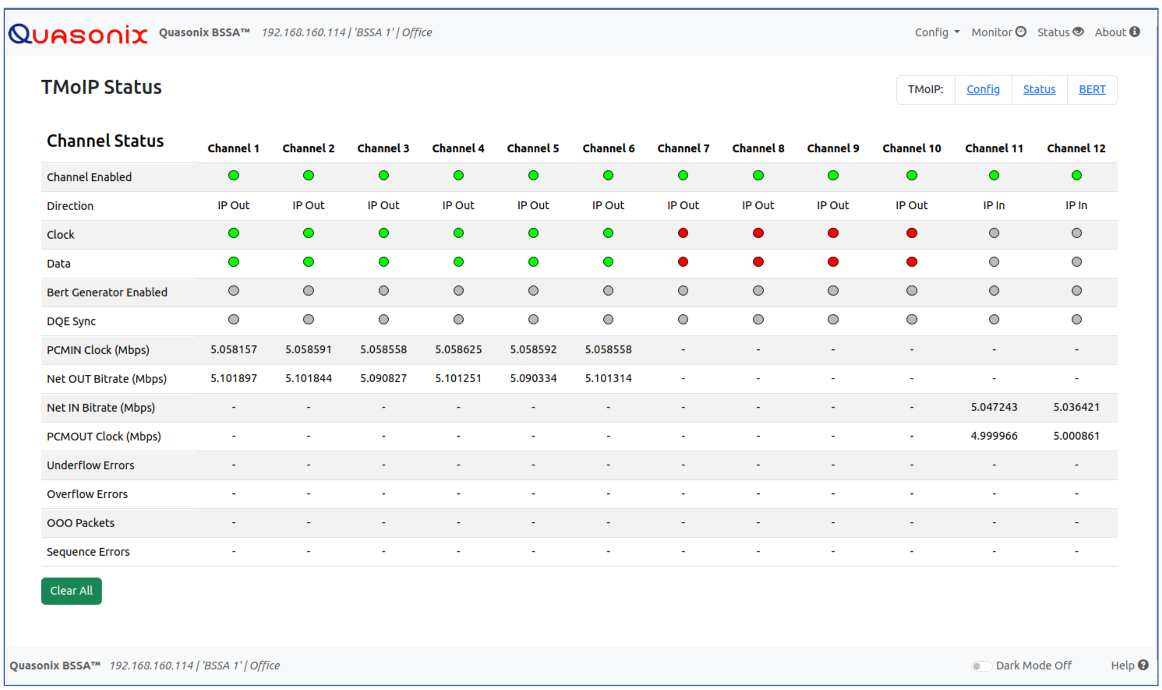


Figure 41: TMoIP Status

TMoIP Status provides status on several per-channel status items. This page can be extremely useful to confirm test conditions and to ensure that data and clock rates are as expected. If DQE Alignment is enabled and DQE Frames are being received, it is also recommended to monitor for DQE Sync.

Note: The TMoIP Network connection must be active (network cable plugged in and also connected to an active device) in order for the Status page to operate properly.

- Channel Enabled – Gray if disabled, Green if enabled
- Direction –IP In or IP Out
- Clock – Gray if in IP In mode, otherwise, Green if PCM in clock is good, Red if PCM in clock is not present (from BSSA™ group output)
- Data – Gray if in IP In mode, otherwise, Green if PCM in data is good, Red if PCM in data is not present (from BSSA™ group output)
- Bert Generator Enabled – Gray if BERT generator is disabled; Yellow if it is enabled; refer to section 4.2.8.1.1 for details on the BERT Generator. If the BERT Generator is enabled, any data that would normally be output is replaced with BERT Generator data.
- DQE Sync – Gray if in IP In mode or DQE Alignment not enabled; Green if syncs on PCM DQE Frames from BSSA™ group output; Red otherwise
- PCMIN Clock (Mbps) – IP Out mode only; Measured rate of incoming PCM IN clock from BSSA™ group output
- Net Out Bitrate (Mbps) – IP Out mode only; Measured rate of outgoing UDP payload sent by this channel
- Net In Bitrate (Mbps) – IP In mode only; Measured rate of incoming UDP packets sent to this channel's IP and Port
- PCMOUT Clock (Mbps) – IP In mode only; Measured rate of outgoing PCM OUT clock to BSSA™ group input
- Underflow Errors – Displays a 1 if any Underflow errors have occurred in the IP In processing
- Overflow Errors – Displays a 1 if any Overflow errors have occurred in the IP Out processing
- OOO Packets – IP In mode only; Number of packets received with sequence numbers Out of Order; these events should not result in lost data if the packets can be reordered, and no Sequence Errors occur.
- Sequence Errors – IP In mode only; Number of times the incoming TMoIP packets could not be reordered in a timely fashion, or an expected packet was never received; this error results in lost data.

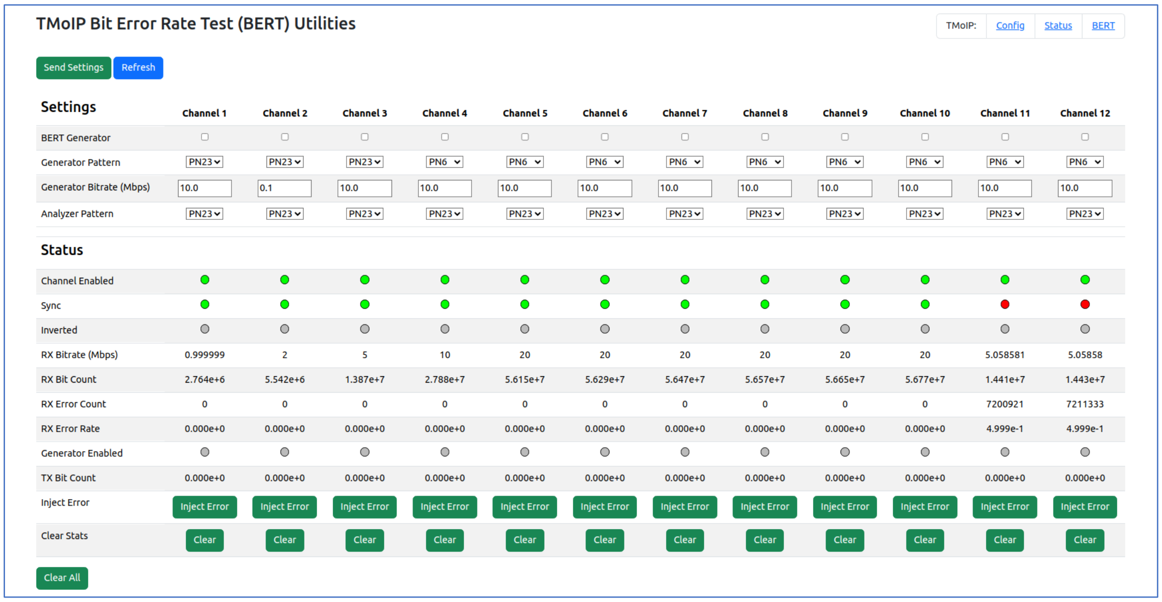
The Clear All button at the bottom of the System and Channel Status page is used to clear all channel status items. This also resets all BERT statistics on the BERT page. This button can be useful if monitoring a particular setup for errors or out of order packets. After starting up a test and allowing a brief period for a steady state to be reached, the operator can click on this button to reset all error counts. This page can then be monitored for a period of time to determine whether any errors are occurring.

If OOO Packets or Sequence Errors are occurring, it can be indicative of a problem with the network being used to carry the TMoIP data traffic. These errors can frequently occur when a switch or router is overloaded.

4.2.8 TMoIP Bit Error Rate (BERT) Utilities

The Bit Error Rate Test (BERT) Utilities page, shown in Figure 42, is intended to be used during set up and pre-test to ensure that all systems are connected and configured properly. The BERT has two main capabilities:

- To generate PN pattern data and send it out the PCM interface (to the BSSA™ group input) or packetized in TMoIP packets
- To analyze PN pattern data that is received either via PCM interface (from the MLSC™ group output) or network TMoIP packets



Settings	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Channel 7	Channel 8	Channel 9	Channel 10	Channel 11	Channel 12
BERT Generator												
Generator Pattern	PN23	PN23	PN23	PN6	PN6	PN6	PN6	PN6	PN6	PN6	PN6	PN6
Generator Bitrate (Mbps)	10.0	0.1	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Analyzer Pattern	PN23	PN23	PN23	PN23	PN23	PN23	PN23	PN23	PN23	PN23	PN23	PN23
Status												
Channel Enabled												
Sync												
Inverted												
RX Bitrate (Mbps)	0.999999	2	5	10	20	20	20	20	20	20	5.058581	5.05858
RX Bit Count	2.764e+6	5.542e+6	1.387e+7	2.788e+7	5.615e+7	5.629e+7	5.647e+7	5.657e+7	5.665e+7	5.677e+7	1.441e+7	1.443e+7
RX Error Count	0	0	0	0	0	0	0	0	0	0	7200921	7211333
RX Error Rate	0.000e+0	0.000e+0	0.000e+0	0.000e+0	0.000e+0	0.000e+0	0.000e+0	0.000e+0	0.000e+0	0.000e+0	4.999e-1	4.999e-1
Generator Enabled												
TX Bit Count	0.000e+0	0.000e+0	0.000e+0	0.000e+0	0.000e+0	0.000e+0	0.000e+0	0.000e+0	0.000e+0	0.000e+0	0.000e+0	0.000e+0
Inject Error	Inject Error	Inject Error	Inject Error	Inject Error	Inject Error	Inject Error	Inject Error	Inject Error	Inject Error	Inject Error	Inject Error	Inject Error
Clear Stats	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear

Figure 42: Bit Error Rate Test (BERT) Utilities

The BERT Analyzer is always analyzing the incoming data, regardless of which mode the channel is in. In IP Out mode, the BERT Analyzer is looking at the PCM data coming in from the BSSA™ group output. In IP In mode, the BERT Analyzer is looking at the TMoIP data coming in via 218-20 network packets.

The BERT Analyzer does not handle data with DQE, so it is best used with pure PN sequence data.

Note: The TMoIP Network connection must be active (network cable plugged in and also connected to an active device) in order for the BERT page to operate properly.

This page consists of three sections: Settings, Status, and Buttons, as described in the following sections.

4.2.8.1 BERT Settings

The BERT Settings are used to configure the BERT Generator and Analyzer behavior.

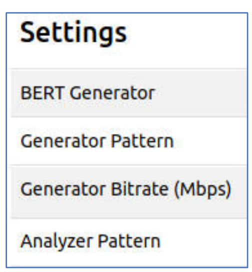


Figure 43: Bit Error Rate Test (BERT) Settings

4.2.8.1.1 BERT Generator

Check the BERT Generator check box to enable the generation of BERT data and send it out the proper interface as defined by the current Data Flow Direction:

- IP Out - BERT data is packetized and sent out the TMoIP network interface as configured by Channel settings.
- IP In - BERT data is sent to the BSSA™ group input.

Note: The BERT Generator is most useful in the IP Out direction, as it can be used to source TMoIP packets and help the user determine whether or not the TMoIP pathway to the destination is operational.

Important: When the BERT Generator is enabled on a channel, any data that would normally be sent to the BSSA™ group input or TMoIP network interfaces is replaced by BERT generated data. For example, in IP Out mode, if data is being received from the BSSA™ group output, that data will be analyzed by the incoming BERT Analyzer, but it will not be packetized. Instead, the BERT Generator data will be packetized and sent out in network packets. Likewise, in IP In mode, if TMoIP packets are being received, their payload will be analyzed by the BERT Analyzer, but it will not be sent out to the BSSA™ group input. Instead, the BERT Generator data will be sent to the BSSA™ group input. ****Be sure to turn off the BERT Generator on each channel before actual data is transported.****

4.2.8.1.2 Generator Pattern

The Generator Pattern is the repeating PN pattern used in generating BERT data and is selected via this drop down menu:

- PN6 – Pseudorandom pattern 2^6 -1 bits in length
- PN11 – Pseudorandom pattern 2^11 -1 bits in length
- PN15 – Pseudorandom pattern 2^15 -1 bits in length
- PN23 – Pseudorandom pattern 2^23 -1 bits in length

4.2.8.1.3 Generator Bitrate (Mbps)

The Generator Bitrate is the bit rate at which BERT data is generated and sent out. Entered in Mbps, this value can range from .001 to 50 (1 kbps to 50 Mbps).

4.2.8.1.4 Analyzer Pattern

The Analyzer Pattern is the PN pattern against which all incoming data is analyzed. Refer to section 4.2.8.1.2 (Generator Pattern) for options.

Note: In general, the Generator and Analyzer Patterns should be set to the same value across all connected systems.

4.2.8.2 BERT Status

As mentioned previously, the BERT Analyzer is always running and analyzing incoming data on every channel, regardless of the interface it comes in. This can be invaluable when setting up an end-to-end system or testing pre-mission.

The BERT Status display continually updates while the page is displayed. The following items are displayed within BERT Status, shown in Figure 44.

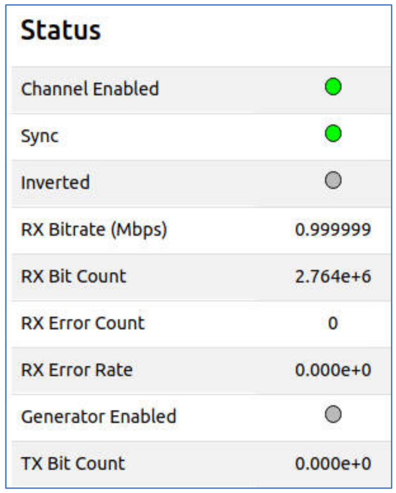


Figure 44: Bit Error Rate Test (BERT)

4.2.8.2.1 Channel Enabled

This LED image indicates whether the TMoIP channel is enabled. It is gray if disabled, green if enabled.

All of the following indicators apply only if the channel is enabled.

4.2.8.2.2 Sync

This LED image indicates if the BERT Analyzer has achieved sync with the PN pattern data incoming via the BSSA™ group output or TMoIP network interface. It is green if Sync'd, red if not Sync'd.

4.2.8.2.3 Inverted

This LED image indicates if the BERT Analyzer detects an inverted PN pattern. It is gray if not inverted, yellow if inverted.

4.2.8.2.4 RX Bitrate (Mbps)

This status indicates the approximate bitrate of incoming data, in Mbps.

4.2.8.2.5 RX Bit Count

This indicates the number of incoming bits analyzed by the BERT Analyzer.

4.2.8.2.6 RX Error Count

This indicates the number of incoming bits in error, as detected by the BERT Analyzer.

4.2.8.2.7 RX Error Rate

This indicates the bit error rate of the incoming data, as detected by the BERT Analyzer.

4.2.8.2.8 Generator Enabled

This LED image indicates whether the BERT Generator is enabled. Green is enabled.

4.2.8.2.9 TX Bit Count

This indicates the number of bits generated and output by the BERT Generator.

4.2.8.3 BERT Buttons

The buttons at the bottom of the Bit Error Rate Test (BERT) Utilities page perform the following functions:

- Inject Error – When the BERT Generator is enabled for a channel, clicking on this button one time injects a single bit error into the BERT data stream (one bit in the pattern is inverted).
- Clear – Clicking on this button clears the BERT statistics for a single TMoIP channel.
- Clear All – Clicking on this button clears the BERT statistics for all TMoIP channels.

Figure 45: Bit Error Rate Test (BERT) Utilities Buttons

Note: The Clear and Clear All buttons also clear the Channel Status pertaining to that channel(s) on the TMoIP Status page.

4.2.9 BSSA™ Source Configuration

The BSSA™ supports four groups for source generation. Each group can source up to twelve (12) outputs via PCM or TMoIP and will process a single input. The total number of usable sources across all groups is 12.

Each source emulates the output from a telemetry receiver. In general, most settings such as Bit Rate and Data Quality Encapsulation will be identical across all sources. However, each channel can be configured completely independently, just as receivers/data paths in the field may be. Settings that will generally be different between received channels include Q* and Delay.

***Note:** Q – the quality value – approximates the exponent of 10 in the bit error probability (BEP). So, for example, Q = 3 means BEP ≈ 1e-3, and Q = 7 means BEP ≈ 1e-7. This approximation is extremely accurate except for small values of Q, below 1. More technically, Q exactly equals the exponent of 10 in the likelihood ratio (LR) as defined in IRIG 106-23, Chapter 2, Appendix 2-G. Therefore, Q is related to DQM by the equation Q = 12 * DQM / 65536.

The Bit Rate and Q parameters can be configured as time-varying. Each can be swept across a range of values, at a specified sweep rate, differently or identically across channels. This allows generating repeatable tests similar to the IRIG 118 Combiner Break Frequency Test, but with more channels.

The Source Configuration page, shown in Figure 19, provides access to every source-specific setting. The settings are displayed as a matrix, with all 12 Source outputs in columns, and source-specific settings in rows.

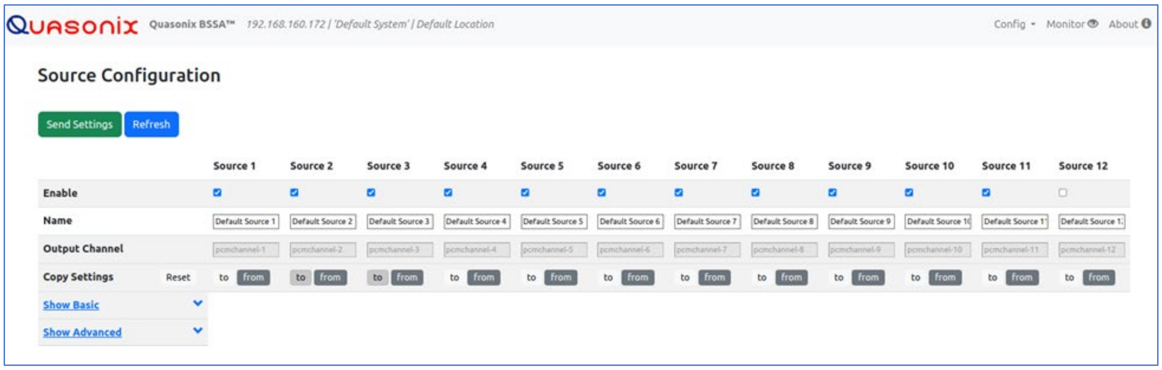


Figure 46: Source Configuration (Condensed)

The Show Basic and Show Advanced links are used to condense or expand additional settings. These settings are visible after the link is clicked, and display as follows:

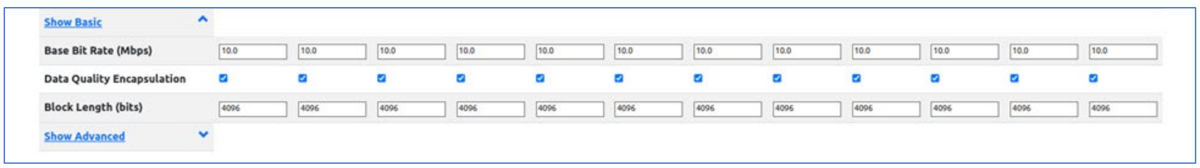


Figure 47: Source Configuration (Expanded Basic)

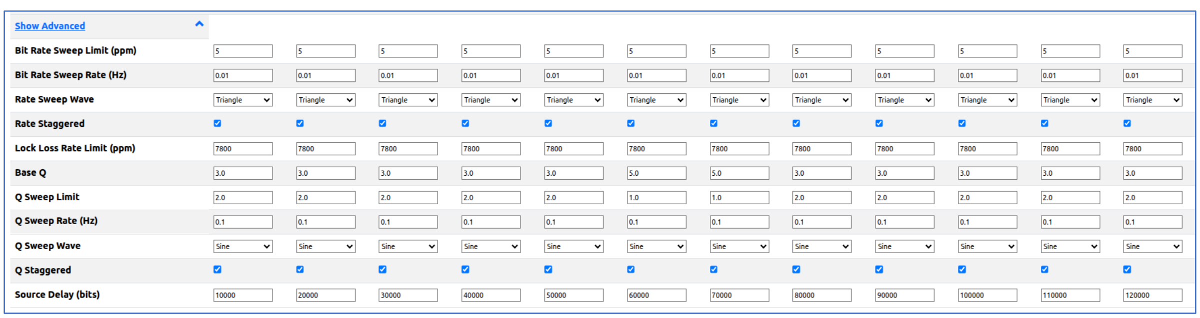


Figure 48: Source Configuration (Expanded Advanced)

4.2.9.1 Enable

Check this box to enable the specified BSSA™ Group. Disabled sources will not create any output.

4.2.9.2 Name

The Group Name is a text identifier used for identification purposes.

4.2.9.3 Output Channel

This field indicates which PCM or TMoIP Channel the Source will output on.

4.2.9.4 Copy Settings

The Copy Settings buttons, To and From, facilitate copying settings from one source to one or more other sources.

To use these buttons, first press the To button in the column of each source you would like to copy settings to. The To button is shaded when pressed.

To remove a source from the group of destinations, press the To button again to clear it. Then, press the From button in the column of the source you would like to copy settings from. All settings in the From column, except Enable and Name, are copied from the From source to the To sources.

If, prior to pressing the From button, the user makes changes to settings in the From source without submitting them, then only those changed settings are copied to the To sources. These settings are the ones highlighted in green, indicating that they have been modified.

After the From button is pressed and the settings are copied to the To columns, any changed fields are highlighted in green. At that point, pressing the Send Settings button applies the new settings to the device.

If the changes are not desired, press the blue Refresh button to reset the settings back to those currently configured on the device.

4.2.9.5 Base Bit Rate (Mbps)

This is the bit rate to be generated for the Source (in Megabits per second). This is the base bit rate for any sweeping that is applied.

4.2.9.6 Data Quality Encapsulation

Check this box to enable Data Quality Encapsulation for the Source.

Note: This is required on all sources for which you would like to perform MLBD combining on a Quasonix MLSC™.

4.2.9.7 Block Length (bits)

The Block Length sets the generated DQE block length in bits for the Source. This value must be between 1024 and 16384 bits, inclusive, and must be a multiple of 32.

4.2.9.8 Bit Rate Sweep

The BSSA™ can sweep the output bit rate for each Source, starting with the Base Bit Rate as the base rate, then using the Bit Rate Sweep Limit for bounds, Bit Rate Sweep Rate as the frequency of the sweep, and Rate Sweep Wave as the type of wave for the sweep. This emulates Doppler rate effects from moving targets. If the Rate Staggered box is checked, the Rate sweep phase of each Source contained in a particular group is offset equally from the other Sources in the group.

4.2.9.8.1 Bit Rate Sweep Limit (ppm)

This sets the bounds of the bit rate sweep for each Source, in ppm. For example, with a base bit rate of 10 Mbps and a bit rate sweep limit of 500 ppm, the limit in hertz would be 10 * 500 = 5000 Hz. A limit of 0 effectively disables the sweep.

4.2.9.8.2 Bit Rate Sweep Rate (Hz)

This sets the bit rate sweep frequency for each Source.

4.2.9.8.3 Rate Sweep Wave

This sets the wave type for each Source's rate sweep. Type selections are Triangle, Sine, and Cycloid.

4.2.9.8.4 Rate Staggered

All sources within the same Group with this checked have their Rate Sweep Wave offset from each other equally in phase.

4.2.9.9 Lock Loss Rate Limit

When Q = 0, the BSSA™ can emulate receiver bit sync lock loss by randomly varying the bit rate. Lock Loss Rate Limit sets the maximum extent of that random variation. The default value matches Quasonix receiver bit sync limits for most modes.

4.2.9.10 Q Sweep

The BSSA™ can sweep the output Q for each Source, starting with the Base Q setting, then using the Q Sweep Limit for bounds, Q Sweep Rate as the frequency of the sweep, and Q Sweep Wave as the type of waveform for the sweep. If the Q Staggered box is checked, the Q sweep phase of each Source contained in a particular group is offset equally from the other Sources in the group. The Q variance emulates signal quality degradation due to any channel impairment, and is reflected in the actual generated bit error rate and the DQM in output DQE frames.

4.2.9.10.1 Base Q

This sets the output bit error rate and equivalent Q value that is included in DQE framing, before any Q Sweeping is applied.

4.2.9.10.2 Q Sweep Limit

This sets the bounds of the Q sweep for each Source. A limit of 0 effectively disables the sweep.

4.2.9.10.3 Q Sweep Rate (Hz)

This sets the Q sweep frequency for each Source.

4.2.9.10.4 Q Sweep Wave

This sets the wave type for each Source's Q sweep. Type selections are Triangle, Sine, and Cycloid.

4.2.9.10.5 Q Staggered

All sources within the same Group with this checked have their Q Sweep Wave offset from each other equally in phase.

4.2.9.11 Source Delay (bits)

This allows the user to set the relative delay (in bits) between each generated Source. This emulates differences in receive channel propagation, whether due to RF propagation or demodulated data propagation through a network. Valid range is 0-250,000,000.

4.2.10 BSSA™ Group Configuration

The BSSA™ supports up to four groups for synchronizing output sources and analyzing inputs.

Each group can synchronize and source up to twelve (12) outputs and analyze a single input. The idea behind the BSSA™ Groups is that each group should output sources to a single BSS Group. The resulting output from that BSS Group is then fed back into the BSSA™ Group input for analysis.

The Group Configuration page, shown in Figure 16, provides access to every group-specific setting.

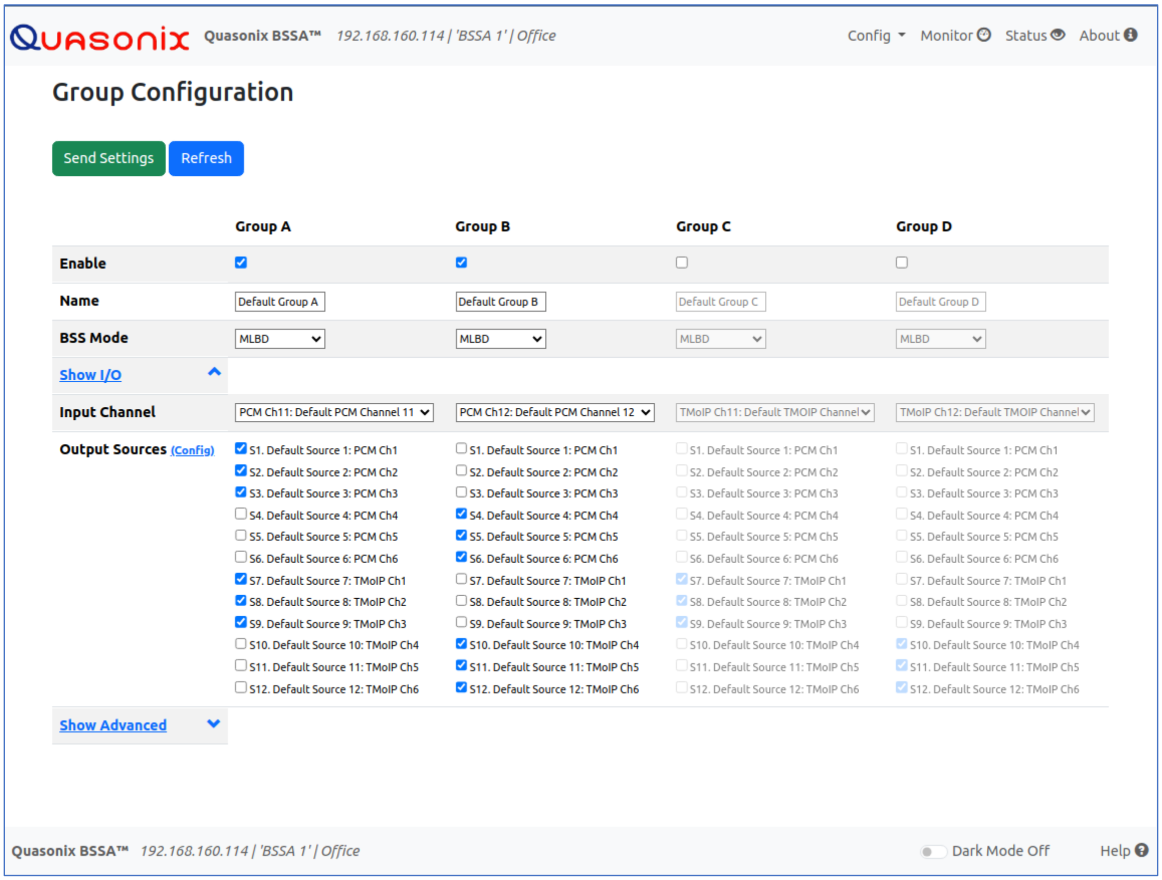


Figure 49: Group Configuration (Condensed)

The Show I/O and Show Advanced links are used to condense/expand additional settings. These settings are visible after the link is clicked and display as follows:

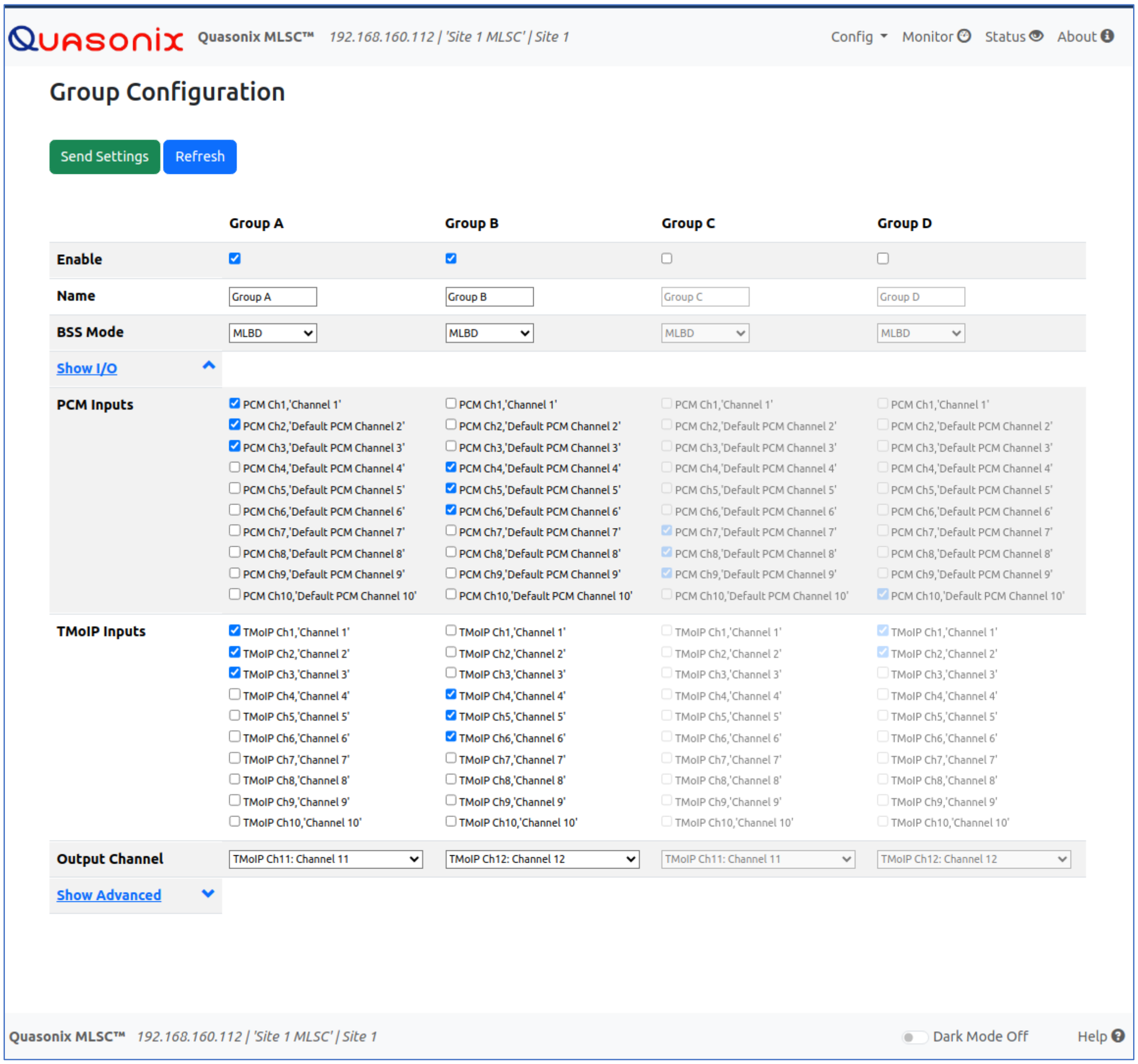


Figure 50: Group Configuration (Expanded I/O)

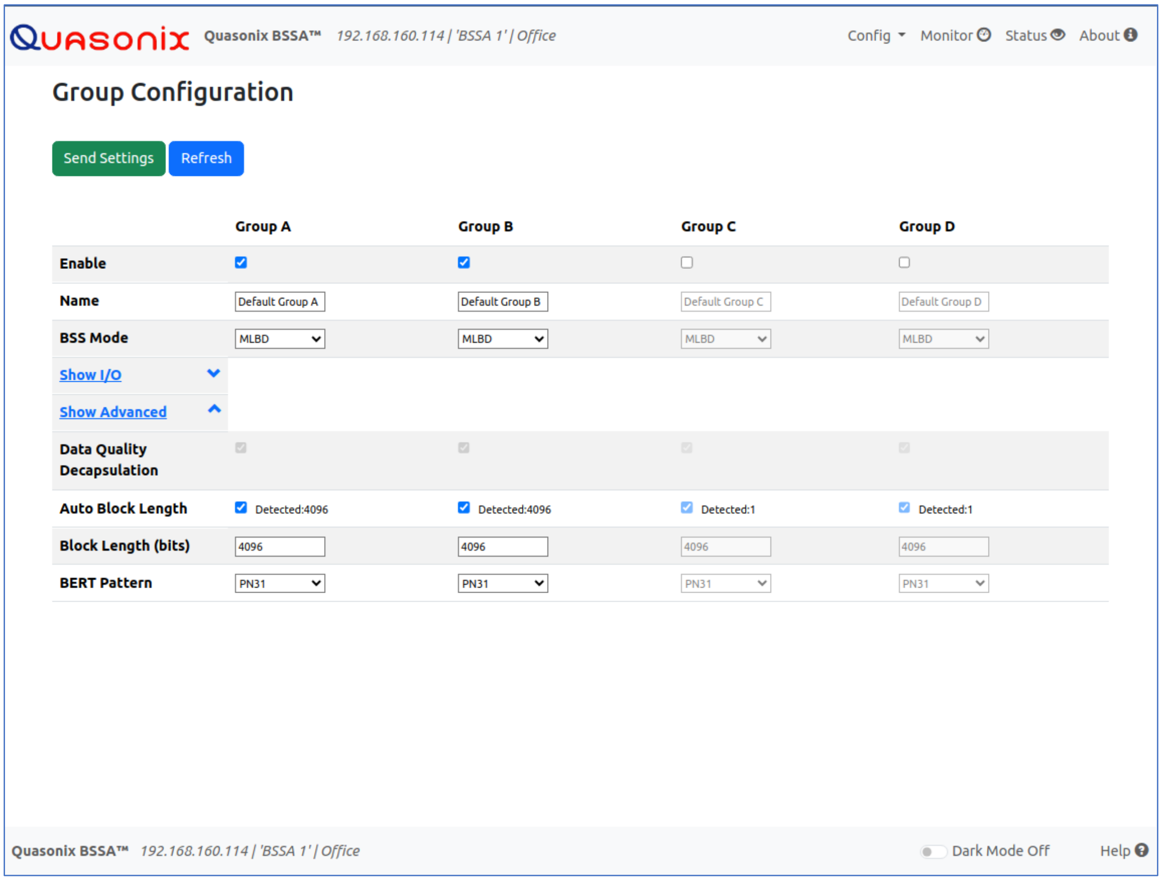


Figure 51: Group Configuration (Expanded Advanced)

4.2.10.1 Enable

Check this box to enable the specified BSSA™ Group. Sources must be selected as part of an enabled Group in order to create any output.

4.2.10.2 Name

The Group Name is a text identifier used for identification purposes.

4.2.10.3 BSS Mode

The BSSA™ Group performs a calculation on the Sources that are synchronized together as part of this BSSA™ Group to determine the theoretical performance of a Best Source Selector that is using the selected mode. Options are the same as for the MLSC™ BSS Mode:

- MLBD
- Best Source
- Majority Vote

The description for each of these modes can be found in the Maximum Likelihood Stream Combiner User Manual.

4.2.10.4 Input Channel

This drop down menu is used to select the PCM or TMoIP input to be used by each BSSA™ Group for analysis purposes. This input should be connected to the output from the BSS under test.

The listed Inputs show only the PCM and TMoIP Channels that have been configured as Inputs on their respective Configuration pages.

A particular Input can only be selected for use in a single group.

4.2.10.5 Output Sources

These check boxes are used to select which of the Sources will be synchronized by each BSSA™ Group. Each enabled BSSA™ Group must have at least one Source.

The listed Outputs show only the PCM and TMoIP Channels that have been configured as outputs on their respective Configuration pages.

4.2.10.6 Data Quality Decapsulation

Data Quality Decapsulation must be set when the output of the BSS Under Test has DQE enabled. If testing an MLSC™, this setting should be the same as the MLSC™ Group's Data Quality Encapsulation setting.

4.2.10.7 Auto Block Length (bits)

When incoming DQE is reliable, this setting allows the BSSA™ to automatically determine the incoming DQE block length in bits. The incoming block length must be between 1024 and 16384 bits, inclusive, and must be a multiple of 32.

4.2.10.8 Block Length (bits)

If Auto Block Length is not enabled, the Block Length must be set to the incoming DQE block length, in bits. In general, this setting would have the same value as the Sources on the Source Configuration page that are included as part of the Group being configured. This value must be between 1024 and 16384, inclusive, and must be a multiple of 32.

4.2.10.9 BERT Pattern

The BERT Pattern sets the PN data pattern to generate data for all Sources that are included in the Group. The selected PN sequence should be at least twice as long as the maximum delay spread between sources.

For example, if Sources 1, 2, and 3 are selected for Group A, then Sources 1, 2, and 3 all use the BERT Pattern configured for Group A.

In general, longer patterns are preferred and shorter patterns, such as PN6 and PN9, should be avoided unless there is a specific need for them. The selected pattern should not repeat within the delay span between sources. Otherwise, the unit under test will see indistinguishable correlation peaks at multiple delays for each signal, which may artificially improve or degrade measured results. For reference, a PNx pattern repeats every 2^x-1 bits. For example, PN23 repeats every 2^{23}-1 = 8,388,607 bits.

4.2.11 Monitor Page

The BSSA™ Group Monitor page, shown in Figure 19, is a one-stop-shop for BSSA™ status on all group input channels.

The page is broken up into two sections, a text-based and a graphical display of information, for each of the enabled Groups.

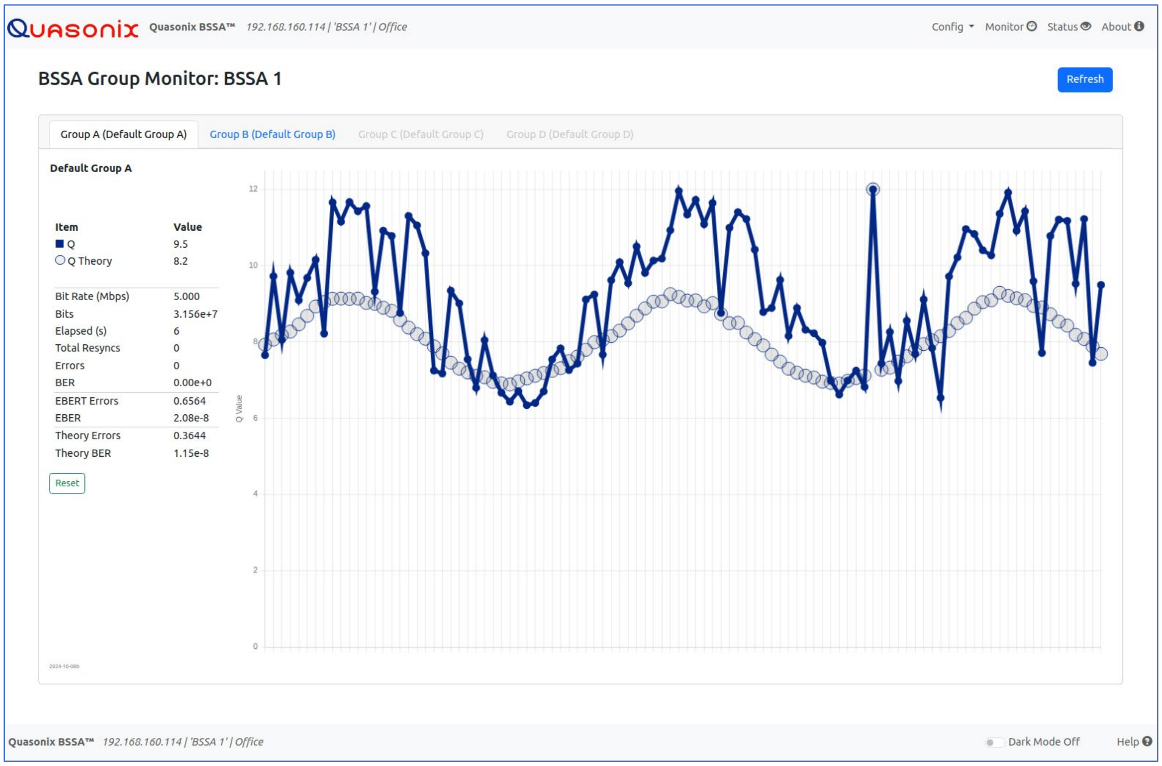


Figure 52: BSSA™ Group Monitor

4.2.11.1 Text-Based Information

The text section, shown in Figure 20, displays the following information. This display continually updates while this page is displayed.

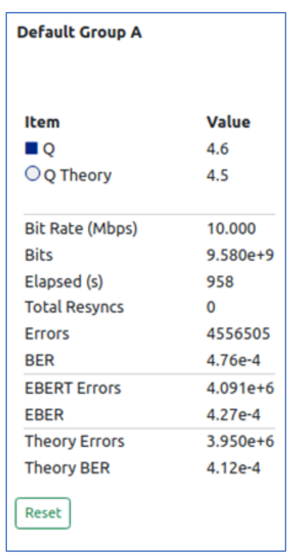


Figure 53: Text-Based Group Monitor Information

- Q – The current Q (Quality) level of the group input
- Q Theory – The current theoretical Q value of the group input, based on a theoretical application of the BSS Mode on the output sources selected for the group
- Bit Rate (Mbps) – Measured incoming bit rate since last press of Reset button
- Bits – Total number of incoming bits since last press of Reset button
- Elapsed – Time in seconds since last press of Reset button
- Total Resyncs – Total number of PN pattern resyncs due to bit errors or drops since last press of Reset button
- Errors – Total number of bit errors in incoming PN pattern test data since last press of Reset button
- BER – Bit Error Rate (Errors / Bits) since last press of Reset button
- EBERT Errors – Number of estimated bit errors based on DQM of incoming data since last press of Reset button; this value and EBER are only valid if the BSS being tested generates output in DQE format
- EBER – Estimated Bit Error Rate (EBERT Errors / Bits) since last press of Reset button
- Theory Errors – Number of theoretical errors, based on a theoretical application of the BSS Mode on the output sources selected for the group, since last press of Reset button
- Theory BER – Theory Errors / Bits
- Reset Button – Used to reset above statistics

4.2.11.2 Graphical Chart

The monitor chart displays two traces on a single chart, with the oldest samples on the left side of the chart:

- Input channel's Q value versus time (dark blue points); this value is only valid if the BSS being tested generates output in DQE format
- Q Theory for the input channel, based on a theoretical application of the chosen BSS Mode on the output sources selected for this group (light gray circles)

4.2.12 Status

4.2.12.1 System Status

The System Status section, shown in Figure 54, provides the following information. This data continually updates as long as this page is displayed.

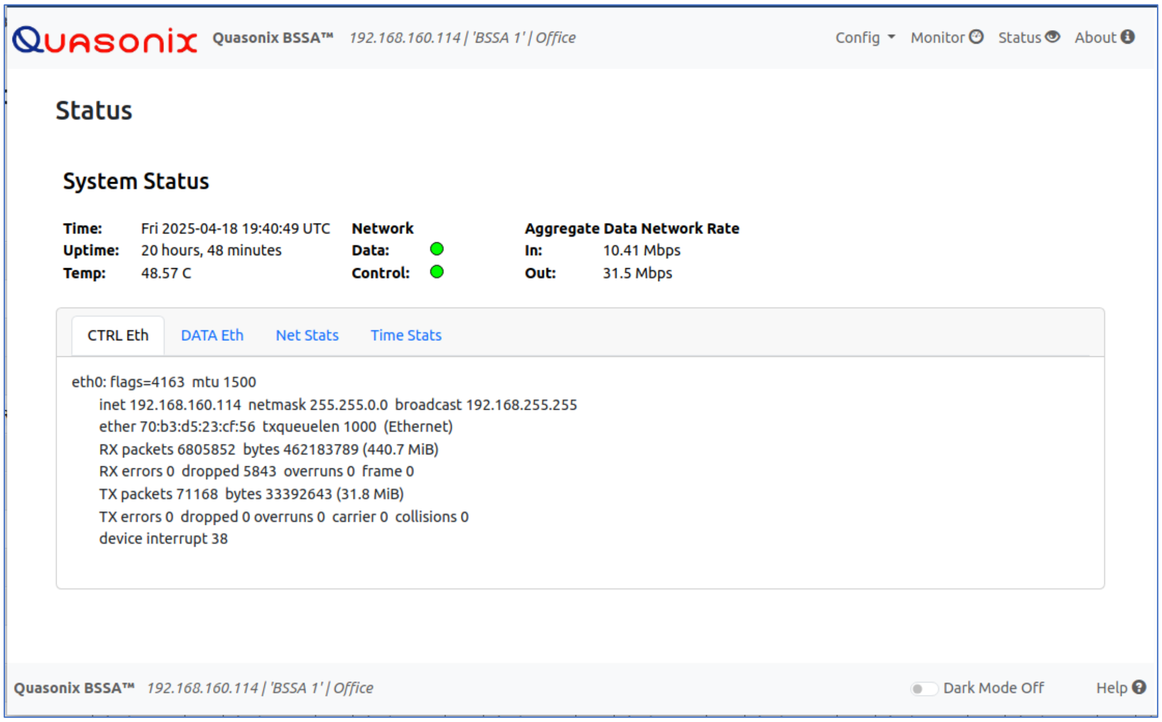


Figure 54: System Status

- System Time – Current system day, date, and time in UTC, formatted as Day YYYY-MM-DD HH:MM:SS
- System Uptime – Current system uptime in days and minutes
- System Temperature – Current internal system temperature in degrees Celsius
- Data Network – The state of Data Network connectivity; Green/connected or Red/disconnected
- Control Network – The state of Control Network connectivity; Green/connected or Red/disconnected
- Aggregate Data Network In Rate – The total incoming Ethernet traffic rate on the TMoIP network
- Aggregate Data Network Out Rate – The total outgoing Ethernet traffic rate on the TMoIP network

4.2.12.2 System Statistics

The four tabs listed under the System Status section include debug information that may be useful when troubleshooting networking issues. These include information regarding Control Ethernet, Data Ethernet, Network, and Time synchronization.

4.2.13 About System

The About System page, shown in Figure 21, displays a variety of identifying information about the system.

Quasonix Quasonix BSSA™ 192.168.160.114 | 'BSSA 1' | Office

About System: BSSA 1

Unit Information

Description	Value
BSSA Features:	Inputs: 12 , TMoIP enabled
Serial Number:	7004
Part Number:	QSX-BSSA
Ctrl Eth Addr:	70:B3:D5:23:CF:56
Data Eth Addr:	70:B3:D5:23:CF:57
HW Version:	1
System Version:	1.2
OS Version:	cb98ad694104
FW Version:	0x1000027
Top Build:	0x11
Build Time:	2025:03:27:16:41:56
Browser Version:	2025-04-16 p

Firmware Update Page

Quasonix BSSA™ 192.168.160.114 | 'BSSA 1' | Office

Figure 55: About System, Unit Information

The Firmware Update link allows in-field firmware updates via an update file provided by Quasonix.

Additional items vary by release and may be requested by Quasonix if support is necessary.

5 Product Warranty

The Best Source Selector Analyzer carries a standard parts and labor warranty of one (1) year from the date of delivery.

6 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.

7 Appendix A – Standard Tests

The BSSA™ facilitates testing many aspects of BSS performance with virtually unlimited combinations of conditions. As a starting point, a few standard tests are defined here.

Presently, these tests are predominantly manual. Some automation of test control and results presentation is being considered for a future software release.

The BSSA™ generates source data based on a statistical model that emulates the effects of additive white Gaussian noise (AWGN) on receiver bit errors. This means that every generated bit experiences its own added noise and therefore every DQE frame has a unique DQM, even when a static Q value is selected. This is the same as a real receiver with a static E_b/N_0. This statistical variation yields the expected *average* DQM and bit error rate.

The BSSA™ estimates theoretical BSS performance based on the DQM in each DQE frame, with no knowledge of which bits in the frame (if any) are actually errored. This theoretical calculation does not generally match BSS performance on a frame-by-frame basis but yields the correct expected *average* value.

The following tests use a small number of channels for simplicity. Further, where possible, they use relatively low Q values to reduce test time and measurement variance due to the statistics described above. These basic tests can obviously be extended with more channels, higher Q values, and other channel conditions to stress the BSS in different ways.

7.1 Maximum Likelihood Bit Detection (MLBD) Test

The IRIG 106 DQE/DQM standard is based on the theoretical foundation of Maximum Likelihood Bit Detection (MLBD)[1]. The MLBD test verifies that a BSS provides expected performance for a proper implementation of the IRIG standard.

Two variations of this test are defined: static and dynamic.

7.1.1 Static Test Setup

The static MLBD test uses three channels set at fixed Q values:

Base Q	2.0	4.0	6.0
Q Sweep Limit	0.0	0.0	0.0
Q Sweep Rate (Hz)	0.1	0.1	0.1
Q Sweep Wave	Sine	Sine	Sine
Q Staggered	☑	☑	☑

Figure 56: MLBD Static Test Setup

[1] *Maximum Likelihood Detection from Multiple Bit Sources*, Michael Rice and Erik Perrins, International Telemetering Conference 2015.

These values are chosen to distinguish MLBD performance from other selection algorithms such as best source and majority vote.

The Theory BER and Q Theory values in the chart shown in Figure 57, accurately reflect expected MLBD performance based on generated source signal statistics described above. This performance noticeably exceeds performance predicted by a static MLBD calculation with fixed source Q values of 2.0, 4.0, and 6.0, due to relatively high statistical variance.

To independently verify BSSA™ theory calculations, lower Q values (with lower statistical variance) are required. For example, source Q values of 2.0, 3.0, and 4.0 will give a BSS output Q around 5.0, much closer to the static MLBD calculation.

7.1.2 Static Test Results

Measured BSS output BER should very closely match the Theory BER. If the BSS supports DQE output, its DQM (represented as Q) should vary slightly above and below the Q Theory values indicated by gray circles:

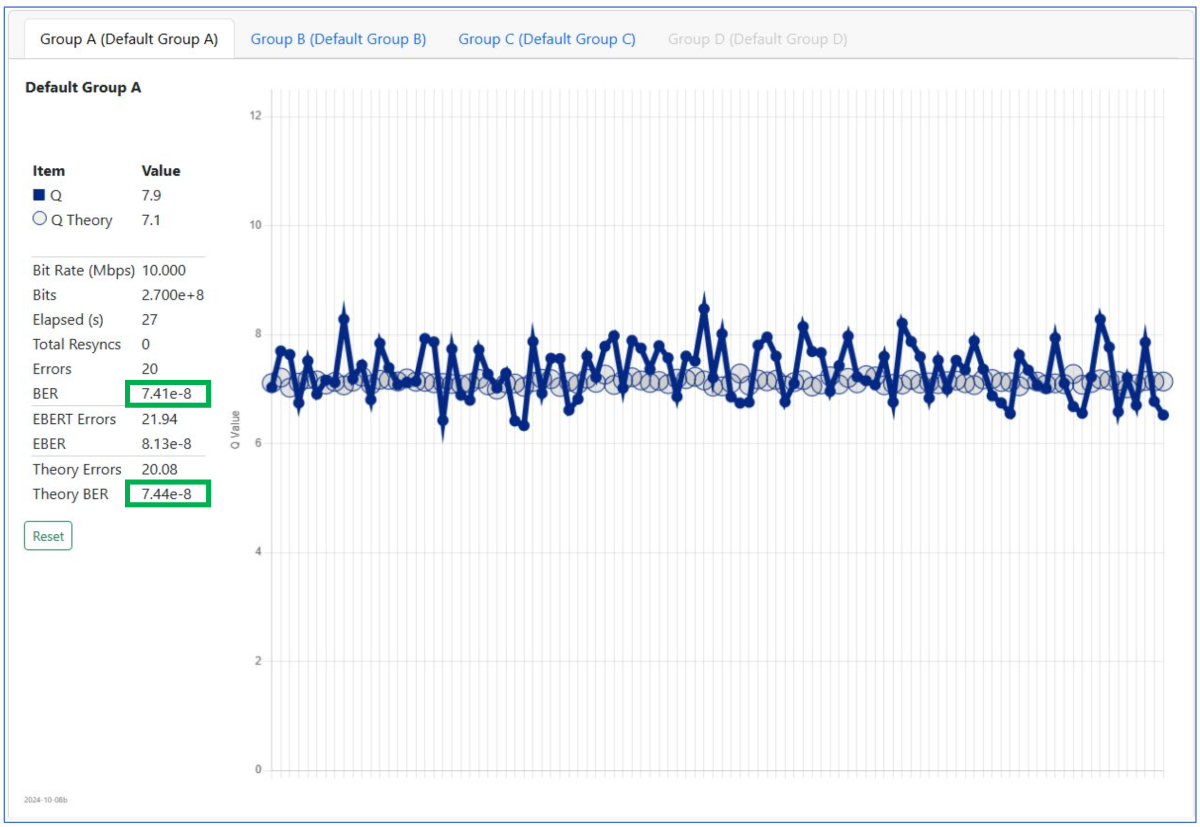


Figure 57: MLBD Static Test Results

Measured BSS output error that differs noticeably from the Theory BER may indicate a poor implementation of MLBD, or a different selection algorithm altogether, as shown in Figure 58 and Figure 59.

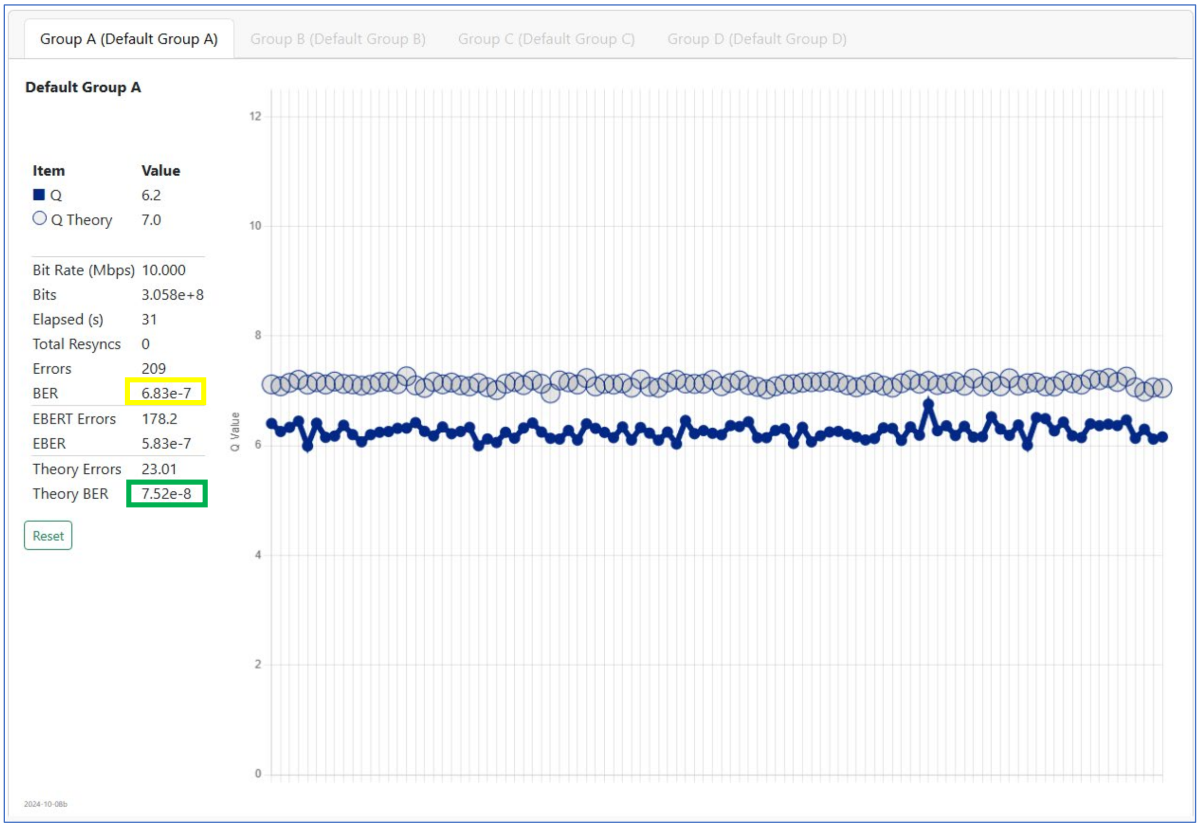


Figure 58: MLBD Static Test Results, Invalid Algorithm (Best Source)

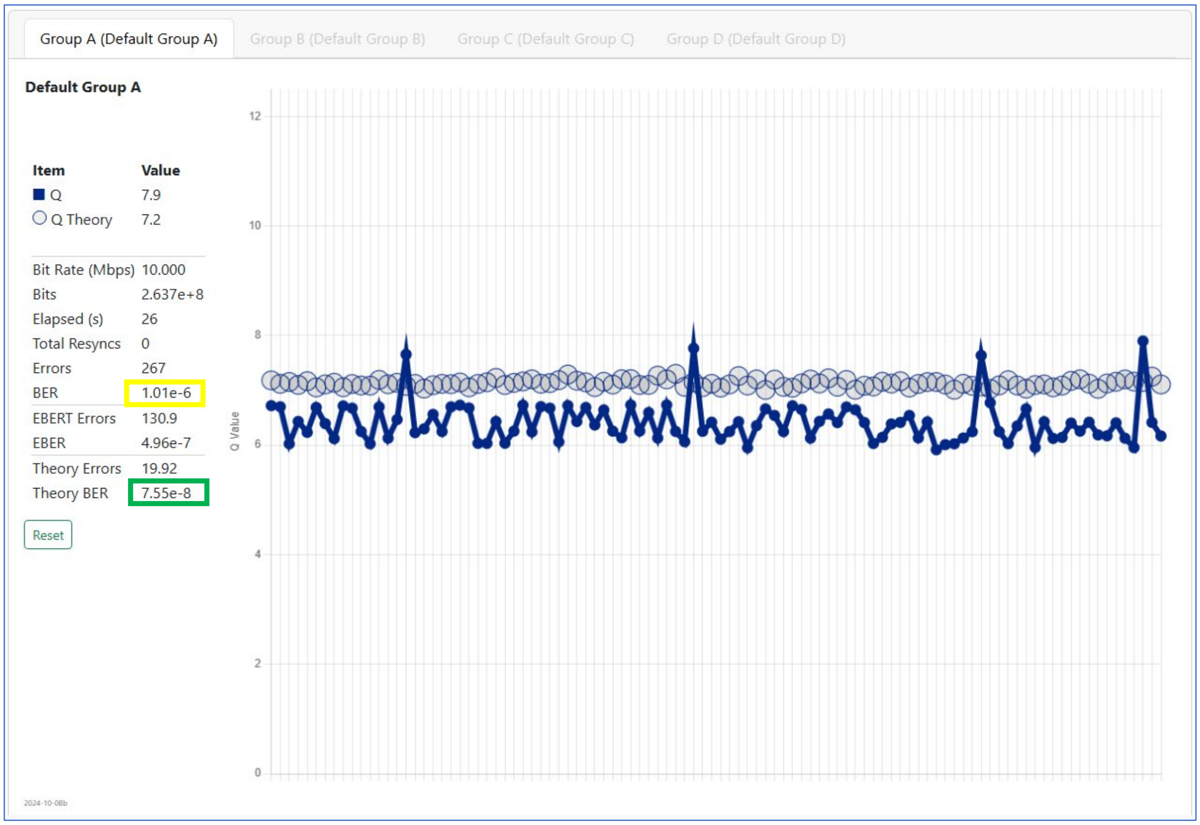


Figure 59: MLBD Static Test Results, Invalid Algorithm (Majority Vote)

7.1.3 Dynamic Test Setup

The dynamic MLBD test uses three channels set at different time-varying Q values, as shown in Figure 60.

Base Q	2.0	3.0	5.0
Q Sweep Limit	1.0	0.5	0.0
Q Sweep Rate (Hz)	0.1	0.1	0.1
Q Sweep Wave	Sine	Sine	Sine
Q Staggered	☑	☑	☑

Figure 60: MLBD Dynamic Test Setup

These values build on the static test to further distinguish a proper MLBD implementation.

7.1.4 Dynamic Test Results

Measured BSS output BER should very closely match the theory BER. If the BSS supports DQE output, its DQM (represented as Q) should closely match the Q Theory values indicated by gray circles, as shown in Figure 61.

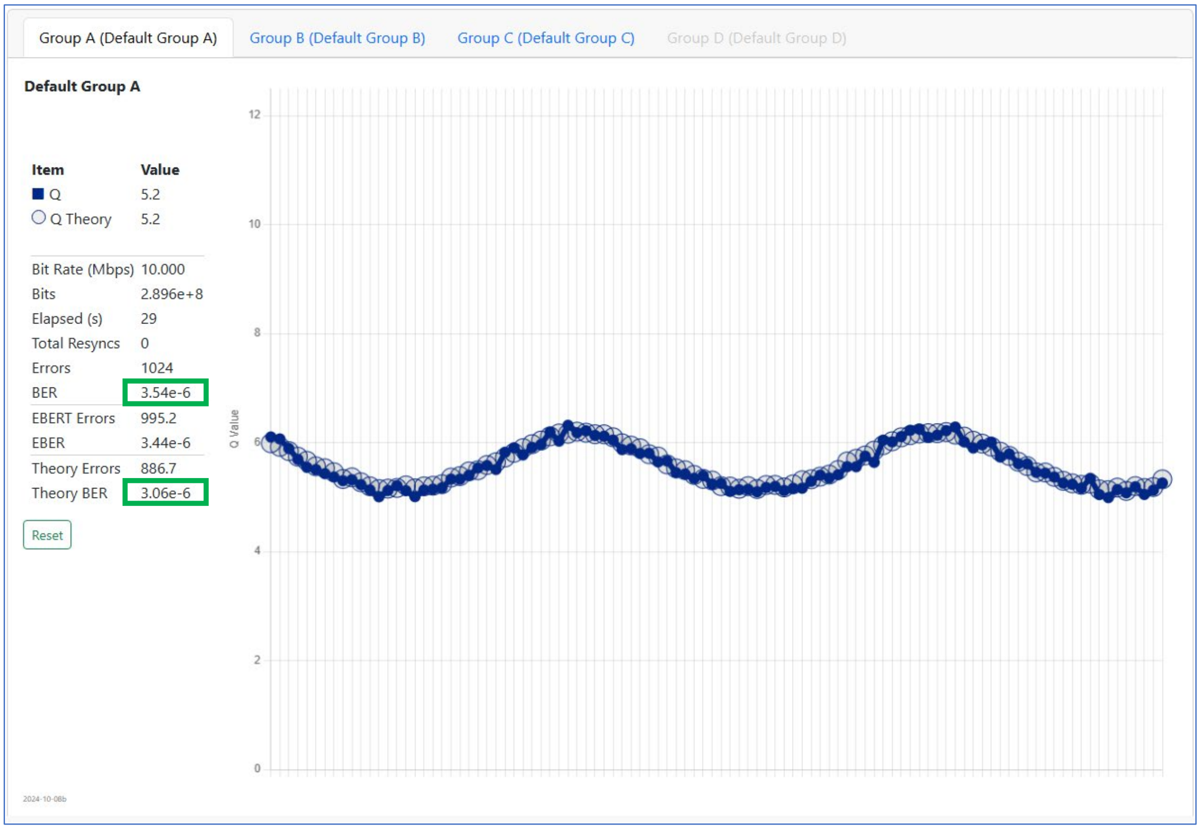


Figure 61: MLBD Dynamic Test Results

Similar to the static test, measured BSS output error that differs noticeably from the Theory BER may indicate a poor implementation of MLBD, or a different selection algorithm altogether, as shown in Figure 62 and Figure 63.

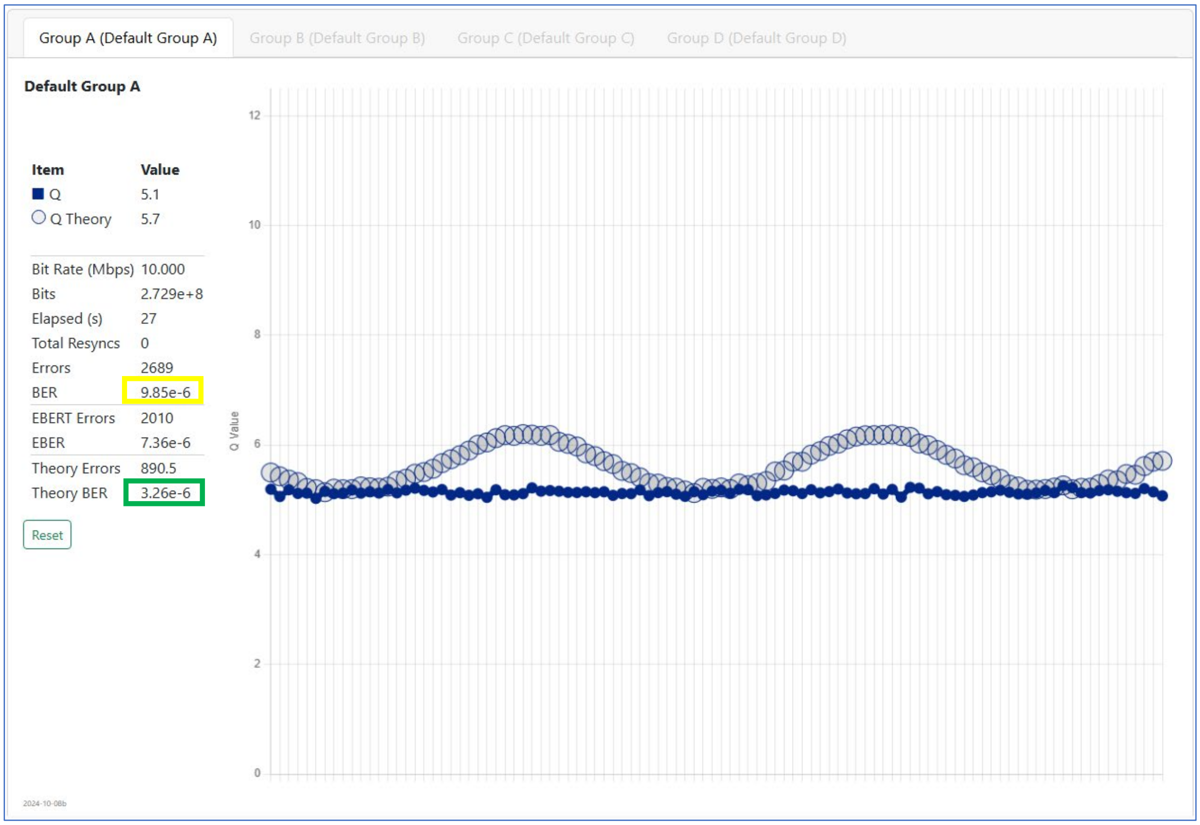


Figure 62: MLBD Dynamic Test Results, Invalid Algorithm (Best Source)

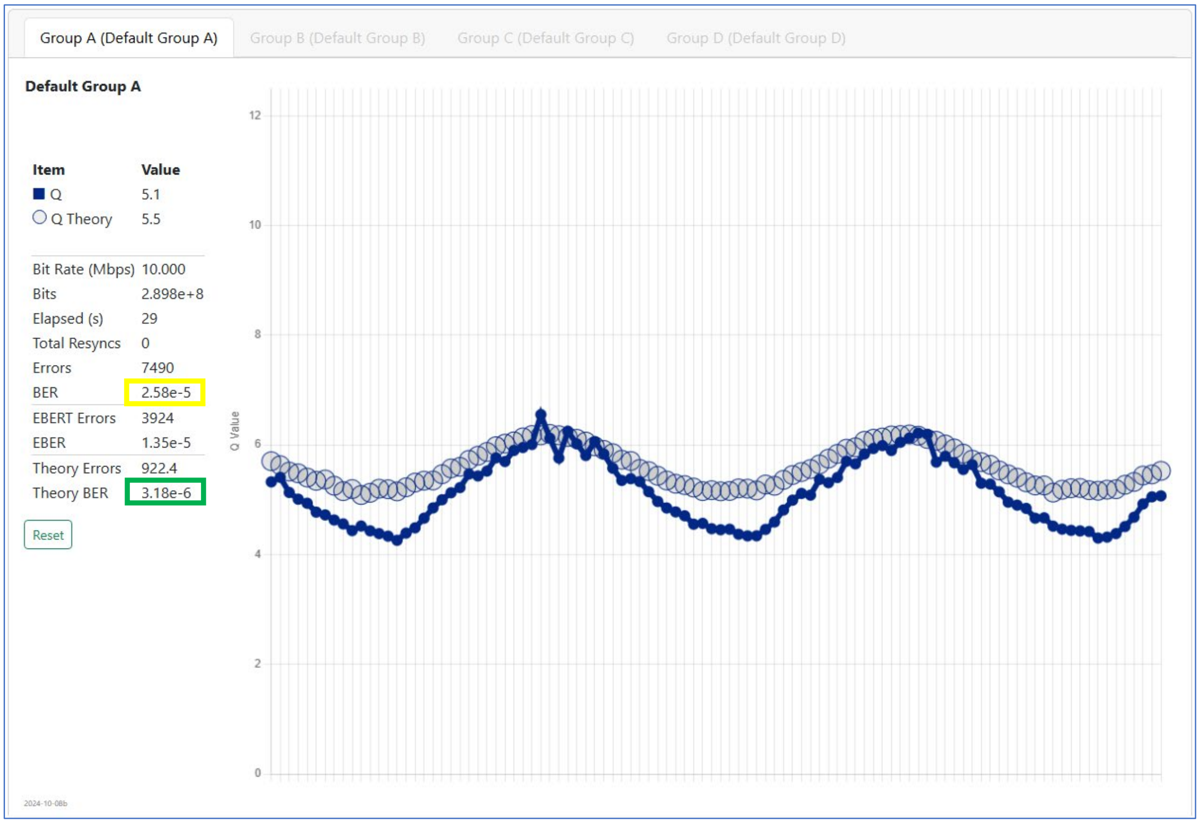


Figure 63: MLBD Dynamic Test Results, Invalid Algorithm (Majority Vote)

7.2 Maximum Delay Spread Test

BSS input sources experience latency due to a number of potential factors, including test article position, physical location of the ground stations, and network latency. The maximum delay spread test measures how much difference in time arrival a BSS can tolerate across sources.

Note that this test relies on a selection algorithm that provides performance gain relative to the best channel. A BSS that only operates in best source mode can be tested using a variant of the break frequency test, as shown in the following sections.

7.2.1 Test Setup

The maximum delay spread test uses three channels set at identical Q values. The third channel Source Delay is then manually increased until measured BSS BER increases, as shown in Figure 64.

Base Q	3.0	3.0	3.0
Q Sweep Limit	0.0	0.0	0.0
Q Sweep Rate (Hz)	0.1	0.1	0.1
Q Sweep Wave	Sine	Sine	Sine
Q Staggered	☑	☑	☑
Source Delay (bits)	0	0	1100000

Figure 64: Maximum Delay Spread Test Setup

7.2.2 Test Results

When the third channel delay exceeds the BSS's maximum delay spread capability, it will fail correlation in the BSS. This will, in turn, greatly increase the measured BSS output BER. It may be helpful to reset the BERT each time the delay is changed to note this difference. If the BSS supports DQE output, its Q will greatly decrease, which will be evident without any BERT reset, as shown in Figure 65.

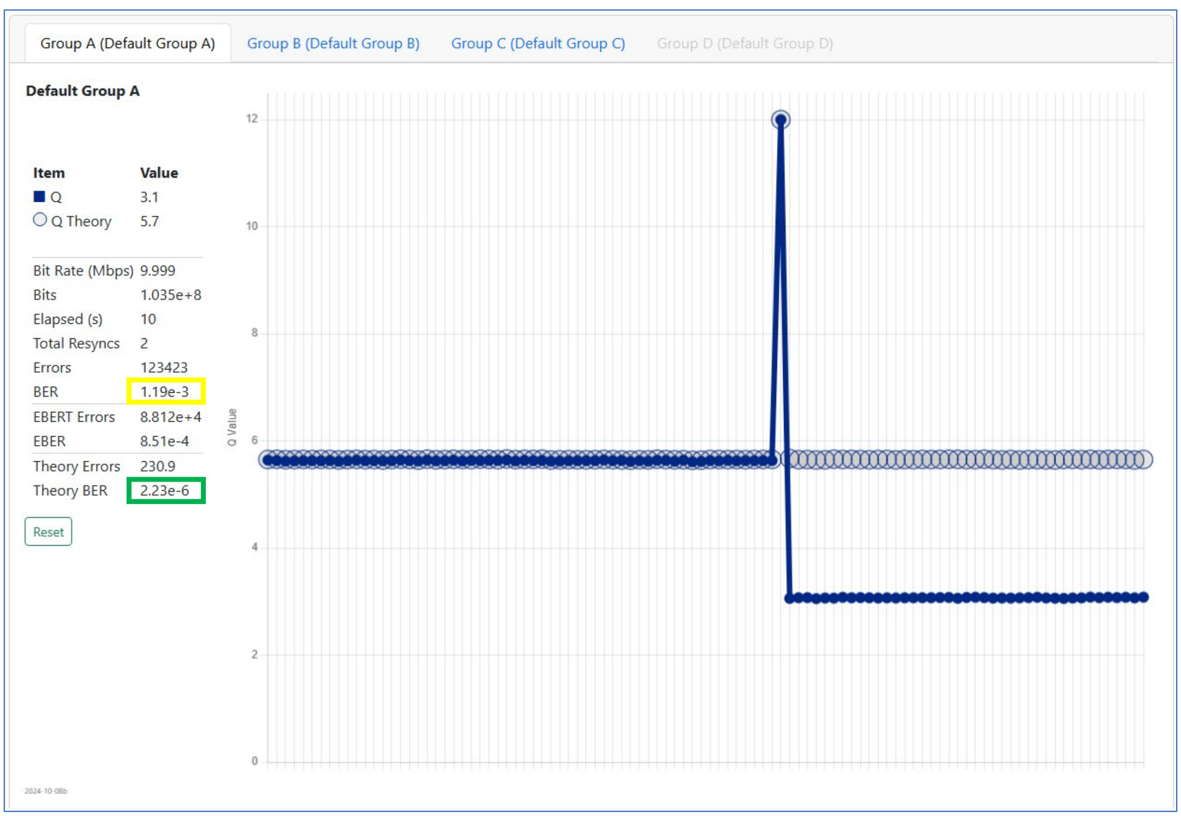


Figure 65: Maximum Delay Spread Test Results

7.3 Correlation Threshold Test

Maintaining source correlation is critical for optimal BSS performance. The correlation threshold test measures the lowest Q (highest BER) that a BSS can tolerate and still accurately correlate its sources.

Note that this test relies on a selection algorithm that provides performance gain relative to the best channel. A BSS that only operates in best source mode cannot readily be tested.

7.3.1 Test Setup

The correlation threshold test uses three channels set at identical Q values. The Base Q of all sources is then manually decreased until measured BSS BER increases above the theory level, as shown in Figure 66.

Figure 66: Correlation Threshold Test Setup

7.3.2 Test Results

When the source BER exceeds the BSS's correlation capability, it will inhibit selection gain in the BSS. This will, in turn, noticeably increase the measured BSS output BER. The BERT should be reset each time the delay is changed to note this difference. When the BSS output BER exceeds 2x the theory value, proper correlation is occurring approximately half the time. The corresponding source Q can be noted as the correlation threshold. This can be converted to bit error probability via the relationship BEP = 10-Q / (1 + 10-Q). Figure 67 illustrates a step from a source Q of 1.4 to a source Q of 1.3, followed by a BERT reset.

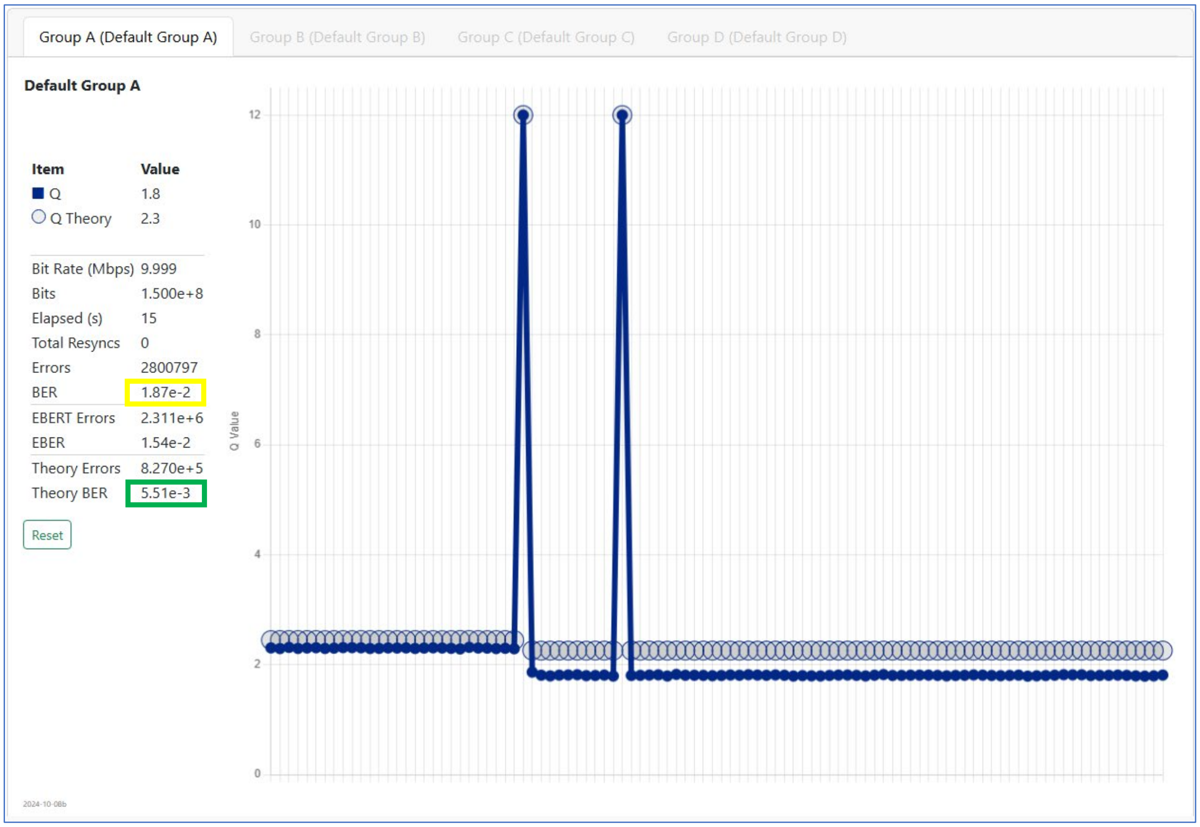


Figure 67: Correlation Threshold Test Results

7.4 Break Frequency Test

The IRIG 118-22 break frequency test measures a pre-detection combiner's ability to handle alternating channel fading. The break frequency is defined as the fade rate at which the combiner can no longer keep up with the fading and loses its gain. The BSSA™ break frequency test measures this same capability for post-detection source selection.

7.4.1 Test Setup

The break frequency test uses two channels set at equal but alternating Q values, with a cycloid sweep waveform. These settings yield output source streams that precisely emulate receiver channels under IRIG 118 test conditions with a 1.0e-4 base BER and 20 dB fade (approximately +5 dB and -15 dB relative to the base signal level). The Q Sweep Rate on both channels is manually increased until the BSS output BER exceeds 1.0e-4, as shown in Figure 68.

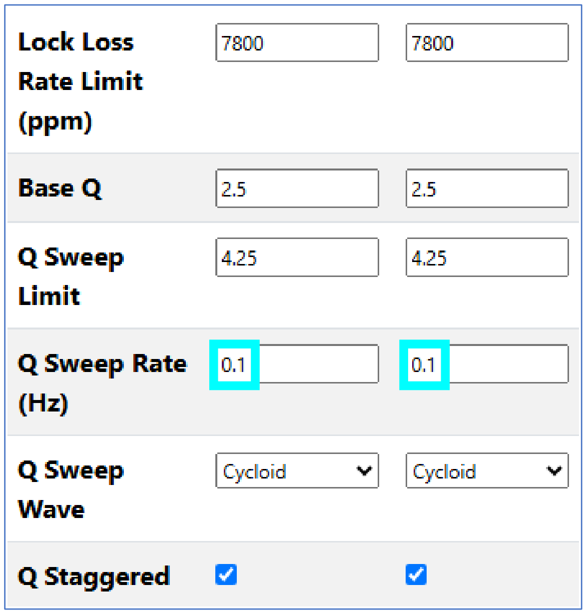


Figure 68: Break Frequency Test Setup

7.4.2 Test Results

Figure 69 shows results at a slow fade rate, with one channel in the BSS disabled to better visualize the fading.

In particular, note that the source Q value is 0 at the lowest point in the fade. When Q is 0, the BSSA™ randomly modulates the source bit rate within a range specified by the Lock Loss Rate Limit. This emulates an unlocked bit sync in the receiver, which naturally occurs during deep fades. Unlike other tests, therefore, the break frequency test intentionally does not preserve bit rate synchronization between sources.

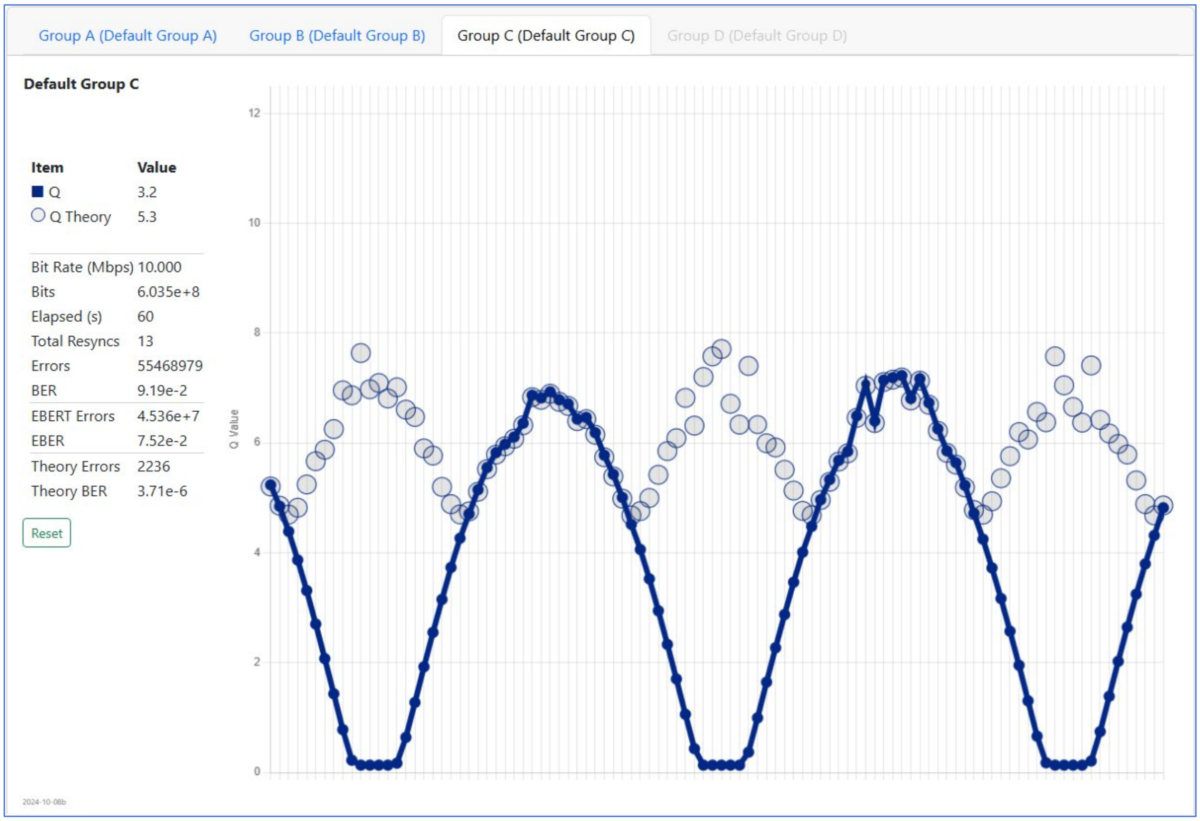


Figure 69: Break Frequency Test Fade Pattern

At low fade rates, the fade cycle is apparent in the Q Theory values indicated by gray circles. The average BER should closely match the Theory BER and be above 1.0e-4, with no BERT resyncs, as shown in Figure 70.

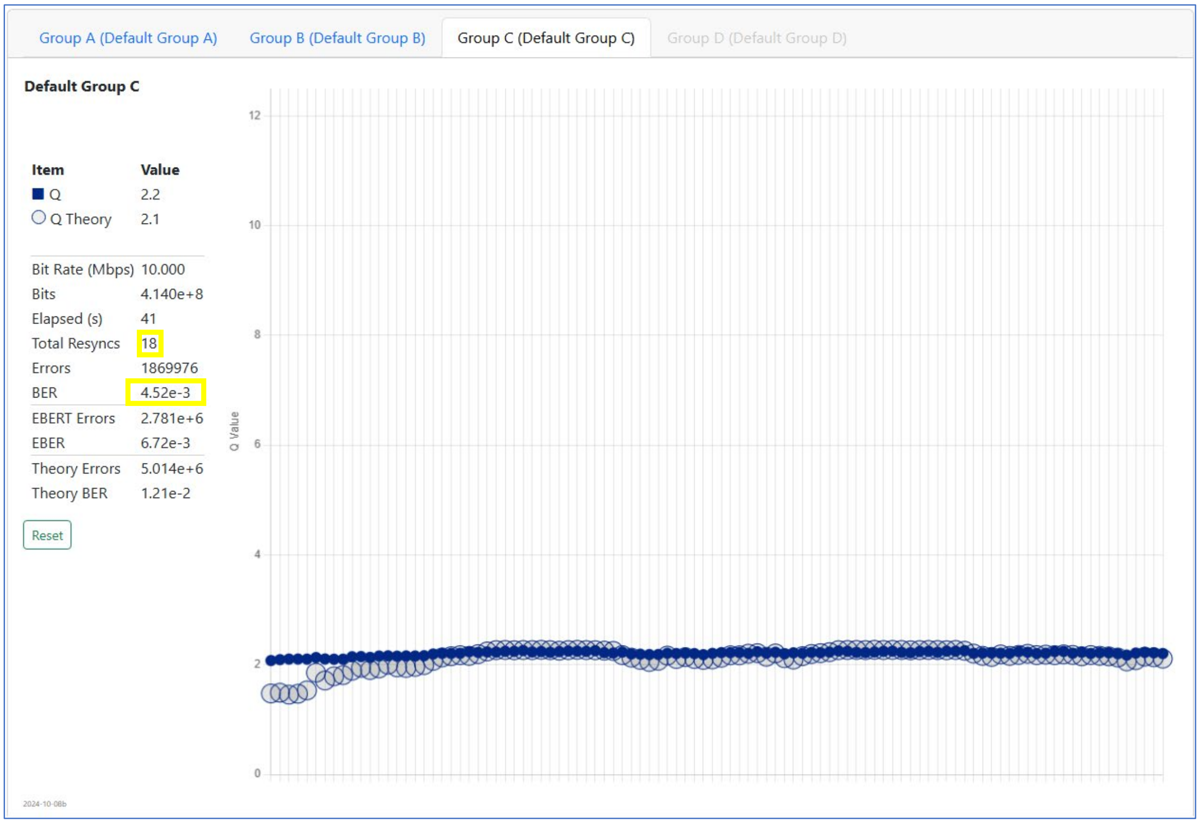


Figure 70: Break Frequency Test Results, Low Fade Rate

At higher fade rates, the fade cycle blurs to an almost constant average Q. The average BER should remain close to the Theory BER and above 1.0e-4, with no BERT resyncs, as shown in Figure 71.

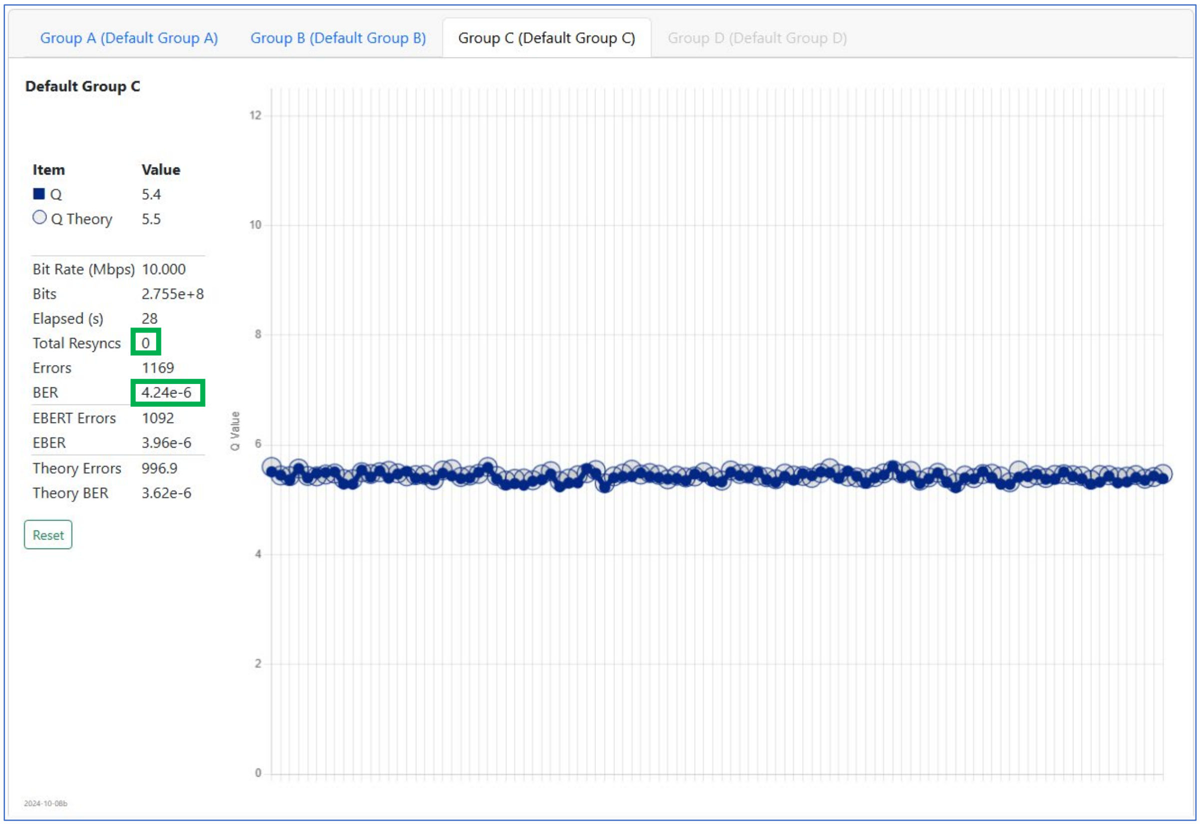


Figure 71: Break Frequency Test Results, Moderate Fade Rate

At sufficiently high fade rate, the average BER will exceed 1.0e-4 and/or BERT resyncs will occur, indicating pattern slip in the BSS output data. The fade rate at which this occurs should be noted as the break frequency, as shown in Figure 72.

Note, the Theory BER and Q Theory values track lower as the fade rate approaches half the bit rate divided by the DQE frame size. This is the point where – if the DQE frames were perfectly aligned to the fade cycle – each channel's DQM value could still indicate it is "bad" or "good". Because the DQE frames are not aligned to the fade cycle, performance will degrade at fade rates below this threshold.

Note also that the Theory BER, Q Theory values, and BSS output DQM may have decreased accuracy near the break frequency threshold. Therefore, it is critical to monitor the actual BSS output BER – along with total resyncs, which should remain at 0 – to determine the break frequency.

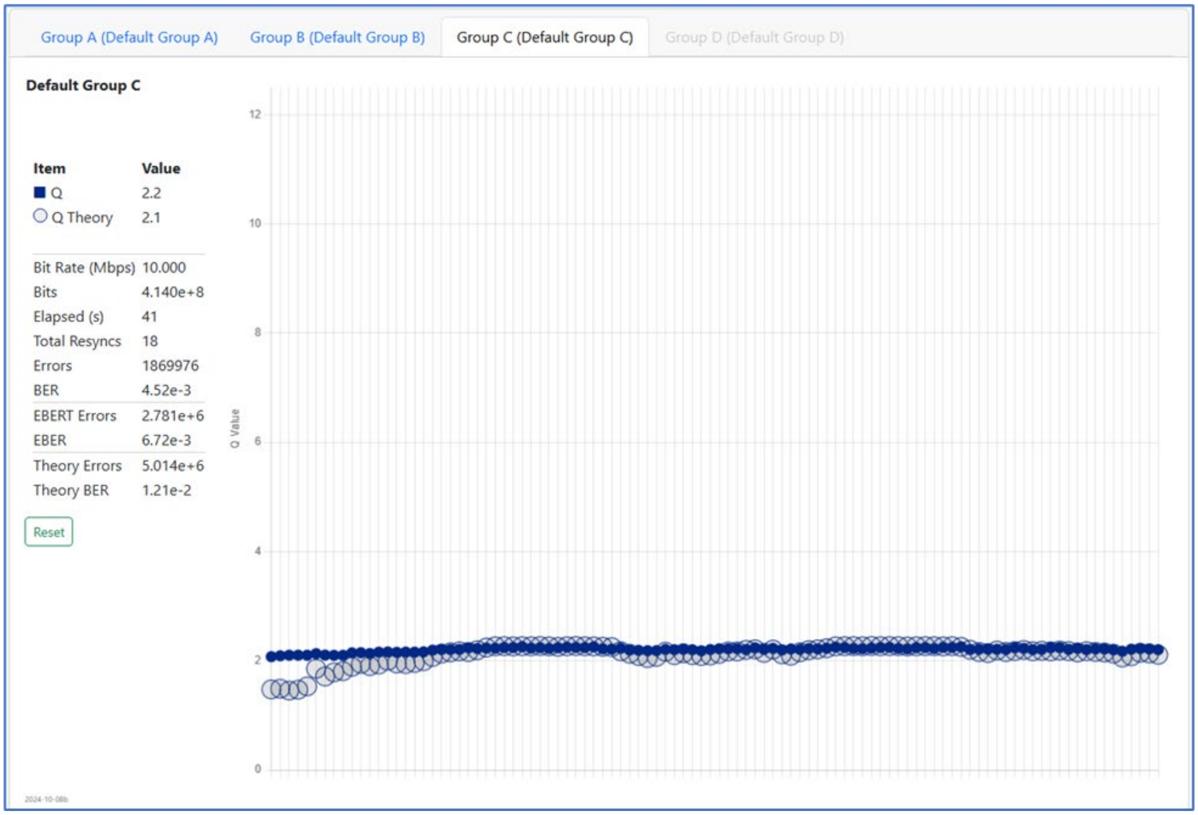


Figure 72: Break Frequency Test Results, High Fade Rate

7.4.3 Test Extension

The break frequency test setup may be used for other test purposes. As noted above, at low fade rates, the BSS output BER should remain below 1.0e-4 and no BERT resyncs should be detected. Assuming this initial state can be achieved, it can be used to detect correlation failure under other test conditions.

For example, after performing break frequency test setup and verifying proper BSS output, the Source Delay of one of the two fading sources could be increased until the BSS output BER increases and/or BERT resyncs are detected. This would be an alternate way of measuring maximum delay spread.

8 Appendix B – Acronym List

Acronym	Description
BEP	Bit Error Probability
BER	Bit Error Rate
BERT	Bit Error Rate Test
BNC	Bayonet Neill-Concelman Connector (RF Connector)
BSSA™	Best Source Selector Analyzer
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name Server
DQE	Data Quality Encapsulation
DQM	Data Quality Metric
GUI	Graphical User Interface
IP	Internet Protocol
kbps	Kilobits per second
KHz	Kilohertz
LAN	Local Area Network
LCD	Liquid Crystal Display
LED	Light-emitting Diode
Mbps	Megabits per second
MHz	Megahertz
MLSC	Maximum Likelihood Stream Combiner
N	(connector type) Threaded RF connector
NTP	Network Time Protocol
OOO	Out of Order
PTP	Precision Time Protocol
Q	Quality value (Q = 12 * DQM / 65536)
QTP	Quasonix TMoIP Processor
RDMS	Receiver DeModulator Synchronizer
RJ-45	Ethernet Connection Jack
RS-232	Recommended Standard 232 (Serial Communications)

Acronym	Description
TMoIP	Telemetry Over Internet Protocol
TSR	Timestamp Source Reference
TTL	Transistor Logic
UDP	User Datagram Protocol
USB	Universal Serial Bus
UTC	Coordinated Universal Time