

Installation and Operation Manual

Quasonix Bit Error Rate Tester (QBERT™)



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

The Quasonix Bit Error Rate Tester (QBERT™) supports measurements, including bit error rate and DQE/DQM verification.

QBERT can obtain pattern sync at extremely high bit error rates. This remarkable performance permits accurate measurements in the harshest of channel conditions. At lower bit error rates, BERT pattern sync is essentially instantaneous, so you know all the errors counted are from your system, not your BERT.

QBERT can automatically recognize and utilize Data Quality Encapsulation information when in use and report on DQE framing errors.

QBERT can compare DQM error estimation against measured results or use calibrated DQM rather than bit error rate measurements for actual mission data.

The QBERT is manufactured by:

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

1.1 Description

This document describes the installation and operation of the Quasonix QBERT.

1.2 Nomenclature

The QBERT is identified by the following part number:

QSX-QBERT-xx

Where xx is one of the three configurations:

01	1 channel
04	4 channel
08	8 channel

1.3 Package Contents

The contents of the box include the following:

- QBERT unit
- Power cord

The latest Quasonix User Manual and Data Sheet are always available through the Quasonix website.

2 Specifications

Pattern Generator/BERT Section		
Clock and Data In/Out	External user data: TTL on BNC connectors Patterns: Mark (all 1s), Space (all 0s), PN6, PN9, PN11, PN15, PN17, PN20, PN23, PN31, User (2 to 32 bits) Manual error insertion Continuous random error insertion, BER 1e-9 to 5e-1	
Bit Rates	0.001 Mbps to 50 Mbps	
BERT Functions	Elapsed time, bit rate, total bits Error rate, error count, errored seconds, link availability Pattern sync, clock sync, pattern inversion, clock inversion	
BERT Sync	Sync time at low BER (less than 1e-3): ~ 0 bits	
	Sync acquisition level (BER):	Sync loss level (BER):
	PN6 – 3.4e-1 PN9 – 3.5e-1 PN11 – 3.6e-1 PN15 – 3.7e-1 PN17 – 3.8e-1 PN20 – 3.4e-1 PN23 – 3.1e-1 PN31 – 2.4e-1	PN6 – 3.4e-1 PN9 – 3.5e-1 PN11 – 3.6e-1 PN15 – 3.7e-1 PN17 – 3.8e-1 PN20 – 4.0e-1 PN23 – 4.4e-1 PN31 – greater than 4.9e-1
Environmental Section		
Operating Temperature	0°C to +50°C	
Storage Temperature	0°C to +70°C	
Operating Humidity	0 to 95% (non-condensing)	
Physical Section		
Size	Base unit (includes rear-panel feet): 15.13" wide, 6.97" tall (4U), 10" deep - Removable kick feet for bottom of unit add 0.6" to height - Provided adapter brackets allow installation in standard 19" rack - Optional portable case available	
Screen	10.1" Capacitive Touch	
Power	100 to 240 VAC, 50/60 Hz	

3 Installation Instructions

3.1 QBERT Front-Panel

The QBERT front panel contains a power switch and an intuitive touchscreen interface.



Figure 1: QBERT Front Panel

3.2 Mechanical

The QBERT base unit (includes rear-panel feet) is 15.13" wide, 6.97" tall (4U), and 10" deep. The removable kick feet for the bottom of the unit add 0.6" to the height.

Provided adapter brackets allow installation in standard 19" rack.

Mechanical layouts are provided in Figure 2 and Figure 3.

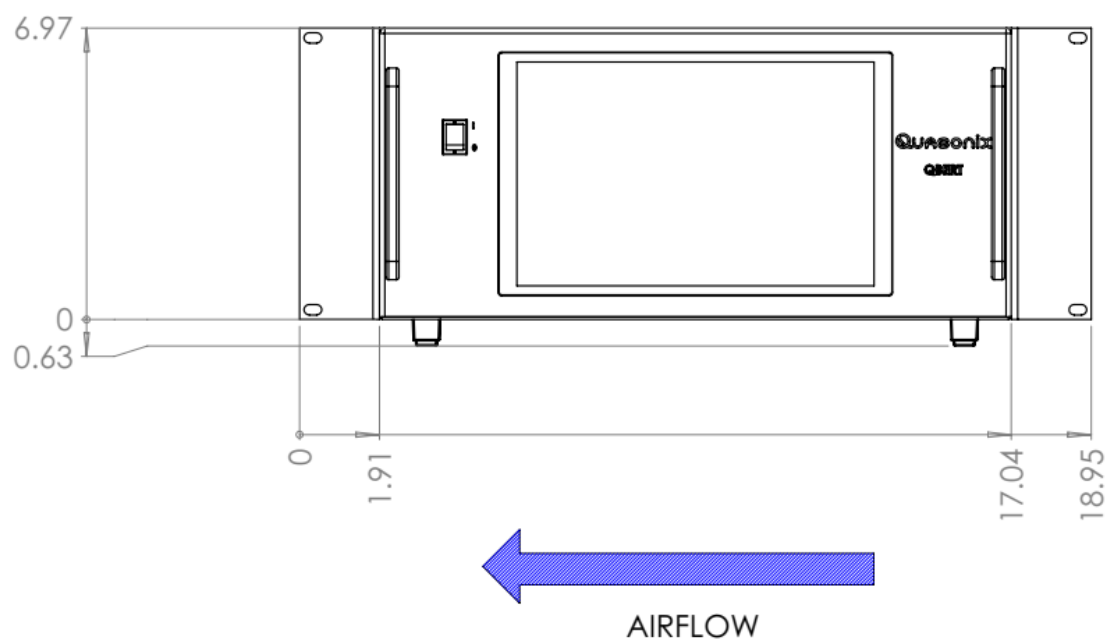


Figure 2: Mechanical Drawing – Front View

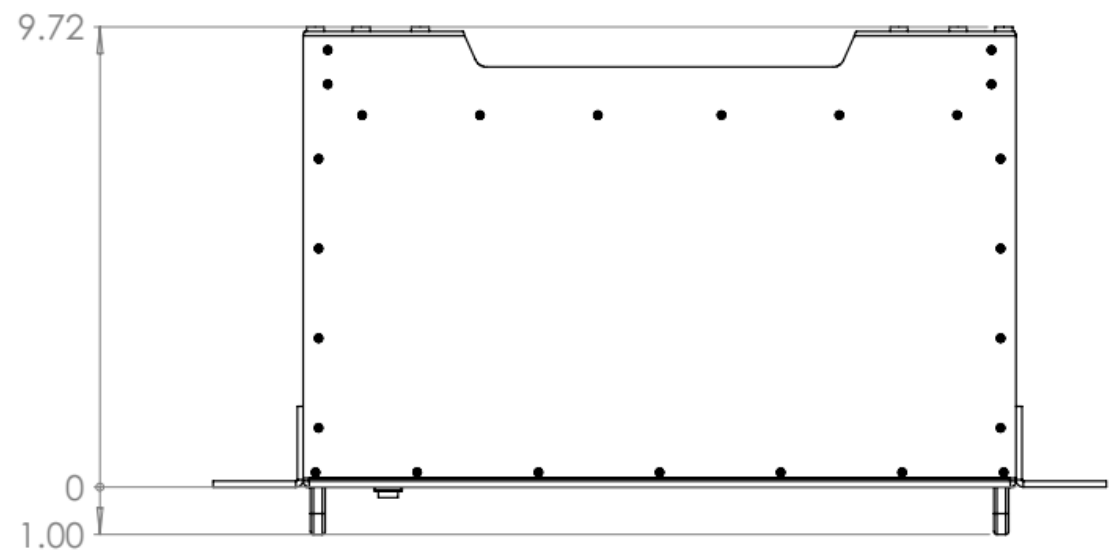


Figure 3: Mechanical Drawing – Top View

3.3 Thermal

The storage temperature of the QBERT is rated for 0°C to +70°C, while the operating temperature is rated for 0°C to +50°C. It is recommended that the unit be kept in a temperature controlled environment to minimize the risk of operating (or storing) outside the ranges specified.

The QBERT 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.

3.4 Electrical

QBERT runs on 100 to 240 VAC, 50/60 Hz, 120 VAC nominal.

3.4.1 QBERT Connections

The electrical interface connector layout for the QBERT is shown in Figure 4. The TTL inputs are compatible with both 3.3 volt and 5 volt signals.



Figure 4: QBERT Back Panel

Table 1: Rear Panel Connector Specifications

Function	Electrical Characteristics	Connector Type
Channel 1, Clock BERT Input	75 ohm TTL	75 ohm BNC
Channel 1, Data BERT Input	75 ohm TTL	75 ohm BNC
Channel 2, Clock BERT Input	75 ohm TTL	75 ohm BNC
Channel 2, Data BERT Input	75 ohm TTL	75 ohm BNC
Clock Out	75 ohm TTL	75 ohm BNC
Data Out	75 ohm TTL	75 ohm BNC
HDMI	Industry Standard	Industry Standard
Channel 3, Clock BERT Input	75 ohm TTL	75 ohm BNC
Channel 3, Data BERT Input	75 ohm TTL	75 ohm BNC
Channel 4, Clock BERT Input	75 ohm TTL	75 ohm BNC
Channel 4, Data BERT Input	75 ohm TTL	75 ohm BNC
Channel 5, Clock BERT Input	75 ohm TTL	75 ohm BNC
Channel 5, Data BERT Input	75 ohm TTL	75 ohm BNC
Channel 6, Clock BERT Input	75 ohm TTL	75 ohm BNC
Channel 6, Data BERT Input	75 ohm TTL	75 ohm BNC
Channel 7, Clock BERT Input	75 ohm TTL	75 ohm BNC
Channel 7, Data BERT Input	75 ohm TTL	75 ohm BNC
Channel 8, Clock BERT Input	75 ohm TTL	75 ohm BNC
Channel 8, Data BERT Input	75 ohm TTL	75 ohm BNC
Power	90-264 V-rms AC, 47-63 Hz	EAC309X

3.5 Connect Devices

Connections to the QBERT varies depending on the type of equipment in use.

1. Connect a Receiver to the QBERT using the appropriate TTL clock and data cables for the receiver.

4 System Configuration

QBERT measures bit error rates at any point in the system where a clock and data stream are present.

Figure 5 shows an example of the Quasonix QBERT factory default screen at power up.



Figure 5: QBERT Factory Default Power Up Screen

The display is divided into two major sections, Display and Configuration.



Figure 6: Display Area

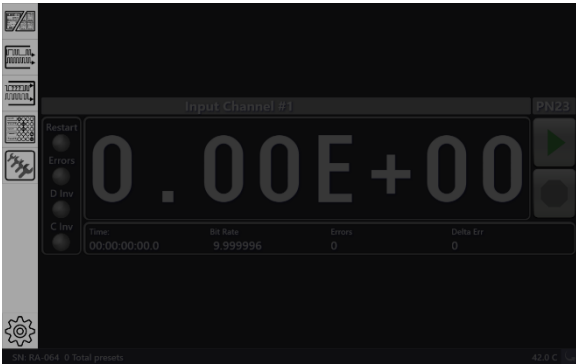


Figure 7: Configuration Tool Bar

4.1 Main Display

The Main Display area, shown in Figure 8, Figure 9, and Figure 10, can be configured to show various combinations and layouts of display panels. If QBERT™ is configured with more than one input channel, each display panel can select which input channel displays.

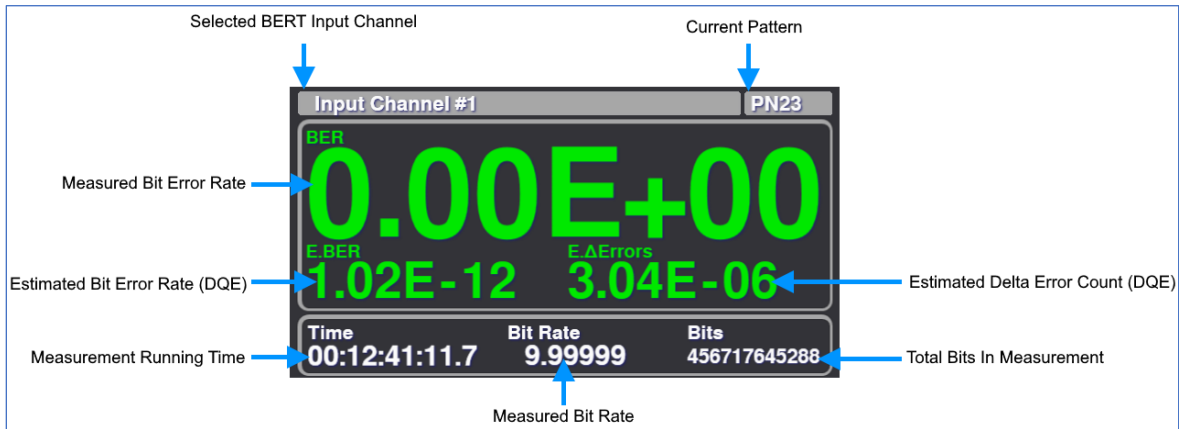


Figure 8: Example of Types of Main Display Parameters

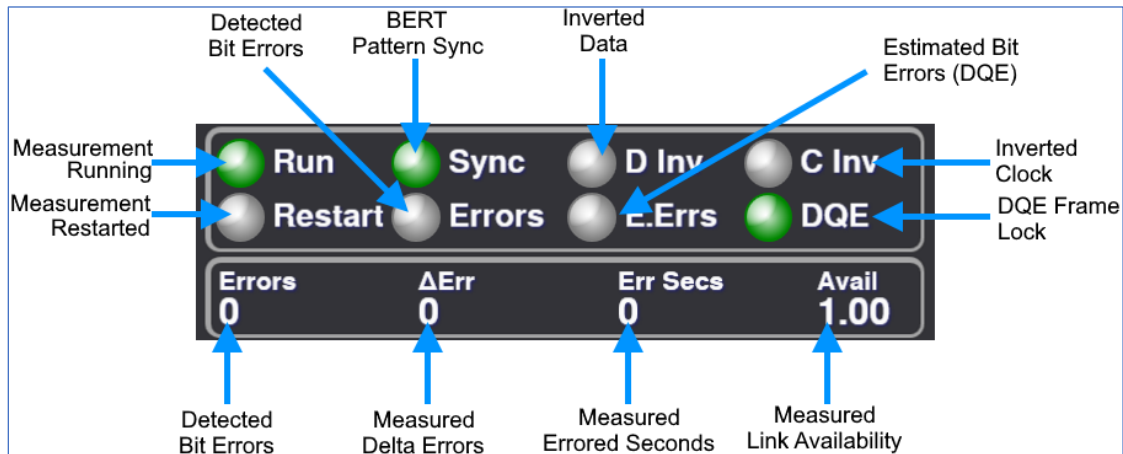


Figure 9: Example Indicators

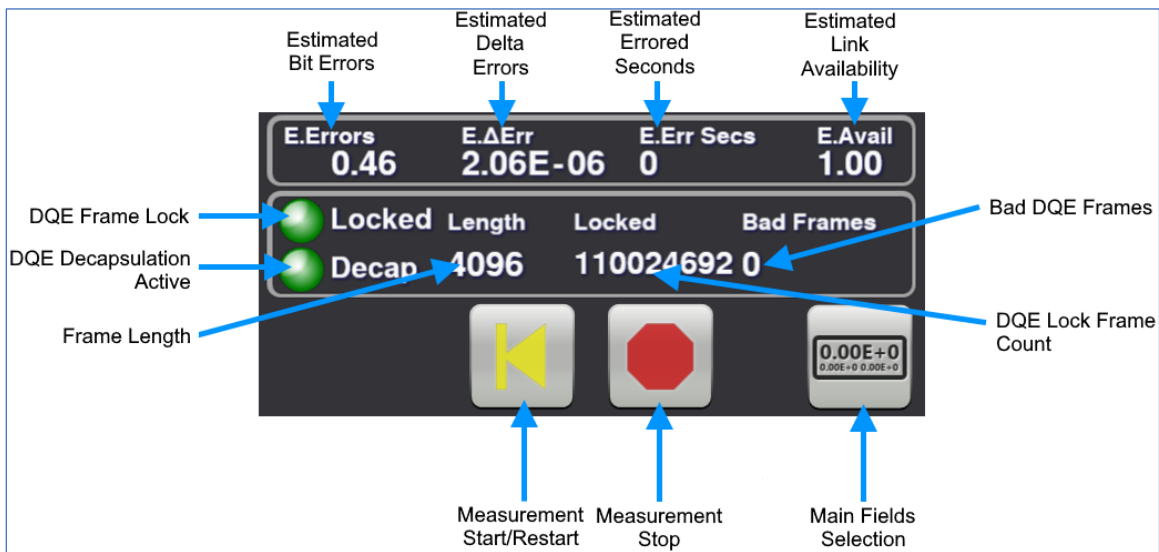


Figure 10: Example Displays and Buttons

4.2 Configuration Tool Bar

The Configuration Bar, shown in Figure 12, provides six buttons used to configure QBERT.

- Layout (Display)
- Data Generator (Output)
- Input Channel (Configurations—connected to the hardware, not the display)
- Group Controls (Channel) – Allow settings for multiple BERTs to be configured the same without having to configure each BERT individually
- Presets
- Settings



Figure 11: Main Display, Configuration Tool Bar Highlighted

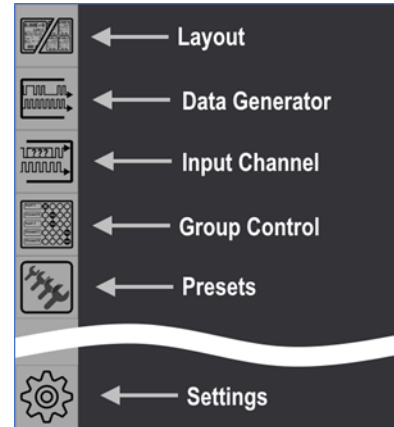


Figure 12: Configuration Tool Bar

4.2.1 Layout

The Layout button enables selection of the number of input channels and their display configuration. Figure 13 shows the Monitor layout as an example of the Layout configuration.

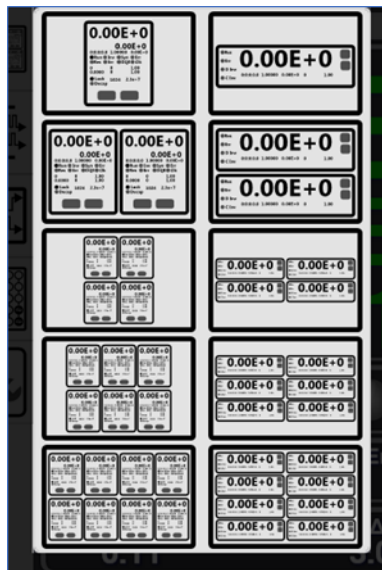


Figure 13: Layout Configuration Example, Monitor

4.2.2 Data Generator/Output Data Configuration

The Data Generator button enables configuration of the single clock/data output, as shown in Figure 14. This includes Pattern, Bit Rate, Continuous Error Rate, Enable Continuous Bit Error Rate, and Insert Single Errors.



Figure 14: Data Generator/Output Data Configuration

- Pattern – Sets the data pattern generated by the QBERT; This is a fixed pattern or a pseudorandom pattern that repeats based on the chosen pattern/sequence (a shorter pattern looks more regular, a longer pattern looks more random).
 - PN6 – Pseudorandom pattern 2^6-1 bits in length
 - PN9 – Pseudorandom pattern 2^9-1 bits in length
 - PN11 – Pseudorandom pattern $2^{11}-1$ bits in length
 - PN15 – Pseudorandom pattern $2^{15}-1$ bits in length
 - PN17 – Pseudorandom pattern $2^{17}-1$ bits in length
 - PN20 – Pseudorandom pattern $2^{20}-1$ bits in length
 - PN23 – Pseudorandom pattern $2^{23}-1$ bits in length
 - PN31 – Pseudorandom pattern $2^{31}-1$ bits in length
 - Any binary pattern between 2 and 32 bits may be typed directly into the Pattern field.
- Rate – Data rate in Mbps – Typing a number in this field sets the data rate.
- BER – Used to add a known bit error rate to the test data stream; Type a bit error rate to adjust the rate.
- Continuous button – Continuously adds bit errors at the specified bit error rate
- Insert Single button – Click on this button to add a single bit error to the test stream

4.2.3 Input Channel Configuration

The Input Channel Configuration button enables configuration of each input channel independently of the channels displayed, as shown in Figure 15.

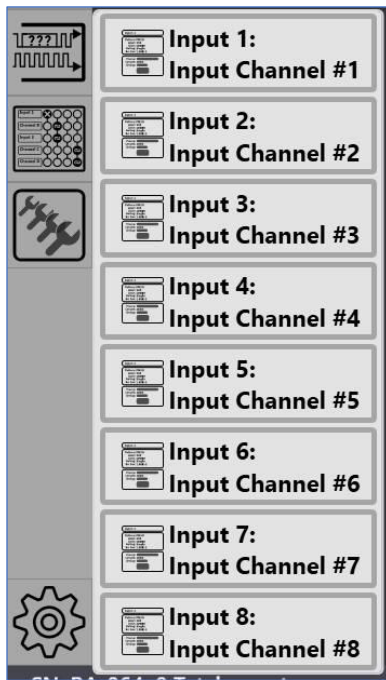


Figure 15: Input Channel Flyout Menu

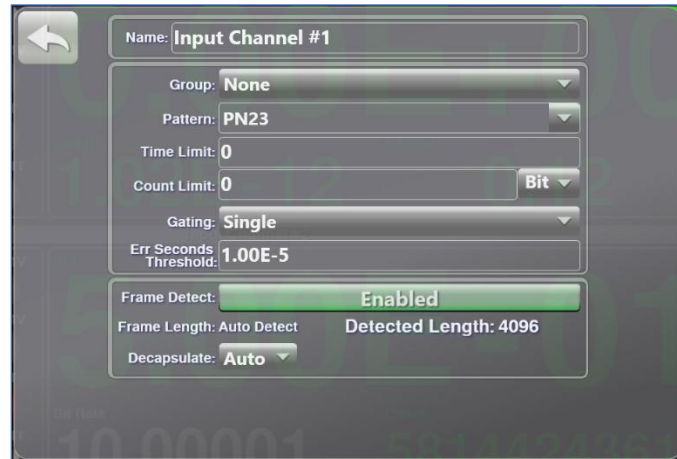


Figure 16: Input Channel Configuration

Tapping on any display panel brings up the input channel settings for the input channel currently associated with that display panel. The user can select which input channel is associated (the input channel can only be named in the input channel Configuration menu) with this display panel using the Channel drop down menu.

Note: The pop up keypad is not specific to any particular field.

- Name – Displays the name of each Input Channel. The name can be modified to provide a unique, more meaningful name to each input channel. This name can only be changed via this window, as shown in Figure 17.



Figure 17: Popup Keypad

- Group – BERT Control Group this BERT is a member of, if any
- Pattern – Sets the data pattern generated by the QBERT; This is a fixed pattern or a pseudorandom pattern that repeats based on the chosen pattern/sequence (a shorter pattern looks more regular, a longer pattern looks more random).
- Time Limit – (In seconds) – Sets a specific time limit for the measurement interval
- Count Limit – (Bits) – Sets a specific number of bits, bit errors, or estimated bit errors on which to terminate the measurement interval
 - Count Limit Drop Down Menu
 - Bit – The interval is complete after the number of bits reach the assigned limit
 - Error – The interval is complete after the number of errored bits is reached
 - E.Error – The interval is complete after the number of estimated error bits is reached
- Gating – Determines the BERT interval
 - Single – Runs a single measurement interval; The BERT must be restarted manually.
 - Repeat – Automatically restarts the BERT when an interval completes
 - Continuous – Continuously runs the BERT unless manually restarted or Count and Time limits are ignored
- Errored Seconds Threshold – The bit error rate within a one second span that defines the second to be errored; Used to determine link availability
- Frame Detect – When enabled, automatically detects the DQE frame length (generally recommended unless DQE framing is 'broken' on the receiver under test)
- Frame Length – Sets the DQE frame length; may be typed manually or detected automatically
- Decapsulate – Decapsulate has three states Off, On, and Auto. Off disables all DQE decapsulation, regardless of whether encapsulation is present. On always attempts to decapsulate DQE. This can cause issues if the receiver does not have DQE enabled. Auto attempts to detect valid DQE and, if found, automatically decapsulates.

4.2.4 BERT Control Groups

The Group Control button allows placement of multiple input channels into a control group, as shown in Figure 18. When a parameter on one input channel in a control group is changed, that same parameter is changed in the other input channels in that control group, as shown in Figure 19. Each control group can be given a unique, more meaningful name.

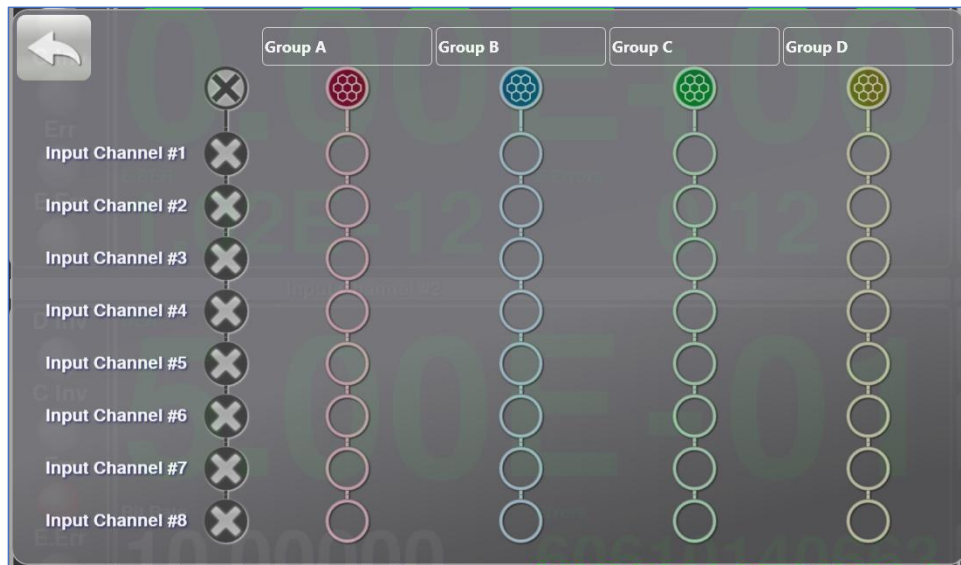


Figure 18: Group Control

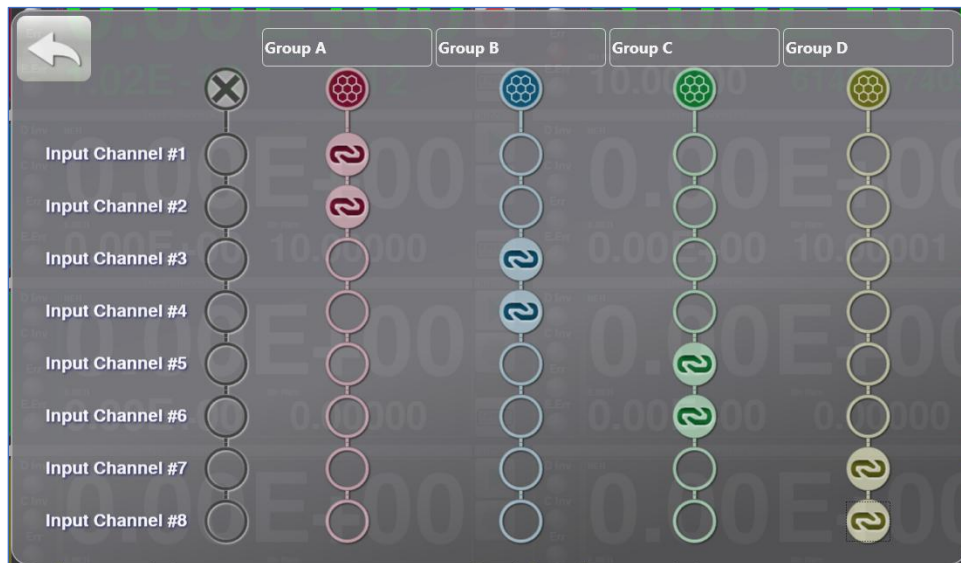


Figure 19: Group Control, Multiple Parameters Changed

Each BERT Input Channel group is color coded and may be assigned a different color by selecting the icon at the top of the group column, as shown in Figure 20 and Figure 21.

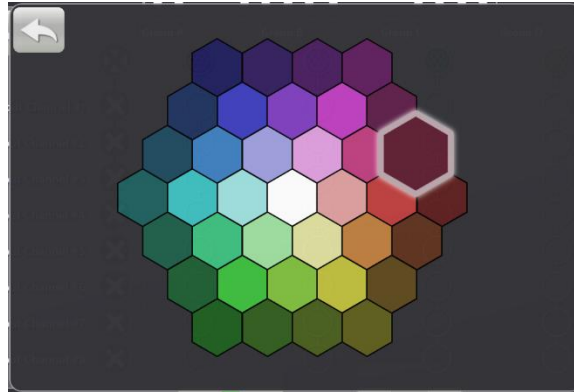
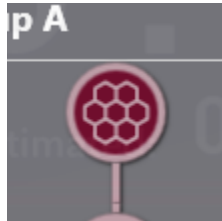


Figure 20: Group Color Selection Icon Figure 21: Color Selection Icon with Color Selected

The borders on the display panels match the colors selected for each control group, as shown in Figure 22. This indicates which BERT Input Channels are grouped together.



Figure 22: Display Panels with Different Control Group Colors

Input channels can be placed in one of up to four control groups (depending on how many channels QBERT is configured with) or no control group. The BERT Input Channel group names may be customized, as shown in Figure 23.



Figure 23: BERT Input Channel Group Names Above Keypad

Selecting the X icon, shown in Figure 24, returns all BERT Input Channels to group None.

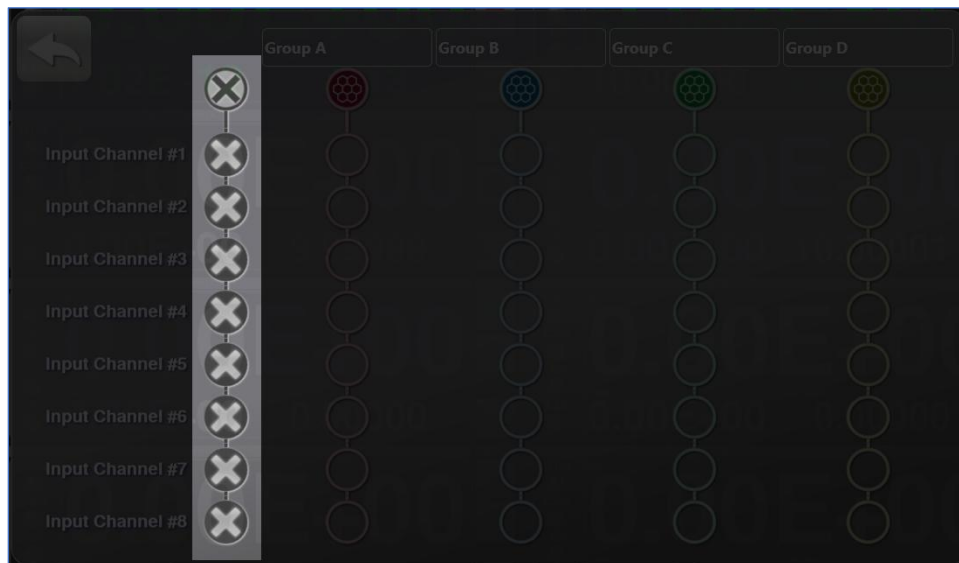


Figure 24: X Icon Returns All Channels to Group None

4.2.5 Presets

Presets are a predefined configuration of QBERT. Multiple named presets can be created and organized into a folder hierarchy, as shown in Figure 25. There is also a single, unnamed, quick preset that enables a quick save of a current configuration for later recall. Preset buttons are described in Figure 26 and Figure 27.



Figure 25: Presets



Figure 26: Preset Buttons

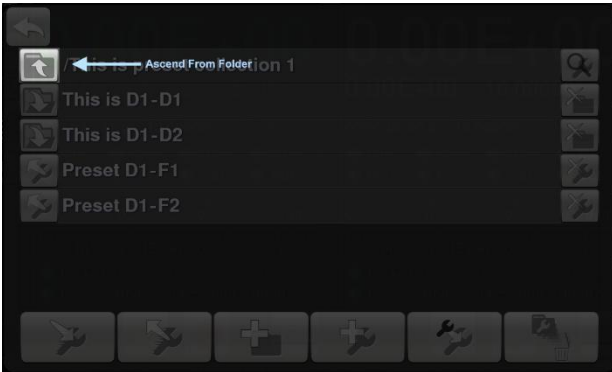


Figure 27: Preset Ascend Button

Presets and folders can be renamed by selecting the name in the list, then typing a new name, as shown in Figure 28.



Figure 28: Preset and Folder Renaming Examples Shown Above Keypad

4.2.6 Settings/Options

Use the Settings/Options button to select the desired operating mode, and to choose the amount of Data Quality Encapsulation (DQE) information to display. This window also provides access to About information and the ability to enter optional configuration unlock codes.



Figure 29: Settings

- Operating Mode – Determines the trade-off between available functionality and display optimization; three modes: Simple, Monitor, and Diagnostic
- DQE Enable – Disabling Data Quality Encapsulation (DQE) (using the slide bar) removes all DQE information from the displays
- DQE Frame Enable - Disabling Data Quality Encapsulation (DQE) (using the slide bar) removes all DQE Frame Status information from the displays

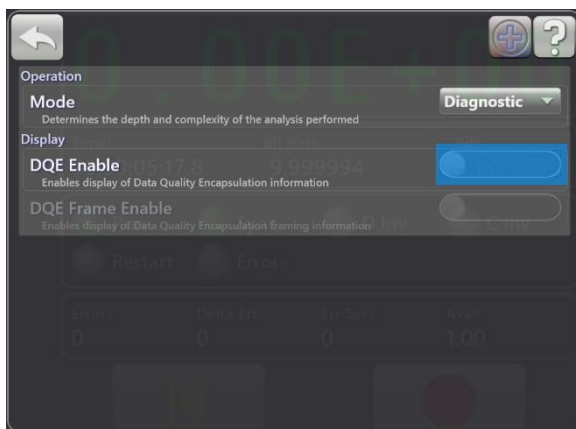


Figure 30: Settings with DQE Disabled



Figure 31: Diagnostic Display Adjusted



Figure 32: Vertical Monitor Display, DQE Enabled



Figure 33: Vertical Monitor Display, DQE Disabled

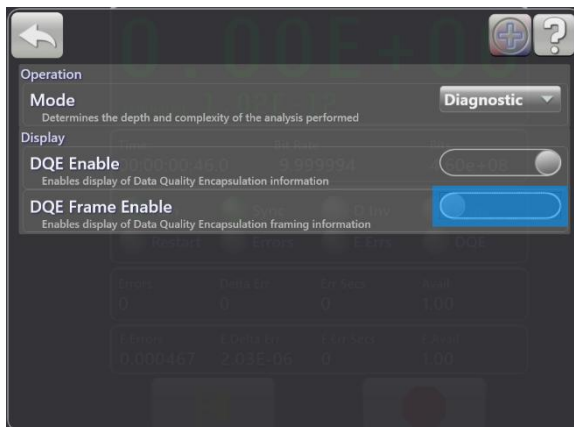


Figure 34: Settings with DQE Frame Enable



Figure 35: Vertical Monitor Display, DQE Frame Status Disabled

4.3 Status Bar

The Status Bar is located at the bottom of the window, as shown in Figure 36. It displays:

- Unit Serial Number
- Total Number of Stored Presets
- Unit Temperature
- Hardware Activity Indicator



Figure 36: Status Bar

4.4 Display Channels

QBERT supports up to 8 input channels, depending on configured options. The display can be configured to display one, two, four, six, or eight channels.

Display configurations showing one or two channels maximizes the size of the displayed channels, as shown in Figure 37 and Figure 38. Displaying four, six, or eight channels reduces the size of each channel display, as shown in Figure 39, Figure 40, and Figure 41.

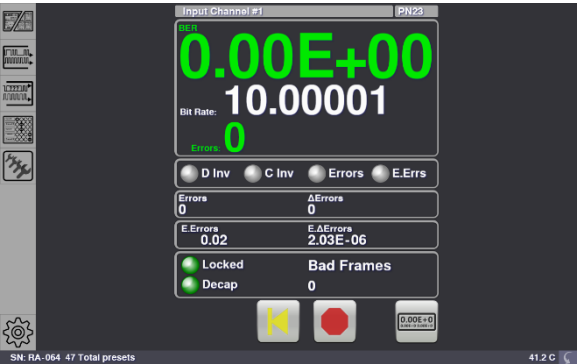


Figure 37: One Channel Display



Figure 38: Two Channel Display



Figure 39: Four Channel Display



Figure 40: Six Channel Display



Figure 41: Eight Channel Display

4.5 Display vs. Input Channels

Input channels may be configured to display in a particular Display channel. Figure 42 shows a Monitor mode, two display layout using Input Channel #2 and Input Channel #8.



Figure 42: Example Monitor Mode, Two Display Layout with Two Channels

4.6 Display Content Options

Displays may be optimized for a specific situation. For example, select the content for the three main fields for each display. This selection is tied to the Display Channel, not the Input Channel.

The displayed content selection is configured using the Content Selection button, as highlighted in Figure 43.



Figure 43: Content Selection Button

4.7 Configurable Display Fields

Each display has three main display fields:

- Primary
- Top/Left (depending on display layout)
- Bottom/Right (depending on display layout)



Figure 44: Configure Display Fields Window

Each main field can be set to any of the following content, as shown in the drop down menu in Figure 45.

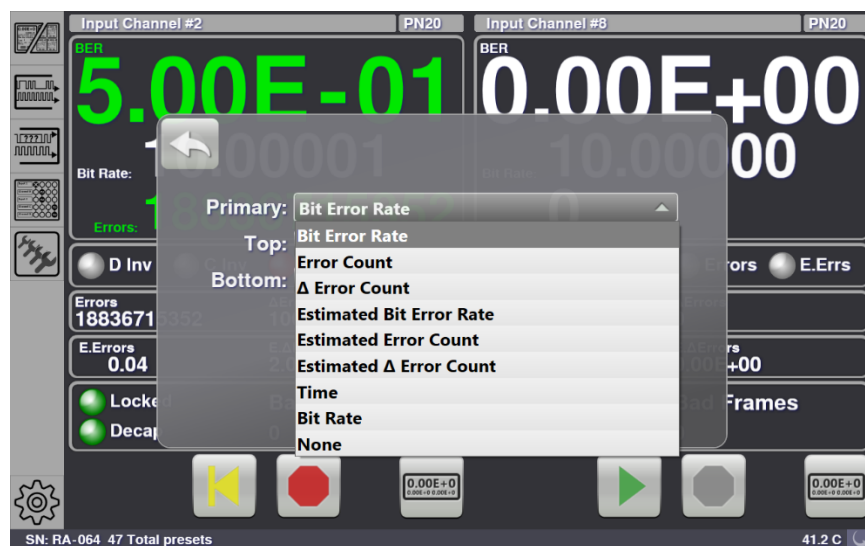


Figure 45: Configure Display Fields, Top Drop Down Menu

4.8 BERT Configuration

Each BERT Input Channel can be independently configured or configured in multiple BERT control groups. Tap on a Display Channel to display the configuration options, as shown in Figure.



Figure 46: BERT Input Channel Configuration Options

Configuration fields are:

- Channel – Input Channel to be configured/displayed
- Group – BERT Control Group
- Pattern – BERT pattern
- Time Limit – Measurement time limit
- Count Limit – Measurement bit or error count limit
- Gating – Single, Repeat, or Continuous
- Err Seconds Threshold – Errored seconds threshold
- Decapsulate – Data Quality Encapsulation control

There are two BERT control buttons: Start/Restart and Stop, as shown in Figure 47 and Figure 48.



Figure 47: Green BERT Start Button



Figure 48: Yellow BERT ReStart and Red Stop Buttons

4.9 Data Quality Encapsulation (DQE)

QBERT supports Data Quality Encapsulation (DQE). It syncs to DQE frames and extracts DQE information to calculate estimated measurements and performs actual measurements on the decapsulated data.

Estimated measurements:

- Estimated Bit Error Rate
- Estimated Error Count
- Estimated Delta Error Count (since last update)
- Estimated Errored Seconds
- Estimated Link Availability

4.9.1 DQE Configuration

4.9.1.1 Frame Length

The DQE frame length must be known for the QBERT to be able to decapsulate frames. The length can be entered manually, or the QBERT can detect the frame length automatically. Manually entered values may be useful in high noise environments.

4.9.1.2 Mode

DQE decapsulation can be configured in one of three modes

- Off – Ignores all DQE framing information, even if present
- On – Assumes DQE framing exists and attempts decapsulation
- Auto – Decapsulates if DQE frame sync is achieved, otherwise it will not

4.10 About

The About screen, accessed via the Question Mark icon on the Settings screen, shown in Figure 49, provides Quasonix contact information, firmware, software, and FPGA versions, and unit serial number, as shown in Figure 50.

The Feature Codes (Plus sign) button allows users to enter purchased configuration enhancements.



Figure 49: Settings, Feature Codes and About Buttons



Figure 50: About

5 Operation Modes

QBERT operates in three modes:

- Diagnostic
- Monitor
- Simple

Each mode is a trade off between the amount of information displayed and the complexity of, and the size of, displayed fields.

5.1 Diagnostic Mode

Diagnostic mode prioritizes displaying the most detailed information at the expense of display size, as shown in Figure 51. This is the most complex, information dense display mode. It is useful for diagnosing and resolving system errors. The DQE information display is controlled through Settings.



Figure 51: Diagnostic Mode

Diagnostic Mode displays the following information:

- Bit Error Rate
- Bit Rate
- Measurement Running Time (since Start/Restart)
- Total Bits (since Start/Restart)
- Status Indicators
 - BERT Running
 - BERT Pattern Sync

- Data Inversion
- Clock Inversion
- BERT Restart
- Bit Errors
- Bit Error Information
- Data Quality Metric Information (if enabled)

5.2 Monitor Mode

Monitor mode can display information in a horizontal or vertical format, and strikes a balance between information and display size, as shown in Figure 52 and Figure 53, with larger display fields than Diagnostic Mode. The DQE information display can be controlled via Settings.



Figure 52: Horizontal Monitor Display



Figure 53: Vertical Monitor Display

Monitor Mode displays the following information:

- Bit Error Rate
- Bit Rate
- Measurement Running Time (since Start/Restart)
- Status Indicators
 - Data Inversion
 - Clock Inversion
 - Bit Errors
- Data Quality Metric Information (if enabled)

5.3 Simple Mode

Simple mode is a low complexity, low density display which shows a minimal set of information and prioritizes display size, as shown in Figure 54. No DQE information is ever displayed.



Figure 54: Simple Mode

Simple Mode displays the following information:

- Bit Error Rate
- Bit Rate
- Status Indicators
 - Data Inversion
 - Clock Inversion
 - Bit Errors
- Data Quality Metric Information (if enabled)

5.4 BERT Monitor Panel

The BERT Monitor panel, shown in Figure 55, displays the status of the BERTs.



Figure 55: BERT Monitor Panel

A common set of colors are used to indicate various statuses, as shown in the following Figures.

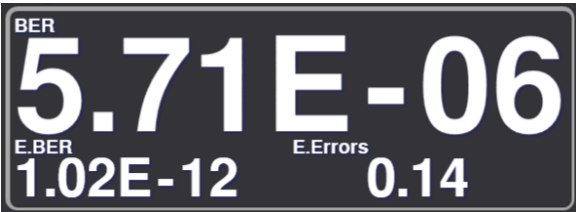


Figure 56: White: No Measurements Running



Figure 57: Green: BERT Pattern Sync/DQE Frame Sync Achieved



Figure 58: Red: BERT Pattern Sync Failure; DQE Mode On with No Frame Sync



Figure 59: Yellow: DQE Mode is Auto; No Frame Sync, No Decapsulation Active

The measurement interval displays show information about the current measurement interval.

- Time – Displays the elapsed time for the measurement interval, in the format Days Hours, Minutes, Seconds, Milliseconds
- Bit Rate – Continuous display of the channel bit rate for the measurement interval
- Bits – Continuous display of the channel bit count for the measurement interval

Five *measured* parameters from the BERT Channel Monitor panel are described here.

- Bit Error Rate – Continuous display of the bit error rate for the duration of a measurement
- Error Count – Continuous display of the channel error count for the duration of a measurement
- Delta Err – The number of errors detected since the last screen update
- Err Secs – Errored Seconds; the number of severely errored seconds in the measurement interval; A severely errored second is one where the bit error rate for that second exceeds the Errored Second Threshold set in the BERT Configuration menu for that BERT.
- Avail – Link Availability; An overall measure of link quality; It is a number between 0.0 and 1.0, and is

$$1 - \frac{\text{errored seconds}}{\text{total seconds}}$$

for the measurement interval.

Five parameters from the BERT Channel Monitor panel that provide *estimated* status information are described here. ‘E.’ in the BERT area is an abbreviation for ‘Estimated’.

- E_BER – Bit error rate, based on DQM extracted from DQE.
- E.Errors – Bit errors based on DQM extracted from DQE
- E.Delta Err – Indicates the number of errors since the last screen update. When all of the deltas are added up, the result is the total number of errors.
- E.Err Secs – Errored Seconds; the number of severely errored seconds in the measurement interval based on the DQM
- E.Avail – Link Availability; An overall measure of link quality based on the DQM
- Locked – When this indicator is active green, the data quality encapsulation frame lock is active (DQE detected).
- Decap – Shows decapsulation is active, either when Decapsulate is set to On, or if Decapsulate is set to Auto and DQE Lock is indicated
- Length – Shows the DQE frame length
- Locked – Shows the count of the properly bounded DQE frames, with a DQE header before and after
- Delta – Shows the difference between Frames and Locked; this is the number of bad or dropped DQE frames detected

When the input channel is not running, the displayed values and status LEDs are gray. Tapping the green arrow starts the input channel measurement, as shown in Figure 60.

When the input channel is running, tapping the yellow rewind button restarts the measurement. Tapping the red stop sign stops the measurement.

When the BERT is synchronized with the incoming data the Bit Error Rate display and Sync status LED (if displayed) are green, as shown in Figure 61.

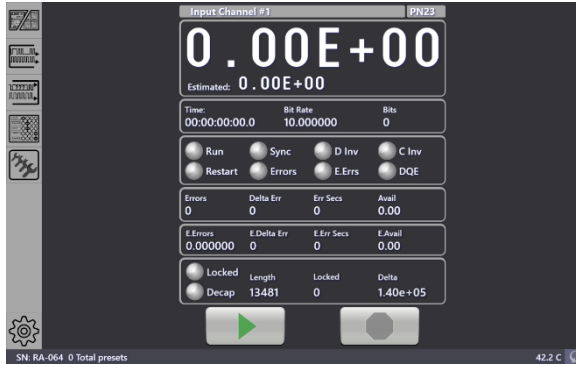


Figure 60: BERT Monitor, Green Button



Figure 61: BERT Monitor, Green Display

When the BERT is not synchronized with the incoming data, the Bit Error Rate display and Sync status LED (if displayed) are red, as shown in Figure 62.



Figure 62: BERT Monitor, Red Display

5.4.1.1 BERT Status Indicators

LED indicators in the BERT Monitor panel are described here and are shown in Figure 62. All inactive indicators are gray.

- Run – Active green, the BERT is running (measuring)
- Sync – Pattern Sync Loss; Active red means the BERT has lost synchronization with the specified pattern.
- D Inv – Data Inversion; When the data is inverted, the indicator is active blue.

- C Inv – Clock Inversion; When the clock is inverted, the indicator is active red.
- Restart – Active green, the BERT has restarted, either from a manual restart or after the completion of a time or count limit
- Errors – Bit Errors; Active red means bit errors were detected in the last observation interval.
- E.Errs – Estimated Errors; An active red indicator means the BERT error estimator has estimated that there are errors.
- DQE – An active red indicator means the BERT Data Quality Decapsulator has lost DQE frame lock.
- Locked – When this indicator is active green, the data quality encapsulation frame lock is active (DQE detected).
- Decap – Shows decapsulation is active, either when Decapsulate is set to On, or if Decapsulate is set to Auto and DQE Lock is indicated

5.4.1.1.1 Clock and Data Polarity

QBERT automatically detects, and compensates for, clock and data polarity. If data polarity is inverted, the D Inv status LED is blue, as shown in Figure 63. If the clock polarity is inverted, the C Inv status LED is red, as shown in Figure 64.

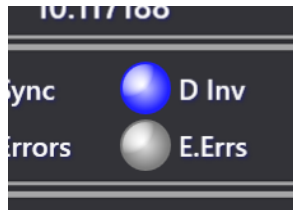


Figure 63: Data Polarity Inverted LED



Figure 64: Clock Polarity Inverted LED

6 Maintenance Instructions

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

7 Product Warranty

The QBERT carries a standard parts and labor warranty of one (1) year from the date of delivery.

7.1 Quasonix Limited Warranty Statement

This Limited Warranty Statement (this “Limited Warranty”) applies to all hardware and software products and internal components of such products (the “Products”) sold by Quasonix, or its representatives, authorized resellers, or country distributors (collectively referred to herein as “Quasonix”). EXCEPT AS EXPRESSLY SET FORTH IN THIS LIMITED WARRANTY, QUASONIX MAKES NO OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO ANY PRODUCTS SOLD BY IT. Quasonix expressly disclaims all warranties and conditions not stated in this limited warranty. There are no warranties which extend beyond the description on the face hereof. Capitalized terms not otherwise defined herein shall have the meaning set forth in those certain General Terms and Conditions of Sale for Standard Product, as amended from time to time.

Quasonix warrants to customer that for one (1) year from the date of shipment of the Products by Quasonix (the “Warranty Period”), such Products purchased from Quasonix, or its authorized affiliate will materially conform to the specifications set forth in the applicable Quasonix Specifications, if any, and are free from defects in materials and workmanship under normal use during the Warranty Period. As used herein, “normal use” means the intended use of the Products for which it was designed by Quasonix.

This Limited Warranty extends only to the original purchaser of the Products and is not transferable to anyone who obtains ownership of the Products from the original purchaser.

Quasonix’s software, whether incorporated into the Products or sold separately, is warranted solely to the extent that problems or “bugs” are found in the software and affect the functional operation of the Products. At no time shall requests for changes in the software architecture or visual esthetics be considered a warranty item.

The Products are manufactured using new materials only. Replacement parts may be new or equivalent to new. Replacement parts are warranted to be free from defects in material or workmanship for thirty (30) days or for the remainder of the Warranty Period of the Products in which they are installed, whichever is longer.

During the Warranty Period, Quasonix will repair or replace the defective Products. All components or hardware products removed from the Products under this Limited Warranty become the property of Quasonix. All warranties are limited to the repair or replacement of the Products.

In no event shall Quasonix be liable for any special, consequential, incidental or indirect damages of any kind, including, without limitation, loss of profits, loss of data, “down-time,” loss of use or damage to other equipment, or personal injury or death, whether or not Quasonix has been advised of the possibility of such loss.

Notwithstanding anything to the contrary herein, Quasonix’s entire liability hereunder from any cause whatsoever and regardless of the form of action shall be limited to the amount actually received by Quasonix.

Quasonix shall not be liable for a breach of the warranty set forth in this Limited Warranty unless: (i) the customer gives written notice of the defect, reasonably described, to Quasonix’s Contracts Administrator within thirty (30) days of the time when customer discovers or ought to have discovered the defect and obtains a Return Materials Authorizations (“RMA”) number; (ii) Quasonix is given a reasonable opportunity after receiving the notice to examine such Products and customer (if requested to do so by Quasonix) returns such Products to Quasonix’s facility in Moorpark, CA, unless otherwise approved by Quasonix; and (iii) Quasonix reasonably verifies customer’s claim that the Products are defective.

Subject to the foregoing, with respect to any such Products during the Warranty Period, Quasonix shall, in its sole discretion, either: (i) repair or replace such Products (or the defective part) or (ii) credit or refund the price of such

Products at the pro rata contract rate provided that, if Quasonix so requests, customer shall, at Quasonix's expense, return such Products to Quasonix.

The customer is responsible for all costs associated with packaging and shipping of the defective Products to Quasonix's facility and clearly marking or affixing the given RMA number on the shipping label. Quasonix is not responsible for any loss or damage during shipment to Quasonix's facility. Following repair or replacement of covered Products, Quasonix will assume responsibility for the costs associated with the return of the material to the customer to an address provided by the customer. Notwithstanding the foregoing, items returned to Quasonix's facility and found to be operational or otherwise not covered by this Limited Warranty shall be returned to the customer at the customer's expense.

This Limited Warranty does not apply to expendable parts, such as cables, lamps, fuses, connectors, etc. This Limited Warranty does not extend to any Products which have been damaged or rendered defective (a) as a result of accident, misuse, abuse, or external causes; (b) by operation outside the usage parameters stated in the user documentation that shipped with the Products; (c) as a result of a failure to follow the instructions in the Operations & Maintenance Manual (d) by the use of parts not manufactured or sold by Quasonix; or (e) by modification or service by anyone other than (i) Quasonix, (ii) an Quasonix authorized service provider, or (iii) your own installation of end-user replaceable Quasonix or Quasonix approved parts if available for the Products in the servicing country.

THE TERMS OF THE WARRANTIES CONTAINED HEREIN DO NOT IN ANY WAY EXTEND TO ANY PRODUCT OR PART THEREOF OR SOFTWARE MATERIALS WHICH WERE NOT MANUFACTURED BY SELLER OR PREPARED BY SELLER OR ANY OF ITS AFFILIATES.

These terms and conditions constitute the complete and exclusive warranty agreement between the customer and Quasonix regarding the Products purchased. This Limited Warranty is applicable in all countries and may be enforced in any country where Quasonix or its authorized affiliates offer warranty service subject to the terms and conditions set forth in this Limited Warranty.

These terms and conditions supersede any prior agreements or representations (including representations made in Quasonix sales literature or advice given to the customer by Quasonix or an agent or employee of Quasonix) that may have been made in connection with the purchase of the Products. No change to the conditions of this Limited Warranty is valid unless it is made in writing and signed by an authorized representative of Quasonix.

7.1.1 Extended Warranties

Extended warranties or extra coverage are available upon request. Please contact Quasonix for details and pricing.

THE REMEDIES SET FORTH IN THIS LIMITED WARRANTY STATEMENT SHALL BE THE BUYER'S SOLE AND EXCLUSIVE REMEDY AND SELLER'S ENTIRE LIABILITY FOR ANY BREACH OF THE LIMITED WARRANTY SET FORTH HEREIN.

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8 Technical Support and RMA Requests

In the event of a product issue, customers should contact Quasonix via phone (1-513-942-1287) or e-mail (support@quasonix.com) to seek technical support. If the Quasonix representative determines that the product issue must be addressed at Quasonix, a returned materials authorization (RMA) number will be provided for return shipment.

Authorized return shipments must be addressed in the following manner:

**Quasonix, Inc.
ATTN: Repair, RMA #
6025 Schumacher Park Drive
West Chester, OH 45069**

To ensure that your shipment is processed most efficiently, please include the following information with your product return:

- Ship To – Company name, address, zip code, and internal mail-drop, if applicable
- Attention/Contact person – Name, Title, Department, Phone number, email address
- Purchase Order Number – If applicable
- RMA Number – provided by the Quasonix representative

Please note that Quasonix reserves the right to refuse shipments that arrive without RMA numbers.