Quasonix

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Installation and Operation Manual

Maximum Likelihood Stream Combiner

Quasonix, Inc.
6025 Schumacher Park Dr.
West Chester, OH 45069
14 May 2025

****** Revision 1.0 ******

Applies to Software Version 1.2

MADE IN USA

Specifications subject to change without notice.

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

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1 Introduction

1.1 Description

This document describes the installation and operation of the Quasonix Maximum Likelihood Stream Combiner (MLSC™). The hardware described in this manual refers to the 12 channel, 1U, Rack-Mount MLSC™ system (part number QSX-MLSC-12).

The Quasonix MLSC™ is a new approach to Best Source Selection that extracts optimal data from multiple received signals. Twelve PCM I/O and twelve TMoIP I/O are independently configurable as input or output for MLSC™ groups, with up to twelve input channels and four channel groups (outputs) per unit. MLSC™ units can be cascaded to achieve any number of channels for larger systems and can be paralleled to support any number of channel groups.

The MLSC™ faithfully implements Maximum Likelihood Bit Detection (MLBD), using the Data Quality Metric (DQM) for each bit of every bit stream to determine the most likely correct output bit. Not only does the MLSC derive the lowest achievable output bit error rate possible, it also constructs accurate DQM for the output stream, which can be used in cascaded MLSC arrangements or by other downstream equipment.

The MLSC™ includes automatic DQE frame detection, a local front panel interface with four displays for health and status monitoring—including presentation of DQM, time skew, and source-selection state, and a browser interface for health status monitoring, including integrated status reporting and logging.

The Quasonix Maximum Likelihood Stream Combiner is manufactured by:

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

1.2 Nomenclature

The Quasonix Maximum Likelihood Stream Combiner is available in a number of variations, depending on the options specified at the time of order. The features and modes installed in each unit are identified in the model number, as depicted in Figure 1.

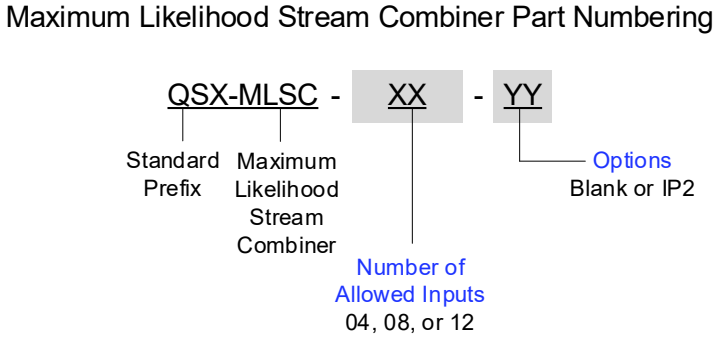

Figure 1: Quasonix Maximum Likelihood Stream Combiner Part Number Construction

For example, model number QSX-MLSC-04-IP2 defines a unit configured as shown in Table 1.

Table 1: Model Configuration Example

Identifiers	Description
QSX	Quasonix product
MLSC	Maximum Likelihood Stream Combiner product
04	Four inputs allowed to be used in groups
IP2	TMoIP capability

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 MLSC™
- 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 Input Channels	4, 8, or 12 optionally available (Each logical input is assignable to one channel group.)
Channel Groups	4 available
Selection Criteria	Signal quality via DQE, Majority Vote, Best Channel
Differential Time Skew	At least 1 second
Differential Delay Skew	Up to 1 ms per second
BERT	Bit error rate test capability using pre-defined patterns on each output and input channel
EBERT	Estimated BER (BEP) based on DQM for data provides quality information for real data, including encrypted data; on each input and output channel
Minimum Sync Threshold	10% BER one channel, 5% BER all channels
Performance Gain	Greater than 6 orders of magnitude in BER over the BER of the best single stream, given 8 streams with BERs between 10% and the best single stream
2-Channel Break Frequency	Up to 10 kHz
Automatic DQE Frame Detection	Yes
Expansion	Cascaded MLSC via DQE
Expansion Limit	Multiple MLSCs can be cascaded to support an effectively unlimited number of channels; Multiple MLSCs can be paralleled to support an effectively unlimited number of channel groups
PCM I/O	
Channels	12, each independently configurable as output or input for MLSC channel groups
BNC Clock and Data Pairs	12 (75 ohm, TTL)
MDM-25 Ports	2, RS-422
Clock/Data Polarity User Selectable	Yes
Auto Clock Edge Detection	Yes
TMoIP I/O	
Channels	12, each can be an output or input for MLSC 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	

Characteristic	Specification
Local Front Panel Interface	Four (4) displays for health and status monitoring, including presentation of DQM, time skew, and BSS state
Browser Interface	Command, Control, Health, Status, and Logging
Integrated Status Reporting, Logging	Yes
Easy Field Updates	Yes
Physical	
Size	1U rack-mount chassis, 18.95” wide, 1.75” tall, 13.83” rack depth, 15.02” overall length
Weight	7.4 lbs
Power	90-264 V-RMS, 47-63 Hz

3 Installation Instructions

3.1 Mechanical

The Maximum Likelihood Stream Combiner enclosure fits in a standard 19” rack, occupying just 1U of rack space. Mechanical layouts are provided in Figure 2, Figure 3, and Figure 4.

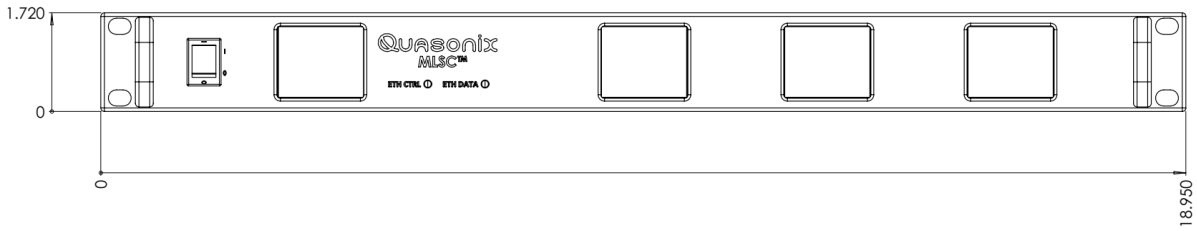

Figure 2: Mechanical Drawing – 1U Front View

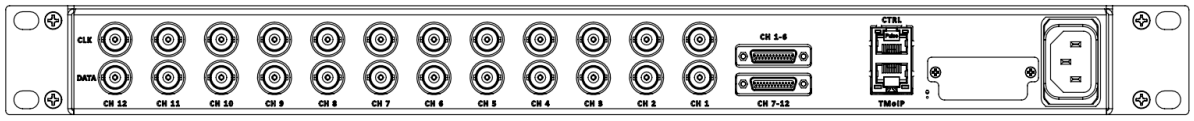

Figure 3: Mechanical Drawing – 1U Back View

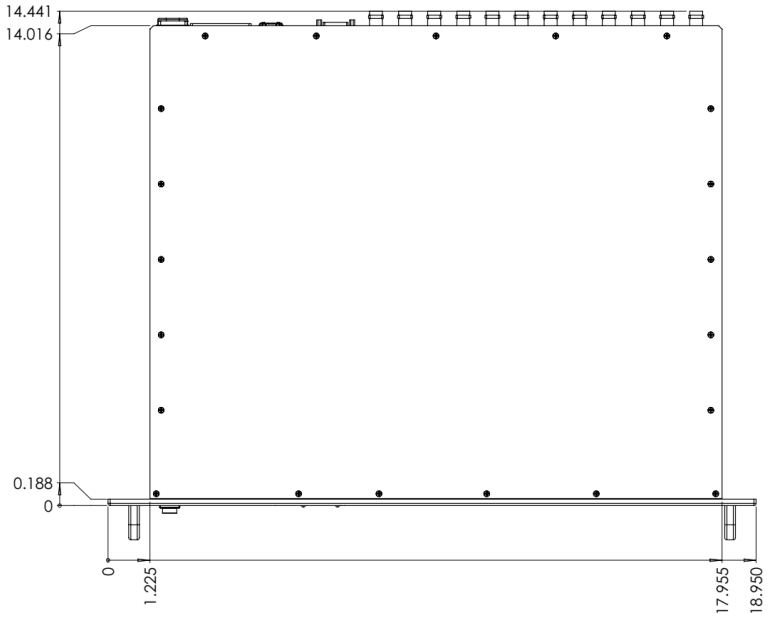

Figure 4: Mechanical Drawing – 1U Top View

3.2 Environmental

The storage temperature of the MLSC™ 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 5. The MLSC™ has all pertinent electrical connections on the rear panel.

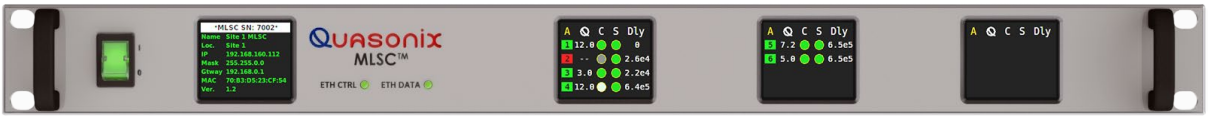

Figure 5: 1U Front Panel

3.3.1 Rear Panel Connections

The MLSC™ 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 6.

Figure 6: 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 2.

Table 2: 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 3. Pin locations are illustrated in Figure 7.

Table 3: 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 4. Pin locations are illustrated in Figure 7.

Table 4: 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		

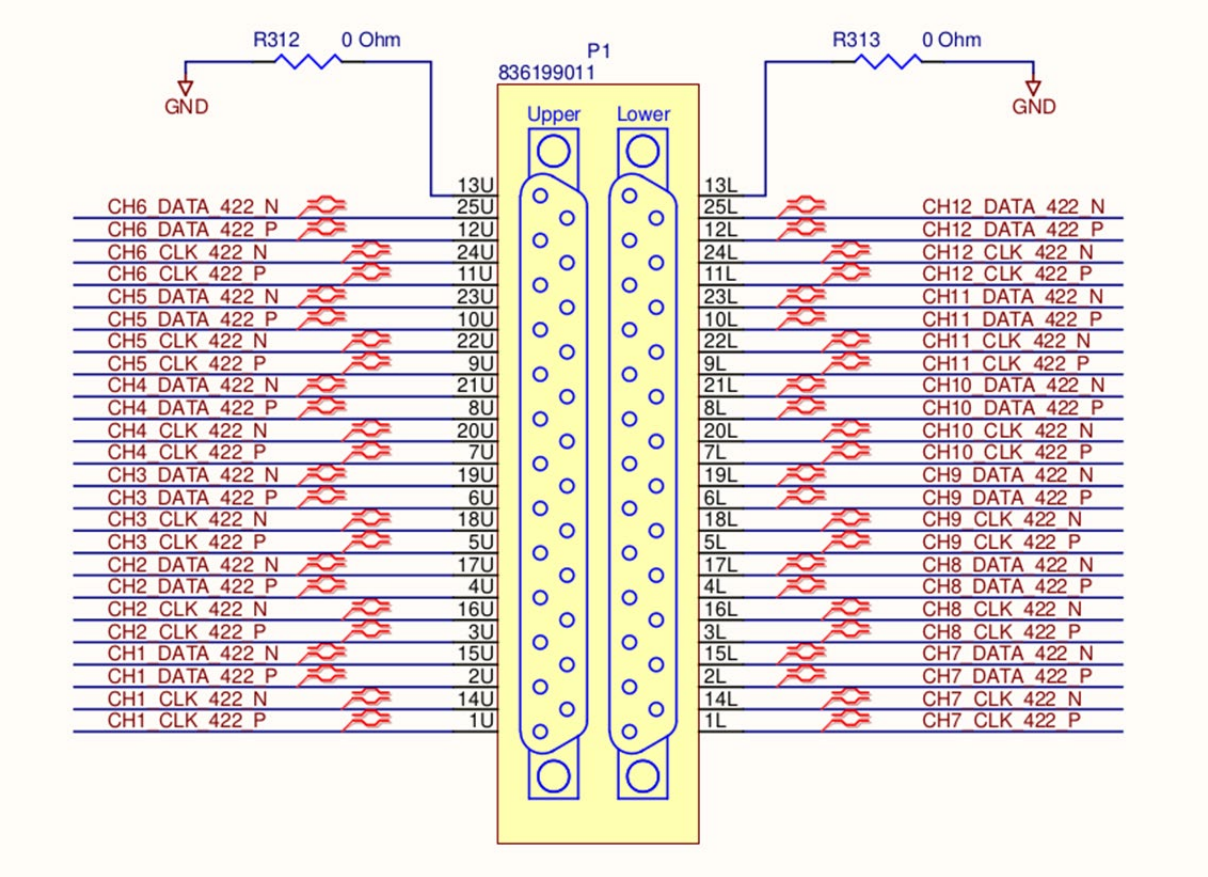

Figure 7: MDM-25 D-Sub Pin Locations for Ch 1-6 and Ch 7-12

3.3.1.3 RJ-45 Ports

The Ethernet connectivity to the MLSC™ 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, network time, and updating the MLSC™.

The TMoIP port is active and useable when the IP2 TMoIP option is included on the hardware.

Figure 8: Back Panel RJ-45 CTRL and TMoIP Ports, LEDs

Figure 9: 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 MLSC™ 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 MLSC™, 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 MLSC™ 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 MLSC™, 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 10: 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, and then power back on. After power is restored, the paperclip can be removed. The unit 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 11 shows the relative timing of clock and data signals. Note, only NRZ-L signaling is supported at this time.

Baseband Signal Timing - 0 degree clock

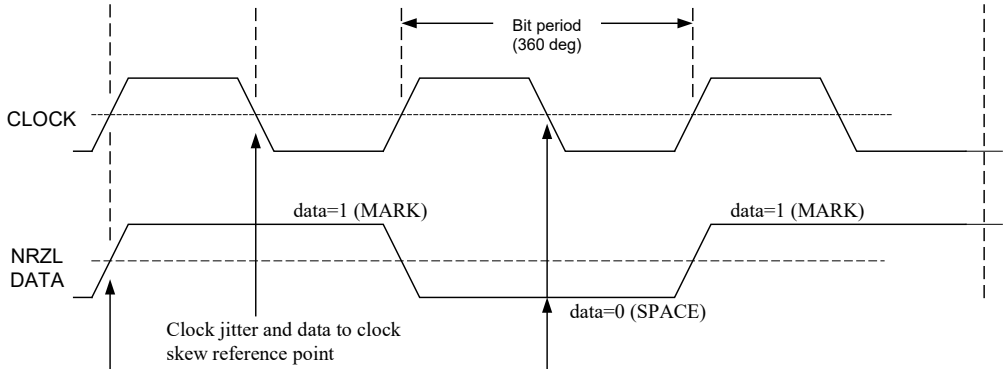

Figure 11: NRZ-L Signal Timing

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 MLSC™ 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 MLSC™ 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.
5. Type the Control IP address into the browser as:

   http://XXX.XXX.XXX.XXX

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

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 MLSC™ processes PCM telemetry data sourced by receivers, such as the Quasonix RDMS3, to extract optimal data from multiple received signals.

This PCM data can be provided to the MLSC™ via PCM serial cabling (BNC TTL or MDM-25 RS-422) or via TMoIP (if enabled via part number). After performing the combining operation, the MLSC™ outputs the resulting stream of PCM data, again via PCM serial cabling or TMoIP.

Twelve (12) PCM serial channels and twelve (12) TMoIP channels (if enabled via part number) are available for use as inputs to, or outputs from, the MLSC™. MLSC™ can support up to a total of twelve (12) inputs (possibly limited to four or eight by part number) to its core across all four groups. These inputs to the MLSC™ groups are also called "Logical Input Channels."

The MLSC™ provides four groups for combining received streams. Each group can take a set of PCM and TMoIP input channels that are sourced from a single data stream and transmitter whose signal is received through one or more antenna and receiver sites. Each group uses bit stream correlation to time align its inputs and then performs the selected BSS combining operation on the aligned streams. This process creates one output stream that has fewer bit errors than any of the individual input streams.

3.6 Setup

When configuring the MLSC™, 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 there are PCM serial data inputs (from receivers) or outputs (to downstream equipment such as decommutators or other data processing).
    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 there are TMoIP data inputs (from receivers) or outputs (to downstream equipment such as decommutators or other data processing).
    b. Set the direction for each channel – either Input or Output.
    c. Configure the Network and Advanced settings.
4. Configure Groups (refer to section 4.2.9)
    a. For each set of telemetry inputs originally sourced from a single transmitter, enable one of the Groups.
    b. Choose a BSS Mode for each group. Note that MLBD is optimal and always performs at least as good as (often better than) either Best Source or Majority Vote.
    c. Select the PCM and TMoIP Inputs that should be combined using this group. These should all be sourced from the same transmitter and contain the same telemetry data stream.
    d. Select a single Output Channel for each group where the output will be sent.

e. Configure Advanced settings as needed.

5. Access the Monitor Page (refer to section 4.2.10)

   a. Check the Locked indicator of each Group. Anything other than a green indicator means that one or more inputs does not have proper DQE frame lock. Inverted data polarity is one of many possible root causes.

   b. Ensure that the Q plot of each input matches the Q value at the sourcing receiver for that input.

4 Operating Instructions

The MLSC™ 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

The MLSC™ 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 12.

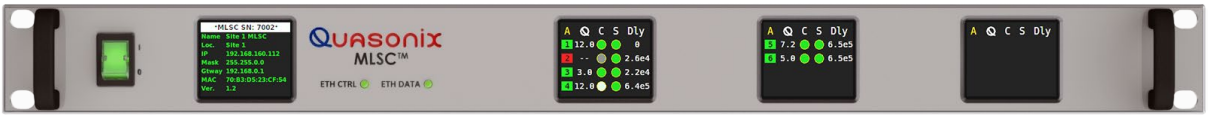

Figure 12: MLSC™ Front Panel Display

4.1.1 Ethernet Status LEDs

The two LEDs labeled ETH CTRL and ETH DATA, shown in Figure 13, 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 13: Front Panel Ethernet Status LEDs

4.1.2 Front Panel LCDs

The leftmost front panel LCD, shown in Figure 14, displays a variety of system settings to help the user in identifying and communicating with the system.

Figure 14: 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 MLSC™ group. The currently-displayed group Letter is shown in the upper left hand corner of the display, in orange. The input channels selected for use in the Group are shown below the header on each display. The numbering is consistent with the numbering on the Browser Interface Monitor Page. Configuration changes are made through the browser interface.

Each display has five columns of information:

- Group Letter / Input Number – Indicates the Group Letter (in orange) in the header, followed by the Group input numbers in rows below
  - Green – The input channel is DQE frame locked
  - Red – The input channel is not DQE frame locked
- Q value – Indicates the Q (Quality) value of the incoming channel based on incoming DQE; range is 0-12
  - "--" displays if the input is not DQE frame locked
- C – Indicates which channels are correlated
  - Green – Input channel is correlated with the output stream
  - Bright Green – Currently the best channel
  - Off – Input channel is not correlated with the output stream
- S – Indicates which input channels are selected for output
  - Green – Input channel is selected for output

- Off – Input channel is not selected for output

- Dly – Indicates the delay of the input channel, in bits, relative to the earliest channel
  - Red – The input channel delay is greater than allowed (refer to Group Config Max Delay and Max Source Spread)

4.2 Browser Interface

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

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

Figure 15 shows an example of the Configure System page.

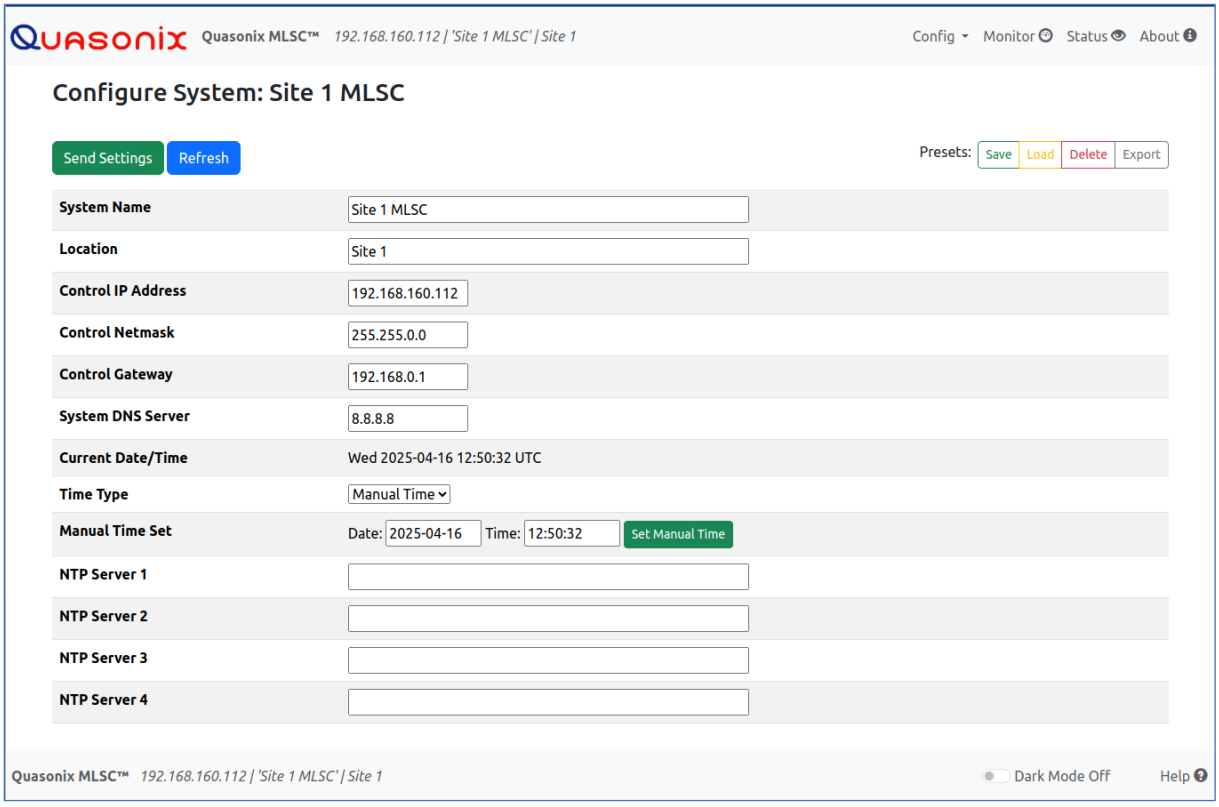

Figure 15: Browser Interface Configure System

Each page of the MLSC™ 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 changes. 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 16, provides identifying information about the system, as well as links to each page in the interface.

Figure 16: Browser Interface Frame Header

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

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

Figure 17: Browser Interface Frame Header, Left Side

The right-hand portion of the Frame Header, shown in Figure 18, consists of links to each page of the interface:

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

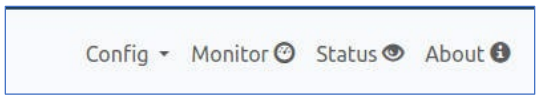

Figure 18: Browser Interface Frame Header, Right Side

4.2.2 Frame Footer

The Frame Footer, shown in Figure 19, provides identifying information about the system.

Figure 19: Browser Interface Frame Footer

The Frame Footer consists of:

- Product Type: Quasonix MLSC™
- 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 the MLSC™ 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 MLSC™, as well as for saving, loading, deleting, and exporting configuration Presets.

There are two buttons above the system properties, as shown in Figure 20. 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.

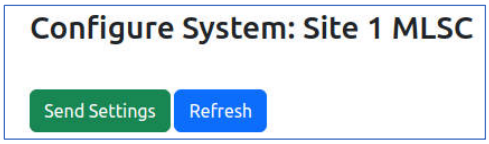

Figure 20: Browser Interface Configure System, Send Settings and Refresh Buttons

While the Send Settings process is executing, a message window displays, as shown in Figure 21.

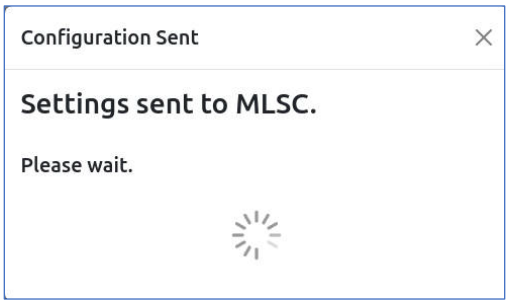

Figure 21: Browser Interface Configure System

If settings are valid and accepted, a message displays, as shown in Figure 22.

Figure 22: Example of Successful Configuration Message

If settings are not valid or another error occurs, a message will be displayed as in Figure 23.

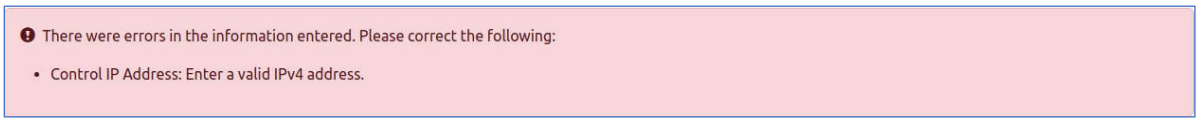

Figure 23: Example of Error Message

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 MLSC™.

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 MLSC™ 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 MLSC™ 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 MLSC™ 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 MLSC™ 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 24. These are initialized with the current system time, when the page is loaded or refreshed.

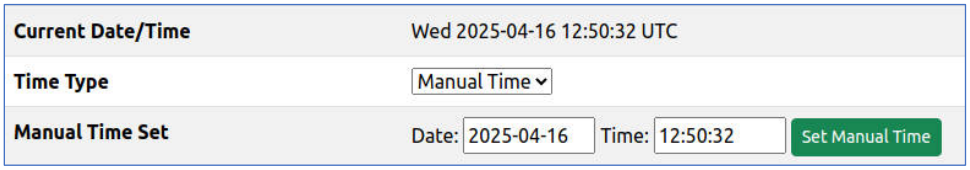

Figure 24: Configure System, Time Type Setting

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 25.

- Date:
  - YYYY-MM-DD
    - YYYY – Year

- MM – Month
- DD – Day

- Time:
  - HH:MM:SS
    - HH – Hour (24-hour time)
    - MM – Minute
    - SS – Second

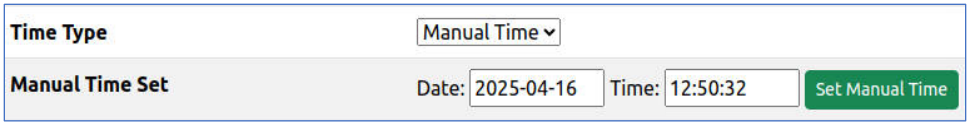

Figure 25: Example of Date/Time Parameters

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 MLSC™ 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 MLSC™ 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 MLSC™.

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 27, then click on the Save button. Figure 28 shows the Save Operation message indicating the completed save. Click on the OK button to close the message box.

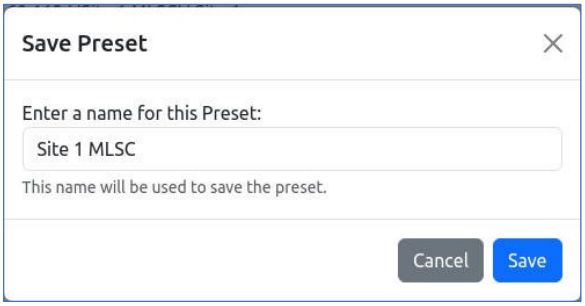

Figure 27: Save Preset Message

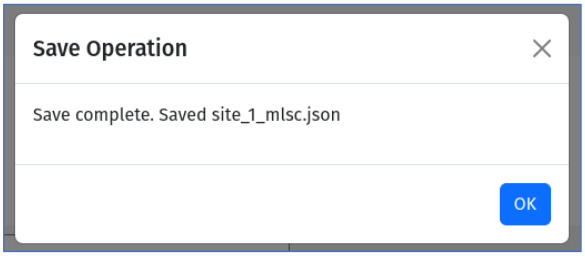

Figure 28: Save Operation Message, Save Complete

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 29. 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 30.

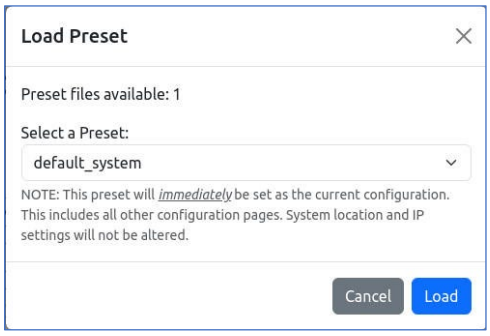

Figure 29: Load Preset Message

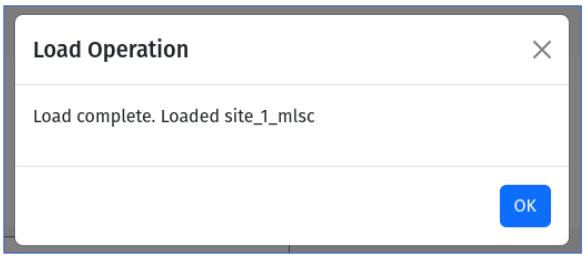

Figure 30: Load Operation Message, Complete

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 31. The Delete Operation message displays when the delete is complete, as shown in Figure 32.

Figure 31: Delete Preset Message

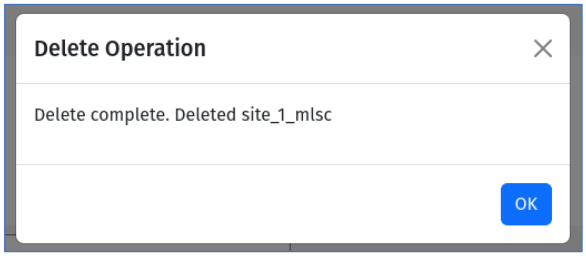

Figure 32: Delete Operation Message, Complete

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 33. The Export Operation message displays when the export is complete, as shown in Figure 34, and a file download occurs within the browser.

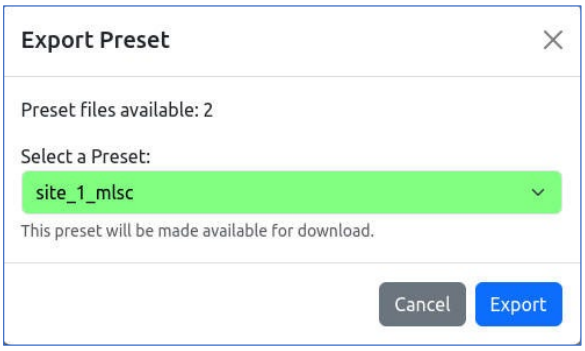

Figure 33: Export Preset Message

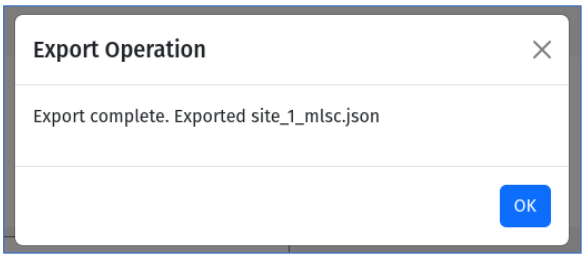

Figure 34: Export Operation Message, Complete

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, as shown in Figure 36. This theme may be preferred by some users, especially in low light environments.

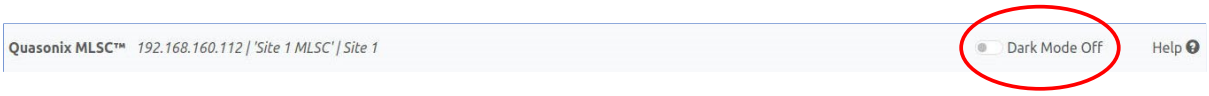

Figure 35: Frame Footer, Dark Mode Switch

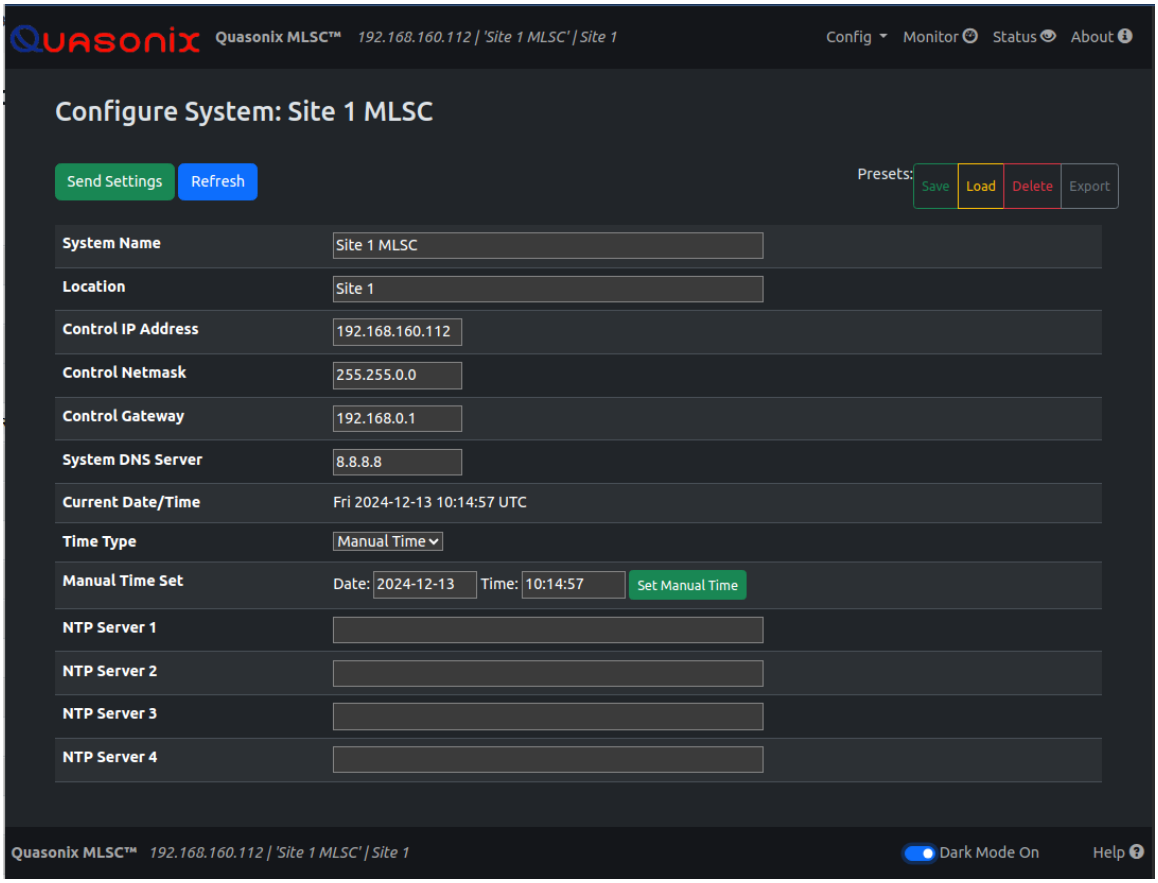

Figure 36: Dark Mode Example

4.2.5 PCM Channel Configuration

The PCM Channel Configuration page, shown in Figure 37, provides access to every PCM channel-specific setting. These channels can be used as inputs to, or outputs from, the MLSC™ groups.

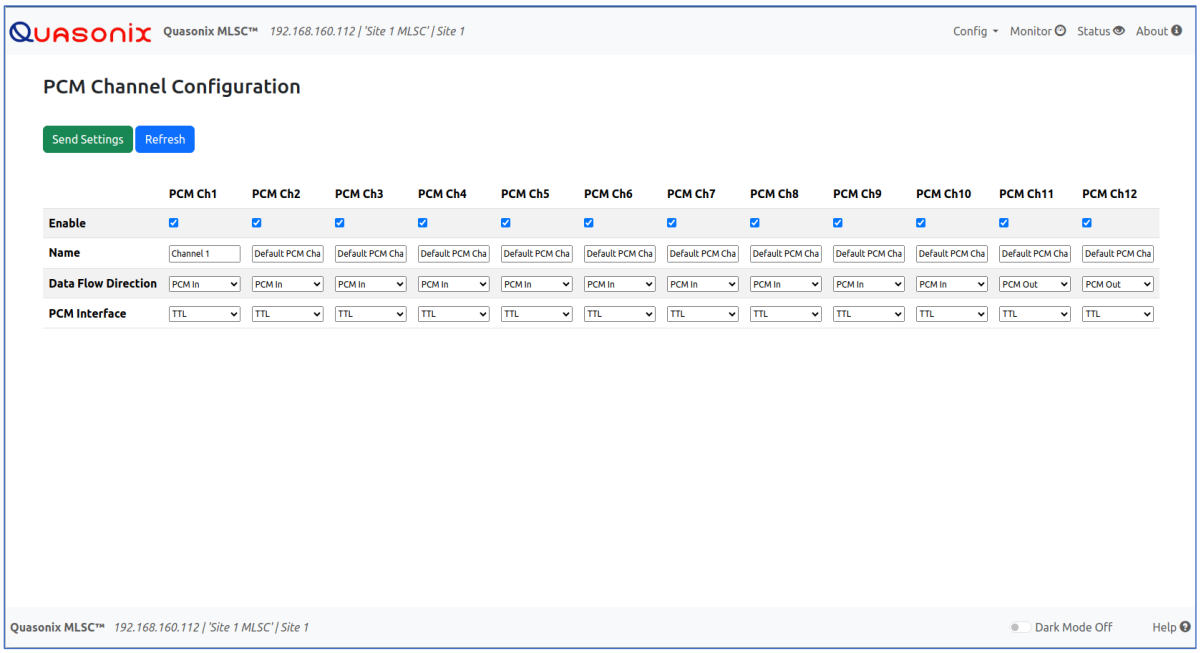

Figure 37: PCM Channel Configuration

The settings available for each channel 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 any channel setting is changed, applying it causes all channels to stop and start again, likely resulting in lost data. If changes are required, it is recommended to make them prior to starting any mission with critical data.

4.2.5.1.1 Enable

Check this box to enable the PCM channel via the back panel connections. When not checked, this channel is disabled. A disabled channel is not displayed as an option for input or output on the Group Configuration page.

4.2.5.1.2 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.

4.2.5.1.3 Data Flow Direction

Each group of the MLSC™ can be independently configured to take PCM as 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 MLSC™ device, or PCM Out to use the channel as an output from the MLSC™ device.

4.2.5.1.4 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 3.1 for the MDM-25 pinout.

4.2.6 TMoIP Channel Configuration

The TMoIP Channel Configuration page, shown in Figure 37, provides access to every channel-specific setting. Each TMoIP Channel in the MLSC™ allows one stream of telemetry data to be sent to an MLSC™ group (IP In) or sent from an MLSC™ group (IP 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 three 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 38 for an example of this behavior.

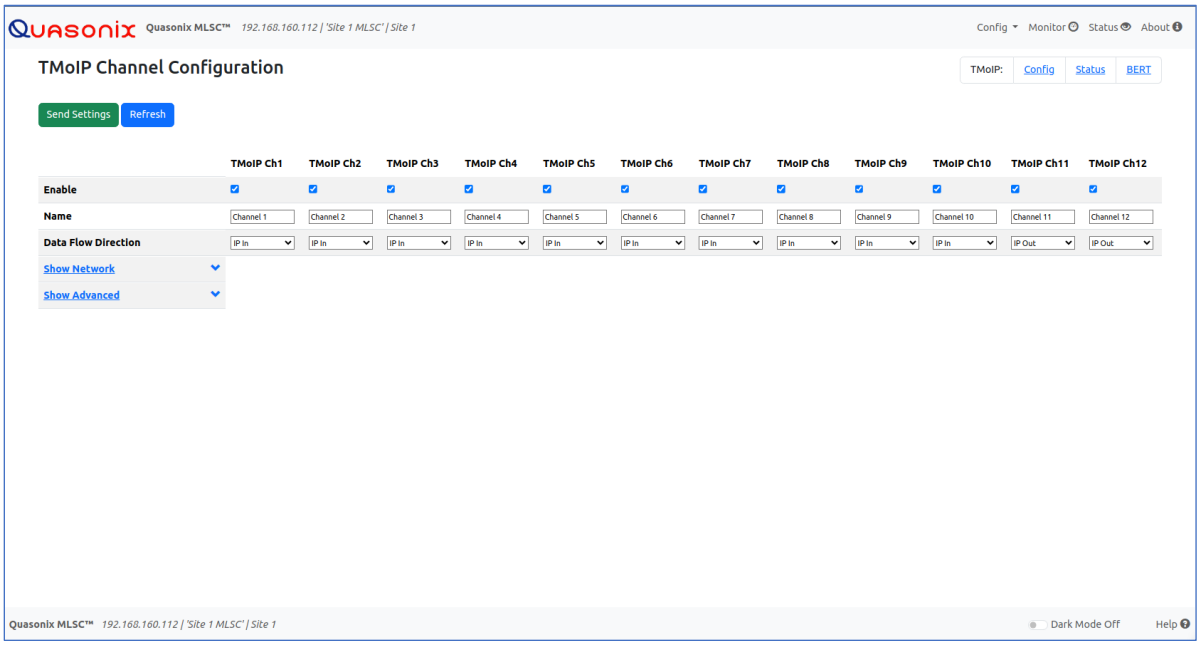

Figure 38: Channel Configuration, Condensed

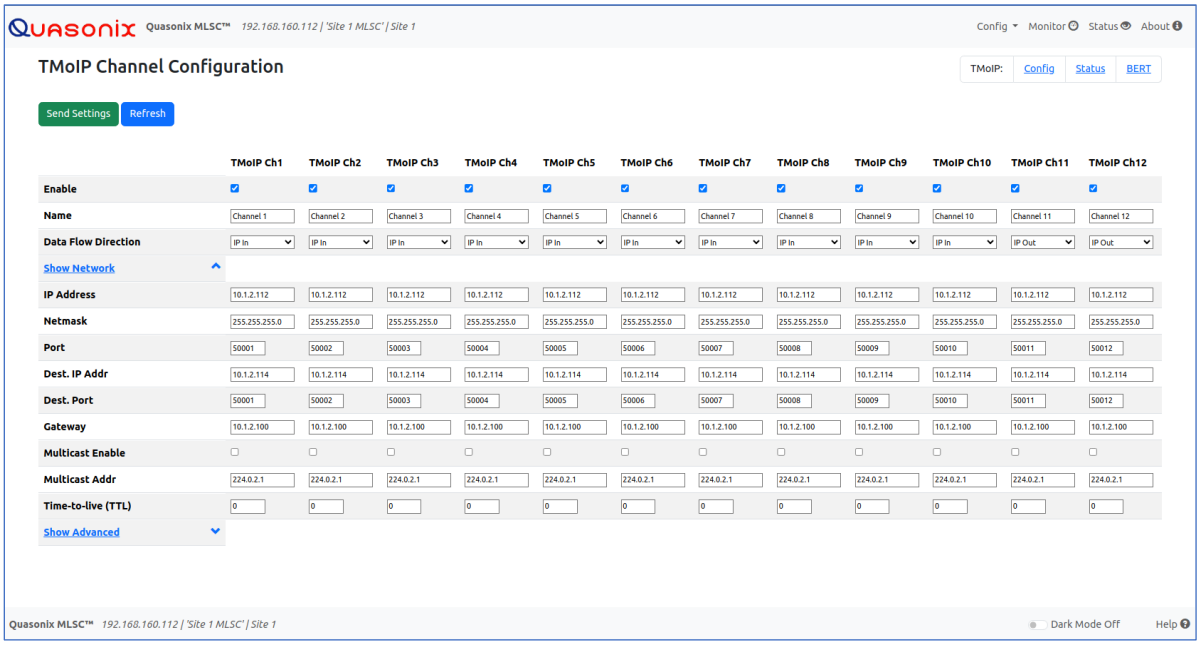

Figure 39: Channel Configuration, Network Expanded

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

4.2.6.1 Default Group

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

4.2.6.1.1 Enable

This check box enables the channel when checked. When not checked, this channel is disabled.

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 MLSC™ 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 MLSC™ receives TMoIP packets via the TMoIP data network, depacketizes them, and sends the resulting data to the MLSC™ core for processing in a group.
- IP Out
  - In this mode, the MLSC™ 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 40.

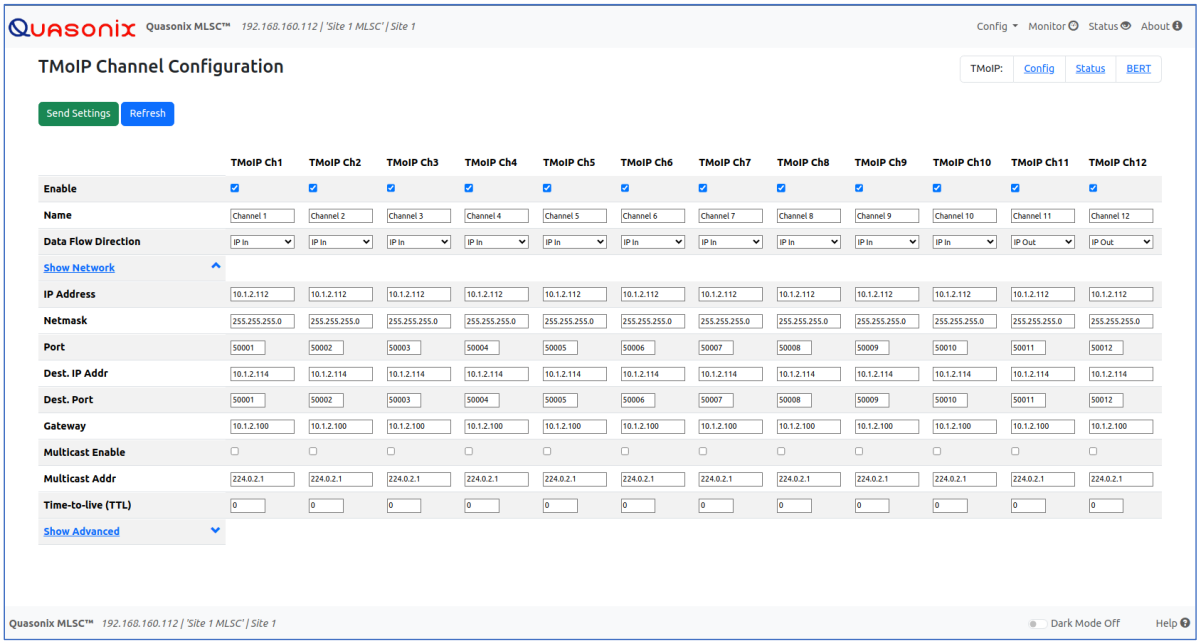

Figure 40: Channel Configuration, Network Expanded

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 MLSC™ 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 each one has a different Port number.

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 MLSC™ 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 (check) 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 MLSC™ 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 41.

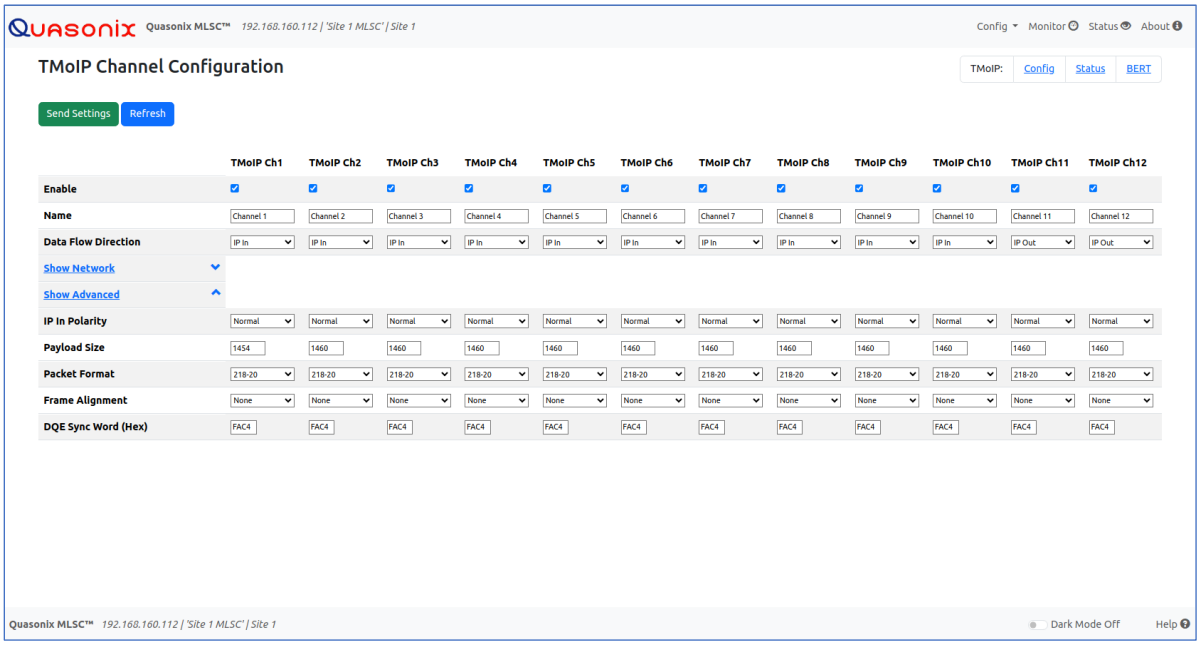

Figure 41: Channel Configuration, Advanced Group

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 5 provides suggested payload sizes at various data rates to balance efficiency and latency.

Table 5: 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 result 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 only the DQE frame header and DQE payload.

When this channel is in IP Out mode, the MLSC™ searches incoming PCM data from the MLSC™ core for the DQE Sync Word (refer to section 4.2.6.3.5). When regularly found at the proper interval, the MLSC™ 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 MLSC™ 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, and this is what the MLSC™ uses when outputting data with DQE regardless of the DQE Sync Word setting.

4.2.7 TMoIP Status

The TMoIP Status page, shown in Figure 42, is a one-stop-shop for status information on all TMoIP channels during operation.

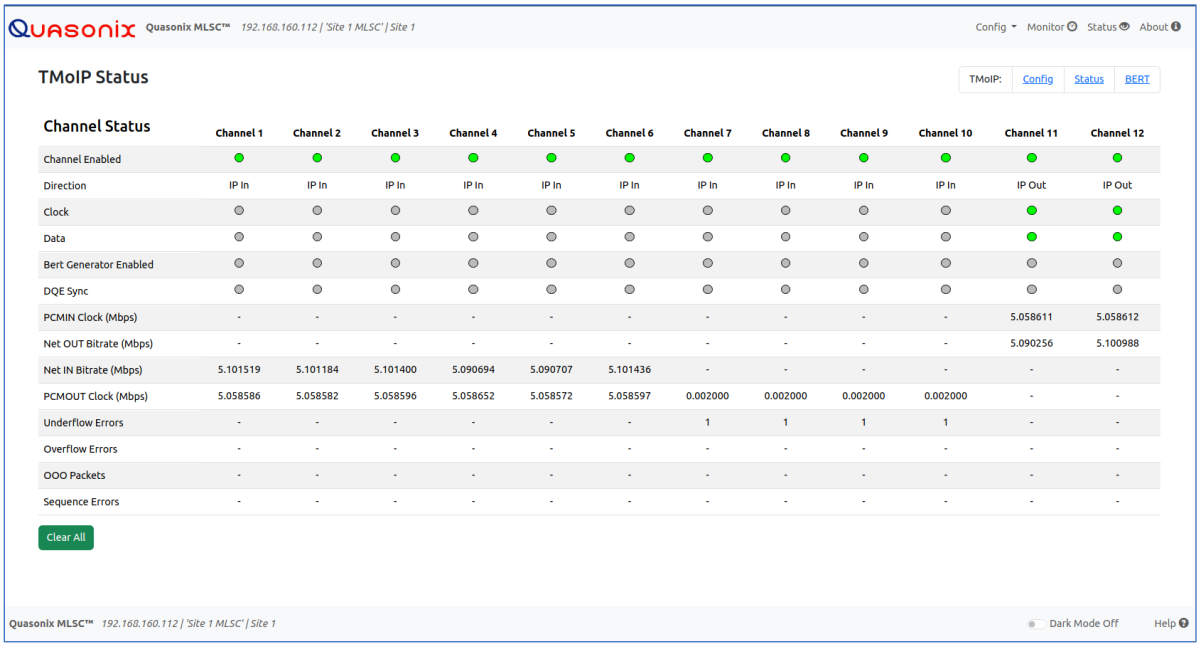

Figure 42: TMoIP Status

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 MLSC™ 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 MLSC™ 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 MLSC™ syncs on incoming PCM DQE Frames from MLSC™ group output; Red otherwise
- PCMIN Clock (Mbps) – IP Out mode only; Measured rate of incoming PCM IN clock from MLSC™ 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 MLSC™ 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 will result 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 Test (BERT) Utilities

The Bit Error Rate Test (BERT) Utilities page, shown in Figure 43, is intended to be used during set up and pre-mission to ensure that all systems are connected and configured properly for TMoIP operation. The BERT has two main capabilities:

- To generate PN pattern data and send it out the PCM interface (to the MLSC™ 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

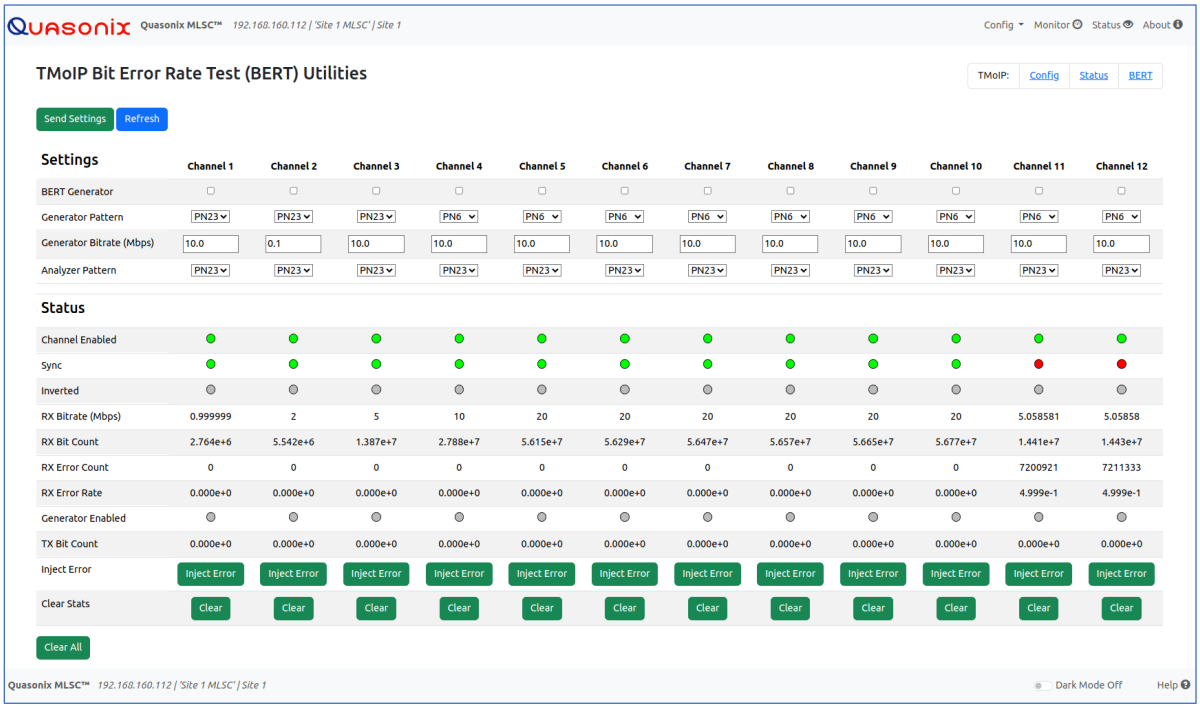

Figure 43: Bit Error Rate Test (BERT) Utilities

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 MLSC™ 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 should be 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.

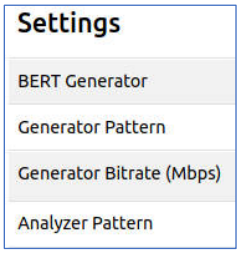

Figure 44: Bit Error Rate Test (BERT) Setting

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 MLSC™ 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 MLSC™ 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 MLSC™ 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 MLSC™ group input. Instead, the BERT Generator data will be sent to the MLSC™ 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 45.

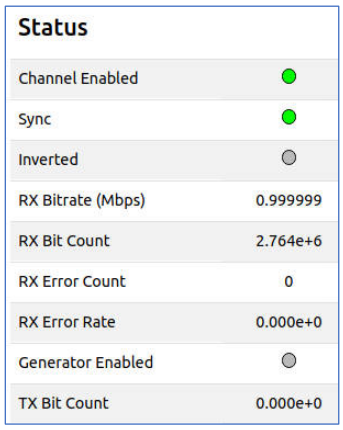

Figure 45: Bit Error Rate Test (BERT) Status

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 MLSC™ 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, shown in Figure, 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 46: 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 MLSC™ Group Configuration

The MLSC™ can support up to a total of twelve (12) inputs (possibly limited to four or eight by part number) to its core across all four groups. Each group can take its inputs from PCM or TMoIP channels and perform a combining operation to produce one output. These inputs should all be sourced from a single data stream and transmitter whose signal is received through one or more antenna and receiver sites.

The Group Configuration page, shown in Figure 47, provides access to every group-specific setting.

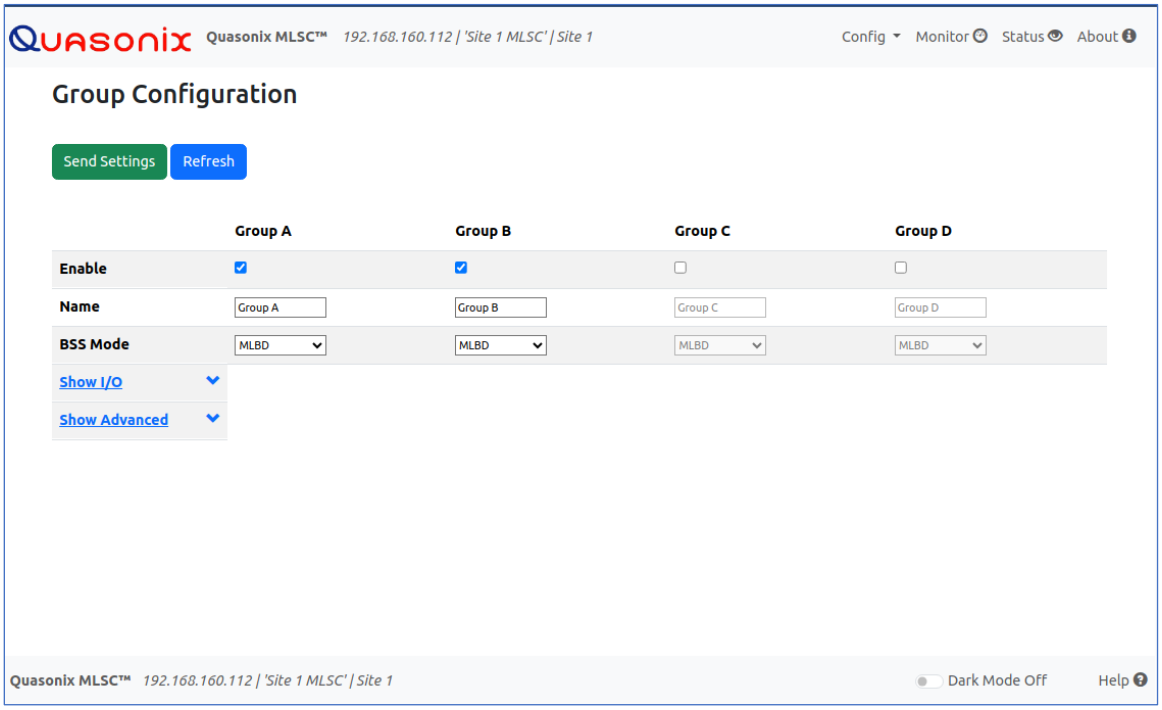

Figure 47: Group Configuration (Condensed)

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:

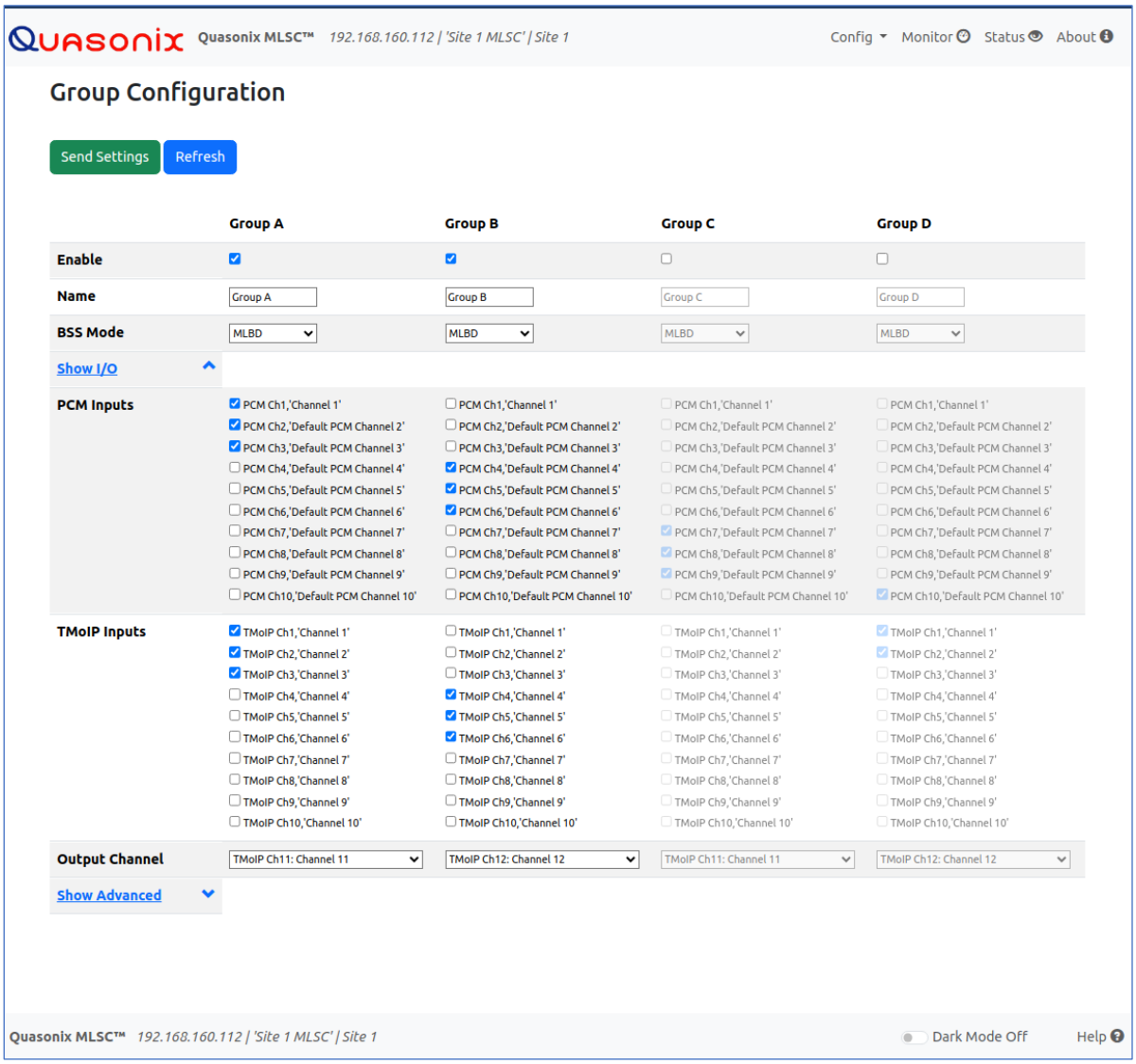

Figure 48: Group Configuration (Expanded I/O)

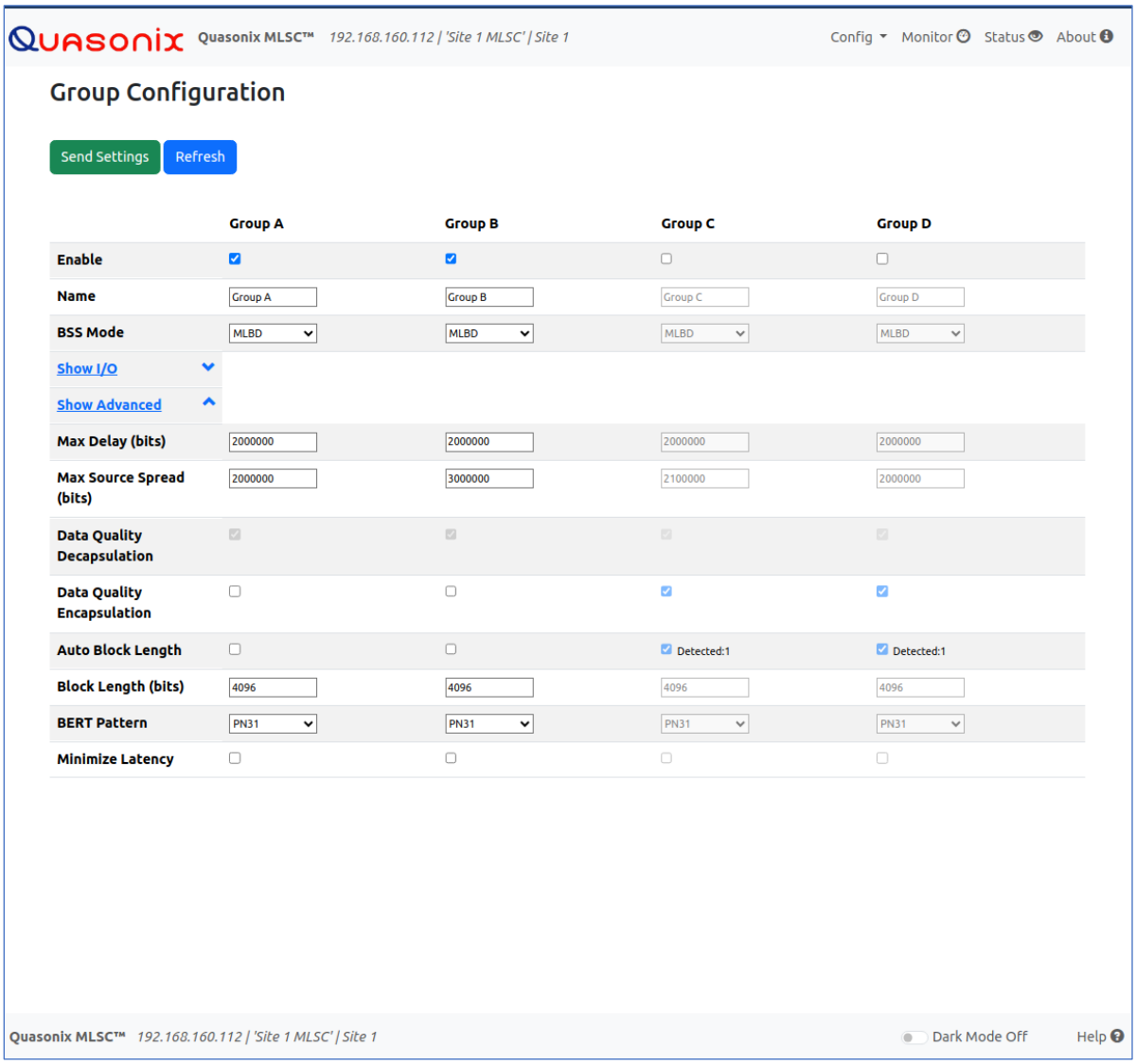

Figure 49: Group Configuration (Expanded Advanced)

Only Groups that have changes to settings are reconfigured. However, in certain cases, latter Groups may also be reconfigured (refer to section 4.2.9.1 and section 4.2.9.4). When a Group is reconfigured, the output has output discontinuities. It is recommended that all settings changes be made prior to operation with mission data.

4.2.9.1 Enable

Check this box to enable the specified MLSC™ Group. When enabled, the MLSC™ Group processes the selected inputs and produces an output, while utilizing the selected BSS Mode.

If any of the Group enables are changed, all latter Groups are also reconfigured. For example, if the Group B Enable is changed, Groups B-D are reconfigured.

4.2.9.2 Name

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

4.2.9.3 BSS Mode

- MLBD (default mode)
  - Maximum Likelihood Bit Detection
  - **Always** produces the optimal output compared to Best Source or Majority Vote, provided DQM is available
  - Uses the Data Quality Metric (DQM) for each bit of every bit stream to determine the most likely correct output bit
  - Sometimes called “weighted majority vote” or “shareholder vote”
- Best Source
  - Uses the DQM to select the single bit stream with highest quality
- Majority Vote
  - Uses a count of “votes” for each bit of every bit stream to determine the output bit
  - Similar to MLBD, but suboptimal because good and bad bit streams are weighed equally
  - Does not require DQM

4.2.9.4 PCM Inputs and TMoIP Inputs

These check boxes are used to select which of the PCM and TMoIP inputs are used by each MLSC™ group to generate an output stream. All selected inputs in a Group must have identical combinable features, such as data, data rate, DQD setting, block length, and PN Pattern (when known test data in use). Another way to think about these inputs is that they must all be sourced originally by the same transmitter (and likely received by different antennas and receivers).

The listed PCM and TMoIP Inputs show only the PCM and TMoIP Channels that have been configured as Inputs on the PCM and TMoIP Channel Configuration pages. PCM Inputs have a Data Flow Direction of “PCM In”, while TMoIP Inputs have a Data Flow Direction of “IP In” (refer to Section 4.2.5 and Section 4.2.6).

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

Select only inputs for which there is a valid clock and data or TMoIP data stream source. All inputs to a particular group should be sourced from the same original telemetry stream.

If any of the Group inputs are changed, all latter Groups are also reconfigured. For example, if the Group B inputs are changed, Groups B-D are reconfigured.

4.2.9.5 Output Channel

Each enabled group must have a single output selected. This is the output where the MLSC™ group output stream will be directed.

The listed outputs show only the PCM and TMoIP Channels that have been configured as Outputs on the PCM Channel Configuration page. PCM Outputs have a Data Flow Direction of “PCM Out”, while TMoIP Outputs have a Data Flow Direction of “IP Out” (refer to Section 4.2.5 and Section 4.2.6).

4.2.9.6 Max Delay (bits)

This setting indicates the maximum delay (in bits) (between the earliest and latest arriving channels) allowed to participate in combining. It must be set less than, or equal to, the Max Source Spread. The valid range is 0-50,000,000.

4.2.9.7 Max Source Spread (bits)

This setting indicates the maximum delay (in bits, between the earliest and latest arriving signals) that the MLSC™ could potentially see. The valid range is 0-50,000,000.

Note: Max Delay and Max Source Spread should be set equal (barring other guidance from Quasonix) and only as high as needed to accommodate the maximum spread between receive channels. **Needlessly high settings may degrade correlation performance.**

If expected system delays are not characterized or well known, these settings can be "tuned" by a simple sequence of steps:

1. Set Max Delay and Max Source Spread to the maximum valid value.
2. On the Group Monitor page:
   a. Establish proper MLSC™/system operation.
   b. Verify green Corr(elation) status for all active sources and black text for all Delays.
   c. Note the largest reported source Delay.
3. Set Max Delay and Max Source Spread to the noted delay, with margin (e.g., multiply by 1.2 to 2)

This process can be performed at any time without disrupting data flow, as long as only these settings are changed.

4.2.9.8 Data Quality Decapsulation

Data Quality Decapsulation must be set when DQE is enabled in the sourcing receiver. It is required (and automatically selected) when using either MLBD or Best Source BSS Mode.

Note: All input streams must have the same DQE block length.

4.2.9.9 Data Quality Encapsulation

Data Quality Encapsulation must be set when encapsulation is desired on the MLSC™ group output.

4.2.9.10 Auto Block Length

When incoming DQE is reliable, this setting allows the MLSC™ to automatically determine the DQE/DQD block length, in bits. The detected block length is displayed next to the check box. A refresh of the page may be required to see the detected block length.

Note: The incoming block length must be between 1024 and 16384 bits, inclusive, and must be a multiple of 32. All inputs must have the same block length.

Note: After the incoming block length is known, it is recommended that the Auto Block Length option be turned off and the Block Length set correctly via the following field. This helps to identify any inconsistencies with the block lengths in incoming streams.

4.2.9.11 Block Length (bits)

If Auto Block Length is not enabled, the Block Length must be set to the incoming DQE block length in bits. This value must be between 1024 and 16384, inclusive, and must be a multiple of 32.

4.2.9.12 BERT Pattern

The BERT Pattern should be set to the PN pattern utilized in incoming test data. This is used to generate Bit Error Rate information on the Monitor page when the incoming data is a known PN pattern.

Note: Actual data that does not include a PN pattern is completely compatible with the MLSC™ combining processes. This BERT Pattern is only used for test purposes with known PN data.

4.2.9.13 Minimize Latency

Check this box when obtaining the least possible latency through the MLSC™ is critical, and the maximum expected source spread within a group cannot be accurately estimated.

Minimize Latency can be used if:

- A user requires the lowest possible latency through the MLSC™

AND

- A user has a conservative setting for Max Delay/Max Source Spread, meaning that:
    a. Expected maximum source spread is not well known or characterized

    OR

    b. Input source spread is highly variable and generally not near the expected maximum

Note: Correlation tracking performance may be negatively impacted when this option is selected, possibly resulting in a discontinuity in the output data stream when new, higher-delay signals are introduced.

4.2.10 Monitor Page

The MLSC™ Group Monitor page, shown in Figure 19, is a one-stop-shop for MLSC™ status on all input channels and the group output channel during operation. The page is broken up into two sections, a text-based and a graphical display of information. Additionally, all four groups can be monitored via the Group A-D tabs at the top of the graphical display. Only **enabled** groups are accessible.

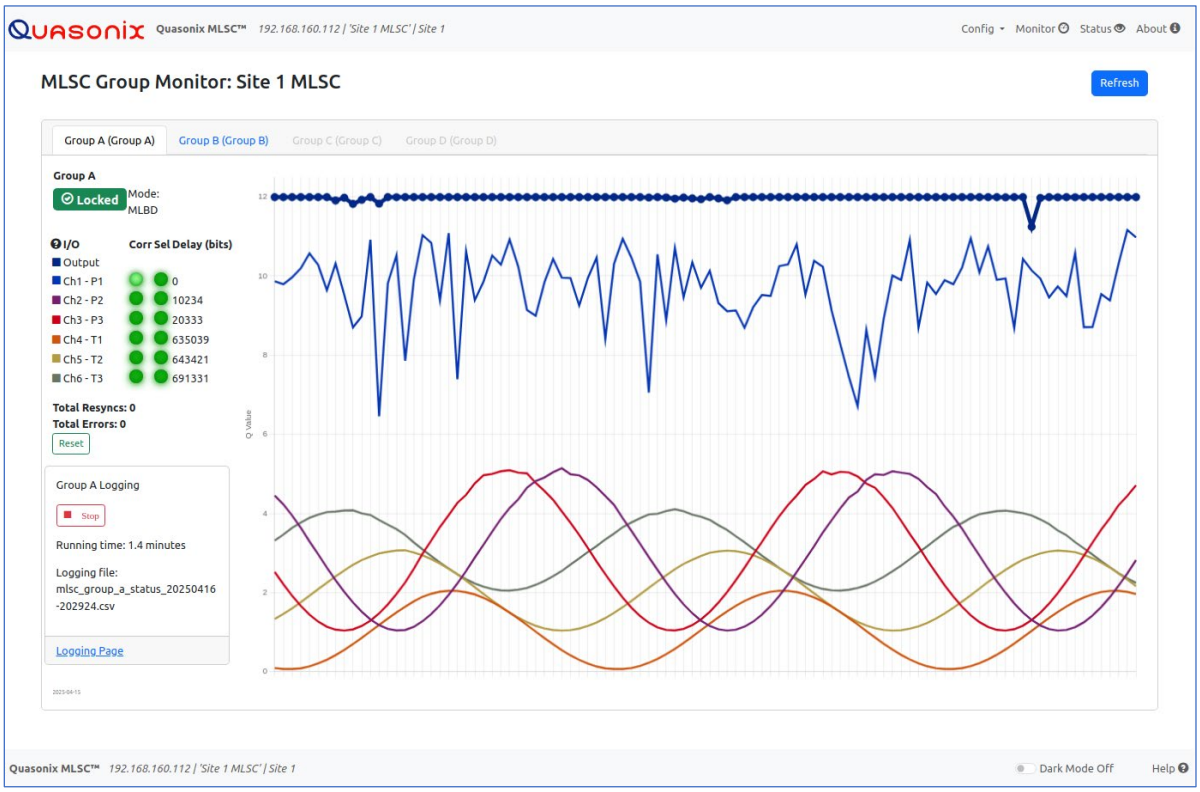

Figure 50: MLSC™ Group Monitor

4.2.10.1 Text-Based Information

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

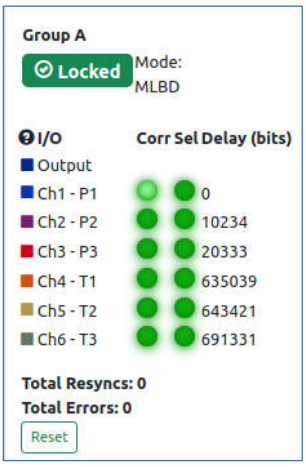

Figure 51: Text-Based Group Monitor Information

- Locked Indicator – Indicates the DQE Frame Lock on Group inputs
  - Green – All group inputs have DQE frame lock
  - Yellow – Some group inputs locked (those not locked are listed with a strikethrough)
  - Red – No group inputs locked (all inputs listed with a strikethrough)
- Mode – The configured selection mode for this group (MLBD, Majority Vote, or Best Source)
- I/O – Indicates the MLSC™ Core channel number and PCM/TMoIP channel number
  - The number after 'Ch' is the core input number (all inputs across all groups are numbered one through twelve. This matches the channel numbers listed on the front panel.
  - If the channel is a PCM channel, it is listed as 'P' with a number after, representing the PCM channel number.

  If the channel is a TMoIP channel, it is listed as 'T' with a number after, representing the TMoIP channel number.
- Corr – Correlated input channels have a green indicator. Bright green indicates the current best channel.
- Sel – Input channels with a green indicator are included in the output.
- Delay (bits) – Indicates the delay of the input channel relative to the earliest arriving channel; If text is red, the delay is greater than the maximum allowed delay (configured on the Group Configuration page)
- Total Resyncs – When the incoming data is based on a PN pattern, this shows the number of times the BERT had to resync due to errors in the group output stream.
- Total Errors – When the incoming data is based on a PN pattern, this shows the number of bit errors in the group output stream.
- Reset Button – Click on this button to reset the Total Resyncs and Total Errors counters.

  Note: This causes a momentary 'spike' in the graphical monitor.

4.2.10.2 Graphical Chart

The Monitor chart displays a plot of the input channel's Q Value versus time (in seconds), with the oldest samples on the left side of the chart.

The Q Value represents the exponent of the estimated bit error rate, based on DQM. For example, a Q Value of 3 indicates an estimated bit error rate of 1e-3, and a Q Value of 7 indicates an estimated bit error rate of 1e-7.

Note: The output channel is always displayed in dark blue with circular dots for each sample.

4.2.10.3 Logging

Each tab within the Group Monitor page includes the capability to log various statistics and status for each group input and output. All information is logged approximately once per second to a CSV file for post processing and analysis.

To start logging for a particular group, click on the tab for the group of interest on the Monitor page. Next, click on the Start button, as shown in Figure 52. This button changes to "Starting" for a few seconds, before changing to a Stop button, shown in Figure 53.

The group logging box indicates the running time and logging file for the current log.

To stop logging, click on the Stop button.

After logging has stopped, the log file may be downloaded by clicking on the displayed filename. Alternatively, click on the Logging Page link to view, export, or delete all log files created by this system.

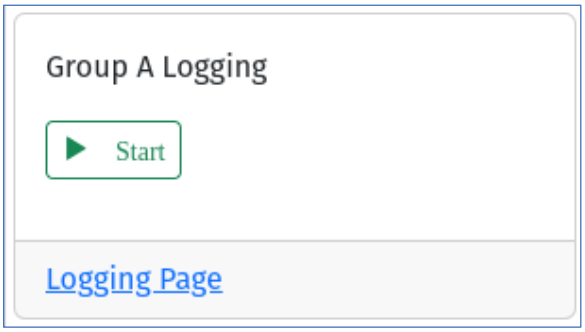

Figure 52: Logging, Start Button

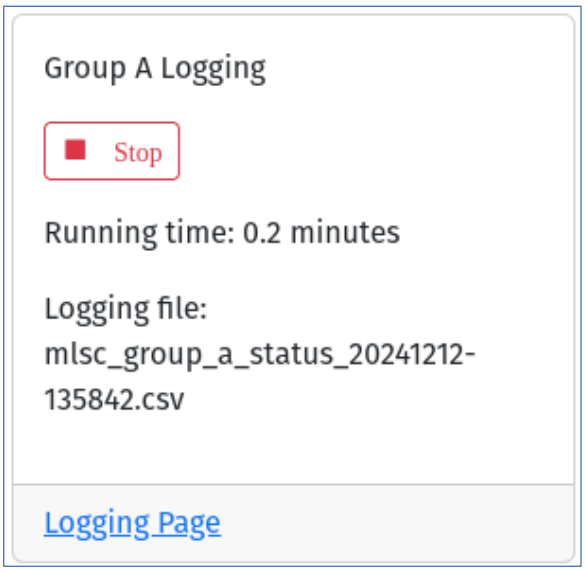

Figure 53: Logging, Stop Button

4.2.11 Logging

The Logging page, shown in Figure 54, indicates the current state of all group logging, as well as a list of all log files.

In addition to group log files, the Logging page includes a filename called ‘config_changes.csv’ which logs the last twenty-five system configuration changes. This file cannot be deleted.

The most recent configuration change time from config_changes.csv is noted in the config_changes column at the start of the log file. Any subsequent changes made while logging are noted in this column with a reference time to config_changes.csv.

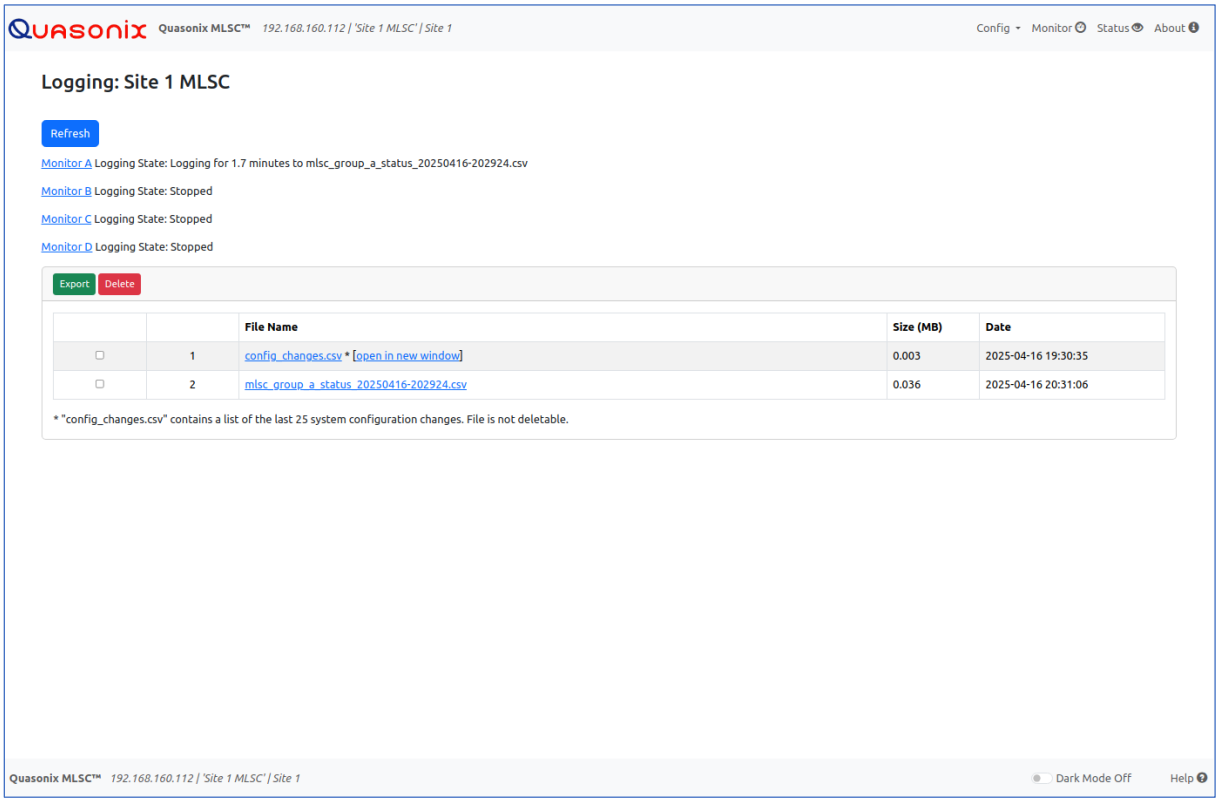

Figure 54: Logging

4.2.12 Status

4.2.12.1 System Status

The System Status section, shown in Figure 55, provides the following information. This data continually updates as long as this page is displayed.

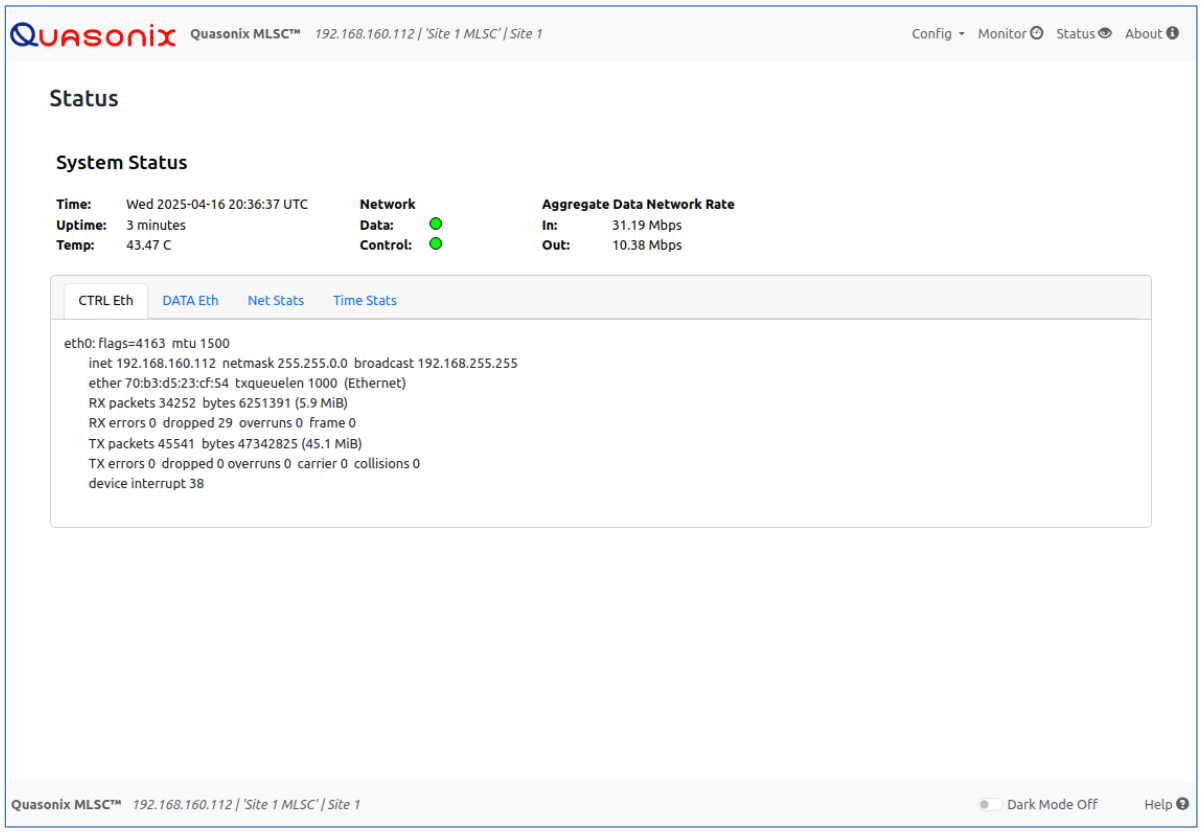

Figure 55: System Status

- 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.

Figure 56: 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 Maximum Likelihood Stream Combiner 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 – Acronym List

Acronym	Description
BEP	Bit Error Probability
BER	Bit Error Rate
BNC	Bayonet Neill-Concelman Connector (RF Connector)
BSS	Best Source Selector
DC	Diversity Combiner
DHCP	Dynamic Host Configuration Protocol
DQE	Data Quality Encapsulation
DQM	Data Quality Metric
GUI	Graphical User Interface
IP	Internet Protocol
kbps	Kilobits per second
KHz	Kilohertz
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
OOO	Out of Order
Q	Quality value (Q = 12 * DQM / 65536)
RDMS	Receiver DeModulator Synchronizer
RF	Radio Frequency
RJ-45	Ethernet Connection Jack
RS-232	Recommended Standard 232 (Serial Communications)
TTL	Transistor Logic
UDP	User Datagram Protocol
USB	Universal Serial Bus
VAC	Voltage Alternating Current