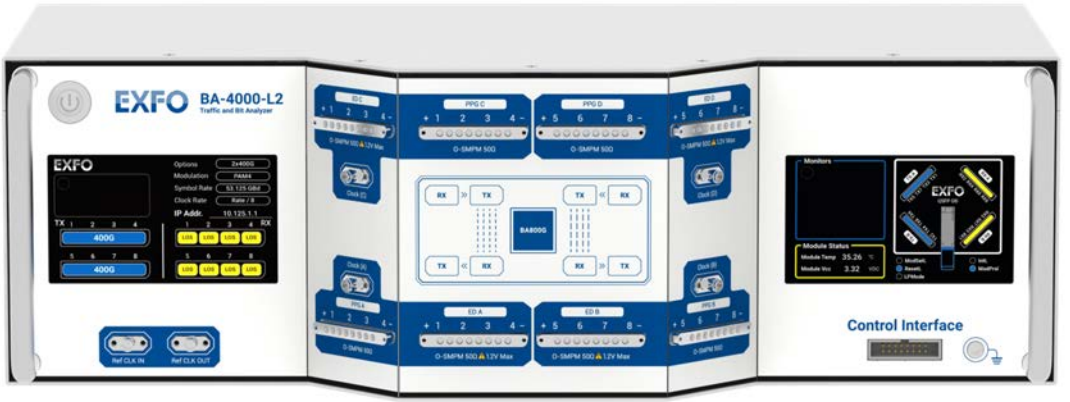
User Guide

BA-4000-L2

Traffic and Bit Analyzer



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Units of Measurement

Units of measurement in this publication conform to SI standards and practices.

Patents

The exhaustive list of patents is available at EXFO.com/patent.

Version number: 2.0.0.1

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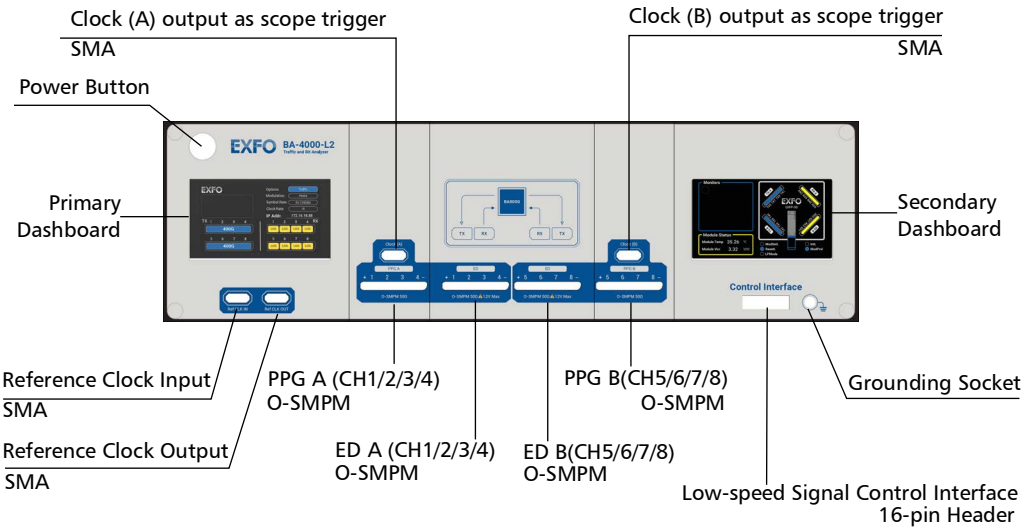
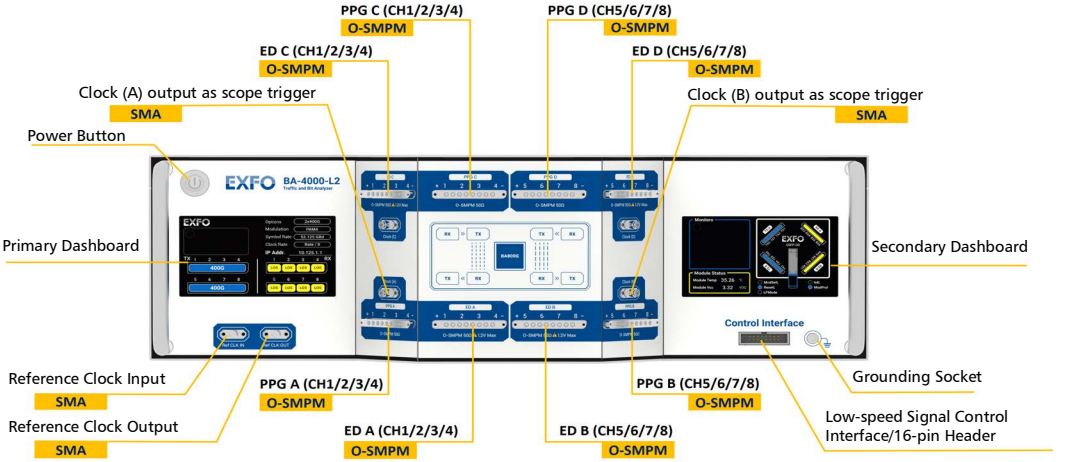
Front Panel



With RCNC Option

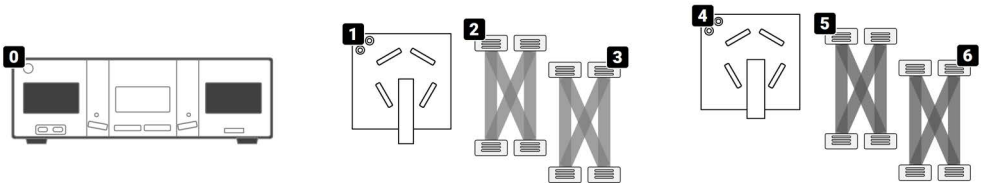


Rear Panel

Connection Guide

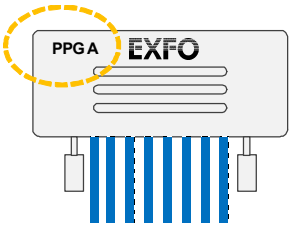
General Kit List of BA L2

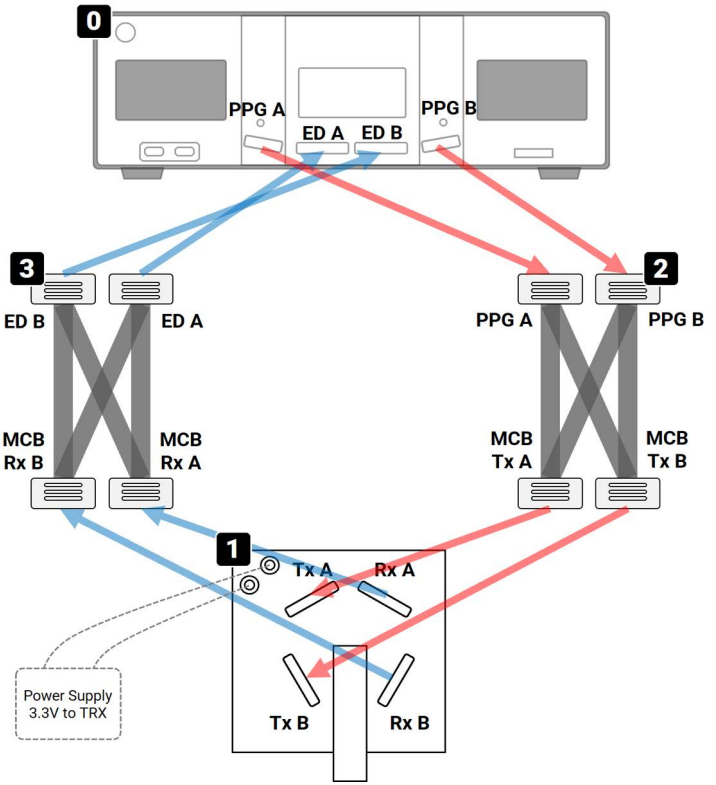
	Model No.	Description	Quantity	Remark
0	BA-4000-L2	Bit and Traffic Analyzer	1	
1	MCB-**QSFPDD**-O	QSFP-DD Module Compliance Board (O-SPMP connectors)	1	
2	ICBOS-30-**QDD**-PPG	30cm O-SMPM Cable Pair specified for [MCB-**QSFPDD**-O TX]	1	PPG A ↔ TxA PPG B ↔ TxB
3	ICBOS-30-**QDD**-ED	30cm O-SMPM Cable Pair specified for [MCB-**QSFPDD**-O RX]	1	ED A ↔ RxA ED B ↔ RxB
4	MCB-**OSFP**-O	OSFP Module Compliance Board (O-SPMP connectors)	1	
5	ICBOS-30-**OSFP**-PPG	30cm O-SMPM Cable Pair specified for [MCB-**OSFP**-O TX]	1	PPG A ↔ TxA PPG B ↔ TxB
6	ICBOS-30-**OSFP**-ED	30cm O-SMPM Cable Pair specified for [MCB-**OSFP**-O RX]	1	ED A ↔ RxA ED B ↔ RxB



Test Configuration of QSFP-DD TRX

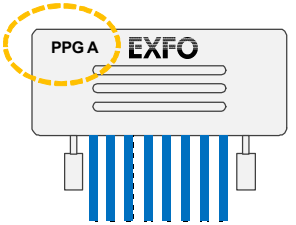
	Model No.
0	BA-4000-L2
1	MCB-**QSFPDD**-O
2	ICBOS-30-**QDD**-PPG
3	ICBOS-30-**QDD**-ED

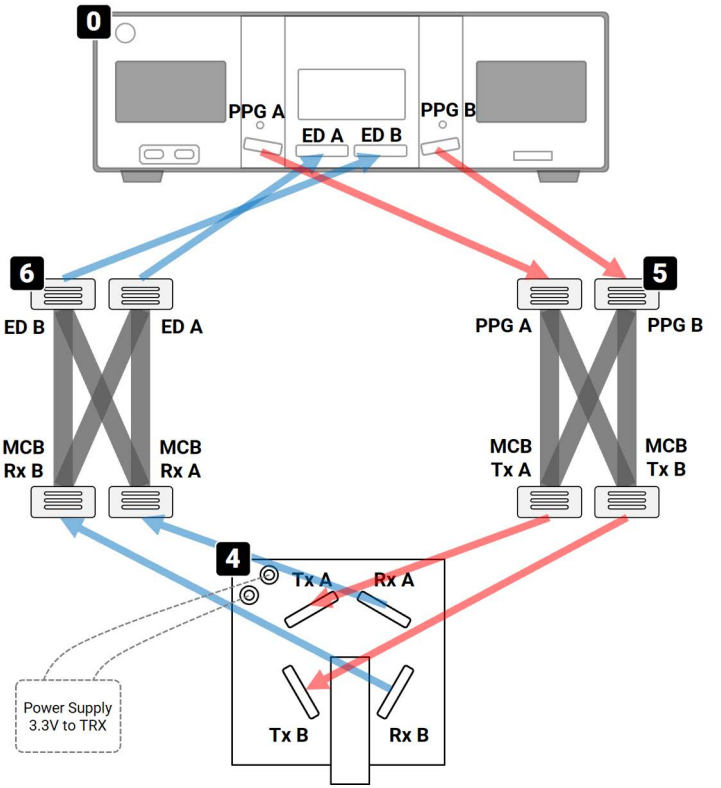




Test Configuration of OSFP TRX

	Model No.
0	BA-4000-L2
4	MCB-**OSFP**-O
5	ICBOS-30-**OSFP**-PPG
6	ICBOS-30-**OSFP**-ED

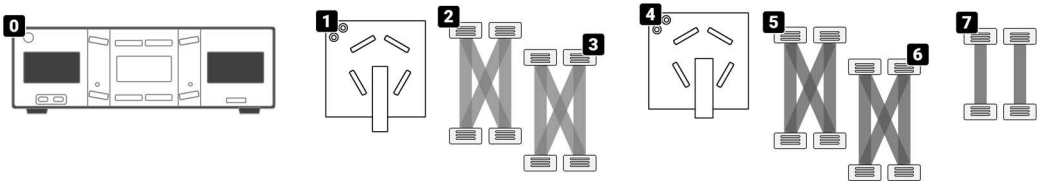




Connection Guide with RCNC

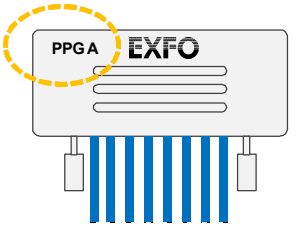
General Kit List of BA L2

	Model No.	Description	Quantity	Remark
0	BA-4000-L2-RCNC	Bit and Traffic Analyzer with RCNC option	1	
1	MCB-**QSFPDD**-O	QSFP-DD Module Compliance Board (O-SPMP connectors)	1	
2	ICBOS-30-**QDD**-PPG	30cm O-SMPM Cable Pair specified for [MCB-**QSFPDD**-O TX]	1	PPG A ↔ TxA PPG B ↔ TxB
3	ICBOS-30-**QDD**-ED	30cm O-SMPM Cable Pair specified for [MCB-**QSFPDD**-O RX]	1	ED A ↔ RxA ED B ↔ RxB
4	MCB-**OSFP**-O	OSFP Module Compliance Board (O-SPMP connectors)	1	
5	ICBOS-30-**OSFP**-PPG	30cm O-SMPM Cable Pair specified for [MCB-**OSFP**-O TX]	1	PPG A ↔ TxA PPG B ↔ TxB
6	ICBOS-30-**OSFP**-ED	30cm O-SMPM Cable Pair specified for [MCB-**OSFP**-O RX]	1	ED A ↔ RxA ED B ↔ RxB
7	ICBOS-OS-20	20cm O-SMPM Loopback Cable	2	Standard accessories of RCNC option



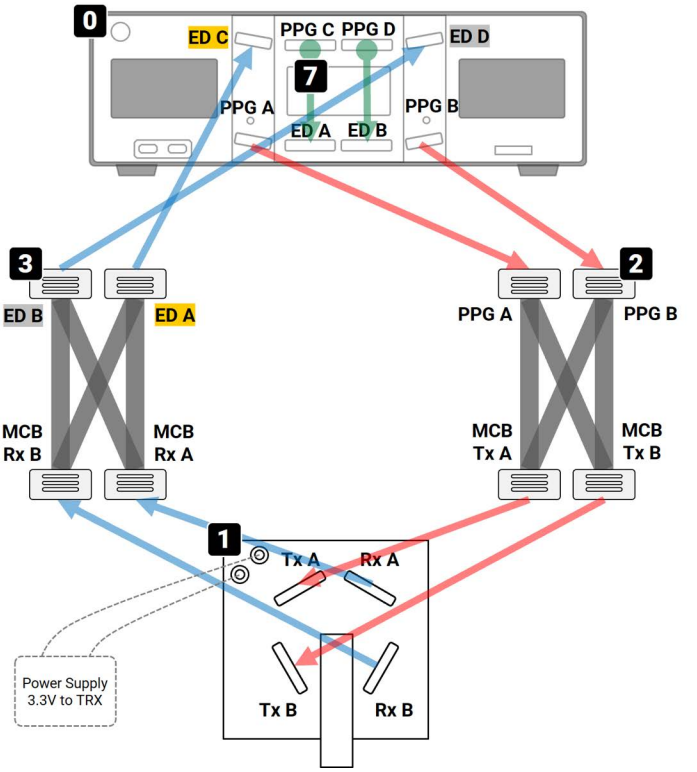
Test Configuration of QSFP-DD TRX

	Model No.
0	BA-4000-L2-RCNC
1	MCB-**QSFPDD**-O
2	ICBOS-30-**QDD**-PPG
3	ICBOS-30-**QDD**-ED
7	ICBOS-OS-20 (x2)



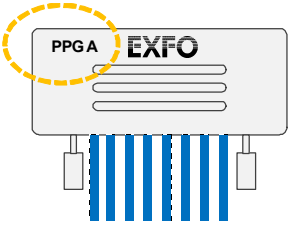
Connect from cable labeled ED A to the BA L2 ED C

Connect from cable labeled ED B to the BA L2 ED D



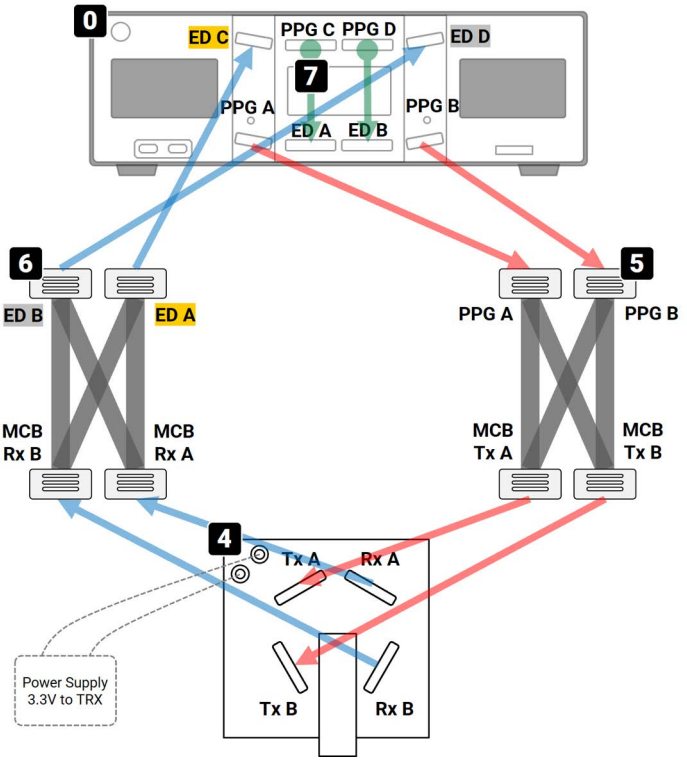
Test Configuration of OSFP TRX

	Model No.
0	BA-4000-L2-RCNC
4	MCB-**OSFP**-O
5	ICBOS-30-**OSFP**-PPG
6	ICBOS-30-**OSFP**-ED
7	ICBOS-OS-20 (x2)



Connect from cable labeled ED A to the BA L2 ED C

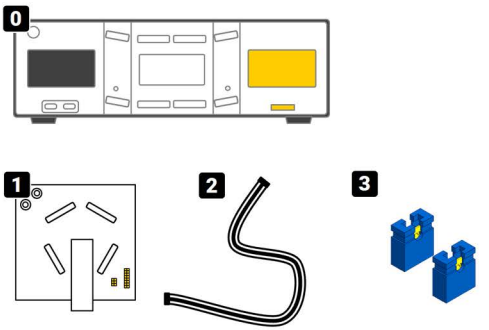
Connect from cable labeled ED B to the BA L2 ED D

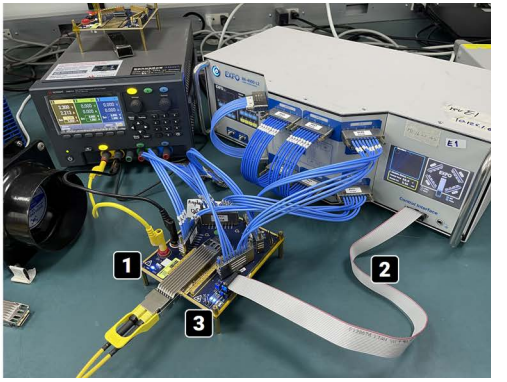


Connection Guide with MCB

List of Control Interfaces

	Model No.	Description	Quantity	Note
0	BA-4000-L2-RCNC	Bit and Traffic Analyzer with RCNC option	1	
1	MCB-OSFP-O	OSFP Module Compliance Board (O-SPMP connectors)	1	
2	N/A	Specific flat flexible cable	1	Standard accessory of BA L2
3	N/A	2.54mm Jumper cap	2	Standard accessory of BA L2 (after Sep. '25)





To connect and configure with the MCB:

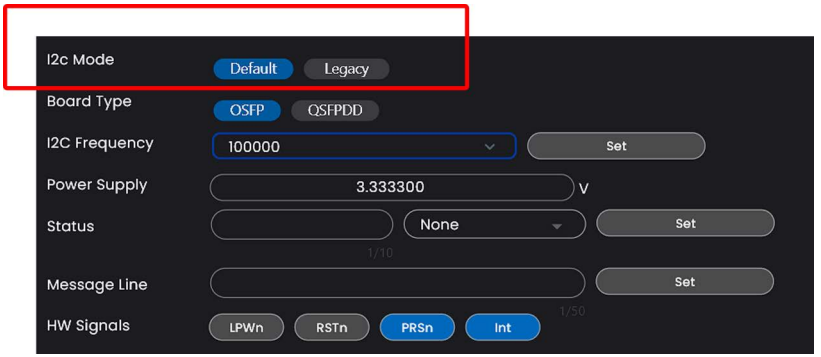
1. Connect from [BA L2 Control Interface] to [MCB 16-pin header] by the flat cable.
2. Put one jumper cap on [SCL – SCL_IN].

3. Put the other jumper cap on [SDA – SDA_IN].

Module Temperature and Voltage

With correct connection and configuration, when the transceiver is on, module temperature and voltage are shown immediately on the 2nd dashboard of the front panel.

If it doesn't work, switch [I2C Mode] from [Default] to [Legacy] at MCB tab of the GUI.

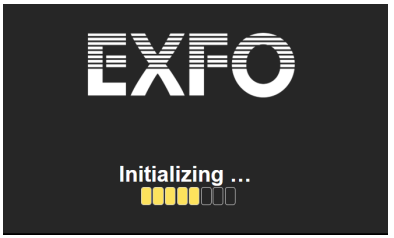


2 General GUI Operation

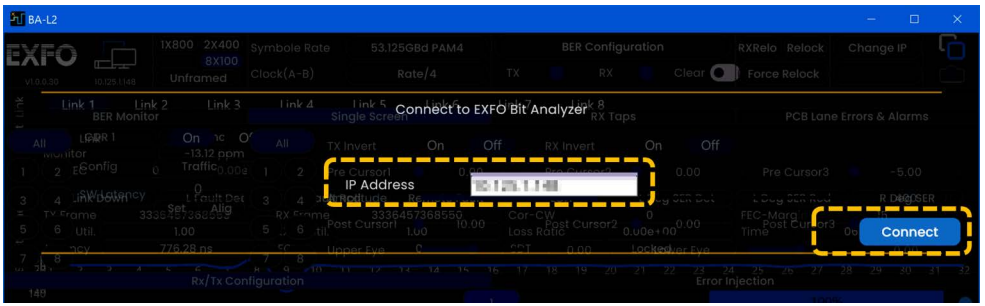
Quick Start

To power on and control with the GUI:

1. Connect the Ethernet cable from the control PC to the RJ45 port on the rear of the BA L2 chassis.
2. Push the power button on the front panel.
3. Wait for initialization. (Initialization is done when the IP address appears on the front-panel monitor)



4. Open the GUI. (The name of the desktop icon is BA-L2.)
5. Enter the IP address and click **Connect** to start controlling the machine.



To set the mode, PPG setting, and view results:

1. Select the operation mode.
2. Switch into RCNC hardware mode.
3. Set the PPG amplitude and cursors.
4. Switch functions to get all kinds of results.

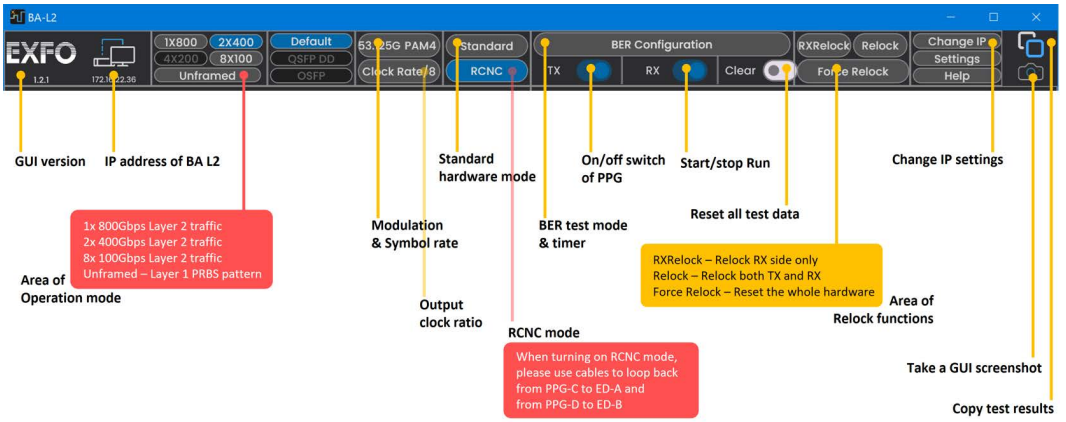
Here are two general settings to test LPO for your reference. Based on these, you can tune your settings.

(pre3, pre2, pre1, main, post1, post2, post3, upper eye, lower eye)

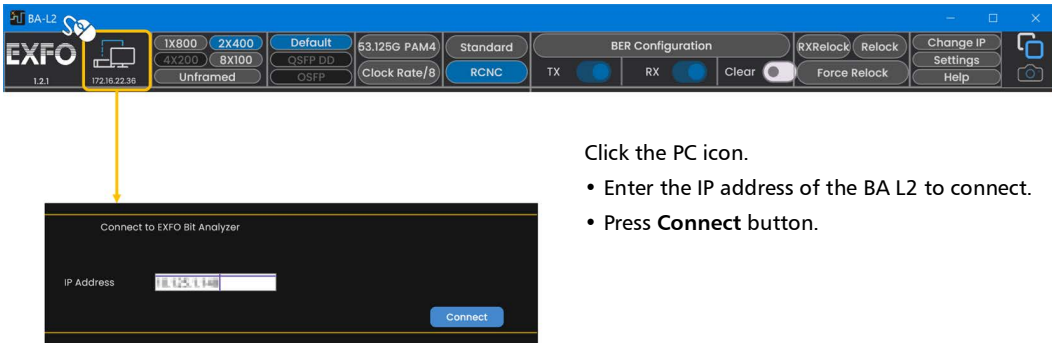
➤ (-4, 12, -20, 500, 20, -10, -6, 3, 3)

➤ (-4, 12, -20, 500, 20, 0, -6, 3, 3)

Main Control Bar



Connecting the BA L2



Click the PC icon.

- Enter the IP address of the BA L2 to connect.
- Press **Connect** button.

Symbol Rate and Clock Ratio

Click Symbol Rate **53.125GBd PAM4** button or Clock (A-B) **Rate/8** button.
Select the clock ratio of output clock signal:

- **Rate/8**
- **Rate/16**
- **Rate/32**
- **Rate/64**

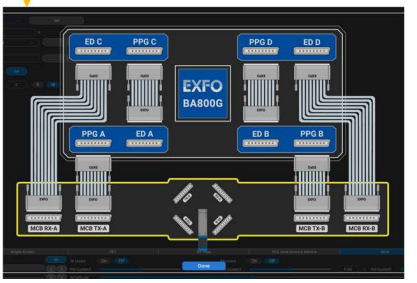
The output clock signal is generally used as the sampling scope's trigger.

RCNC Mode

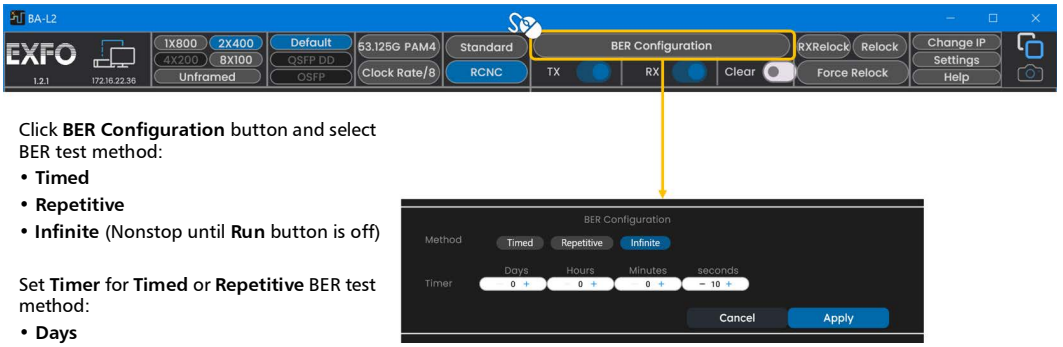
Click **RCNC** button to switch from Standard hardware mode to RCNC hardware mode.

RCNC (Reflection Cancellation and Noise Cancellation) is a hardware option with superior capabilities optimized for LPO transceivers.

You cannot switch on RCNC hardware without the option.



BER Configuration



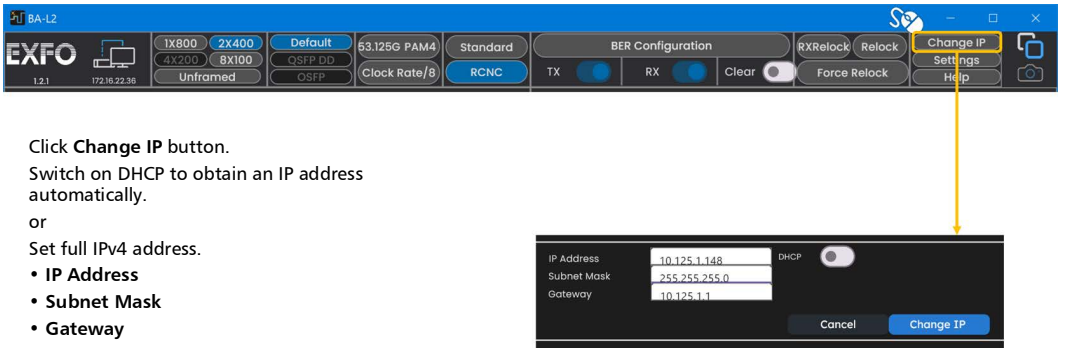
Click **BER Configuration** button and select BER test method:

- **Timed**
- **Repetitive**
- **Infinite** (Nonstop until **Run** button is off)

Set **Timer** for **Timed** or **Repetitive** BER test method:

- **Days**
- **Hours**
- **Minutes**
- **Seconds**

Changing IP Address Settings



Click **Change IP** button.

Switch on DHCP to obtain an IP address automatically.

or

Set full IPv4 address.

- **IP Address**
- **Subnet Mask**
- **Gateway**

Save/Load Settings

Click **Setup** button.

Save Settings to save the current configuration as a file with a **.bal2** extension. This file will store all your selected settings, which can be reloaded later.

Load Settings to load a previously saved configuration file.

Configuration List

The **Save Settings** feature allows you to save the following options:

- **Selected Mode**

  Options: 1x800, 2x400, 8x100, Unframed Mode

- **Data Rate**
- **TX and RX (Run) Enable/Disable**
- **Tap Values**

  Pre Cursor 3, Pre Cursor 2, Pre Cursor 1, Amplitude, Post Cursor 1, Post Cursor 2, Post Cursor 3, Upper Eye, Lower Eye

- **Channel-Wise TX/RX Invert Settings**

  Enable/Disable for each channel

- **Traffic Settings**
  - Pattern – TX Inversion, RX Inversion

- Ethernet Frame – Fixed Size or EMIX Sequence Length, TX Rate (%)
- Latency and Excess Skew

➤ **Link On/Off and Channel Enable/Disable**

➤ **Unframed Mode Channel-Wise Pattern**

TX, RX pattern for each channel

➤ **BER Configuration Settings**

Once the settings are saved, they are stored in a file and can be retrieved for future use.

The **Load Settings** feature allows you to load a previously saved configuration file. The feature restores all the settings listed above, so manual configuration is not needed.

To load the settings:

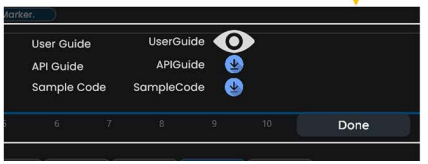
Select the saved **.bal2** file.

The system will automatically apply all configurations from the file, including mode, data rate, tap values, invert settings, and more.

Help

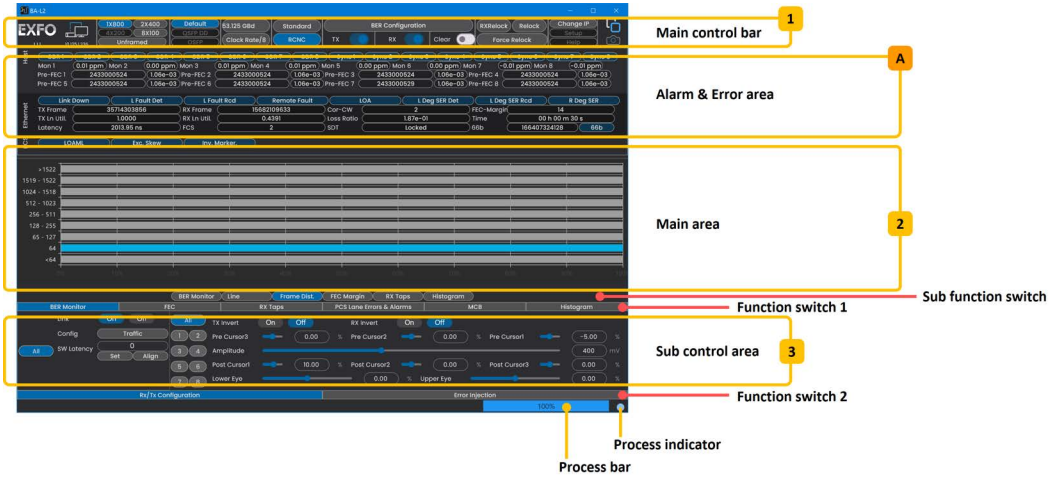
Click **Help** button.

User Guide to show the user guide on GUI.
API Guide to download the programming guide of API commands.
Sample Code to download the sample code for reference.

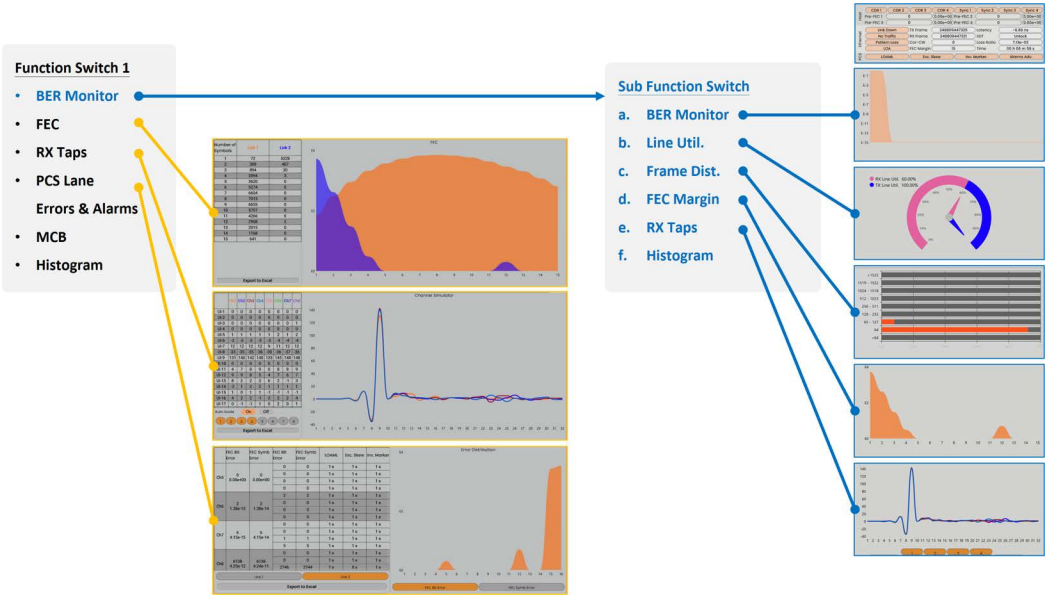


3 1x 800G Mode

GUI Sections

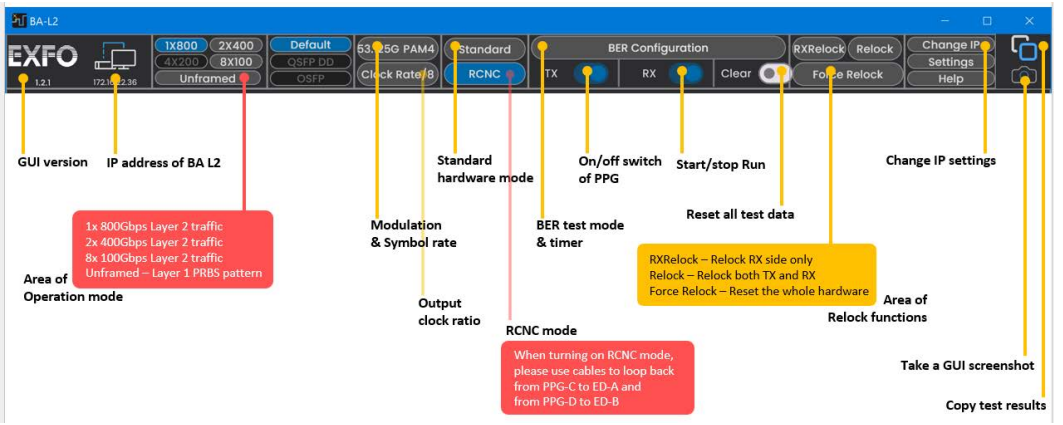


GUI Map


Function Switch 1
BER Monitor
FEC
RX Taps
PCS Lane
Errors & Alarms
MCB
Histogram
Sub Function Switch
a. BER Monitor
b. Line Util.
c. Frame Dist.
d. FEC Margin
e. RX Taps
f. Histogram

Main Control Bar

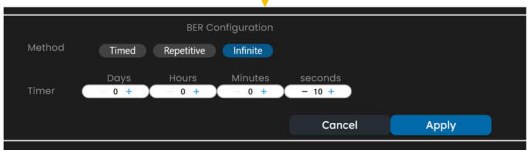
1



BER Configuration (1/2)

Click **BER Configuration** button and select test method:

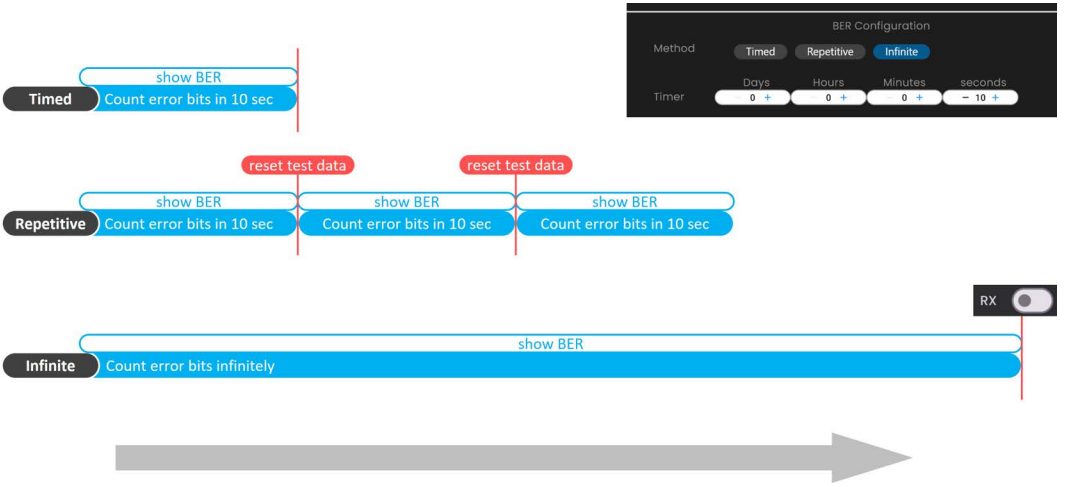
- **Timed**
- **Repetitive**
- **Infinite** (Nonstop until **RX** button is off)



Set **Timer** for **Timed** or **Repetitive** test method:

- **Days**
- **Hours**
- **Minutes**
- **Seconds**

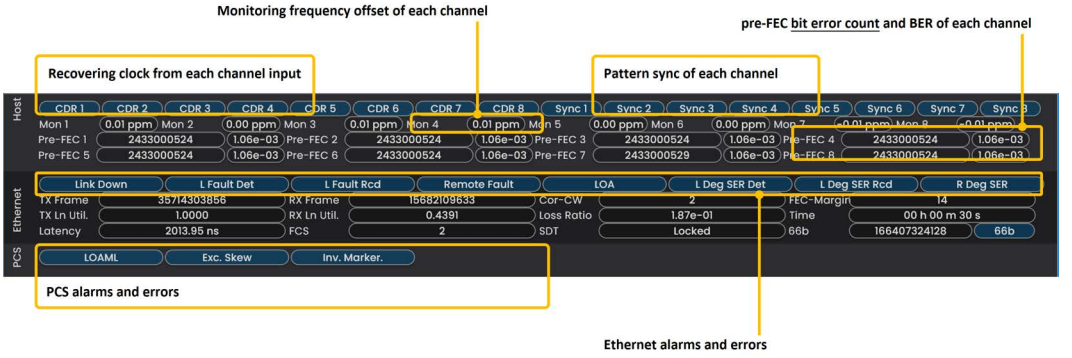
BER Configuration (2/2)



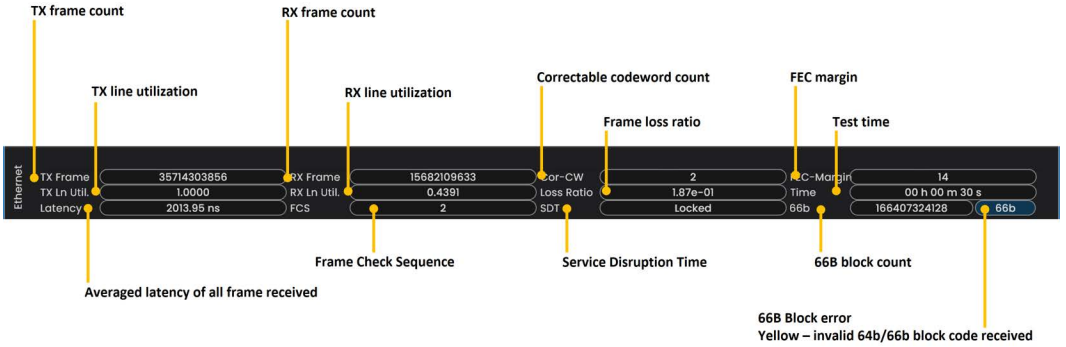
Alarm & Error Area

A

BER Monitor (1/3)



BER Monitor (2/3)



BER Monitor (3/3)

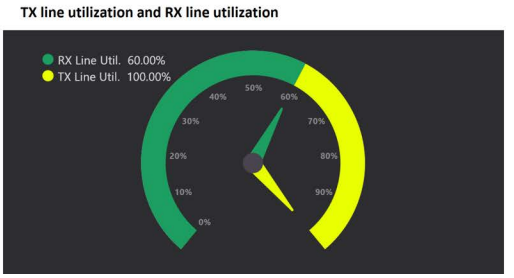
Layer	A/E	Alarm/Error	Note
Physical	A	**CDR**	Recover clock from input | Blue – successfully recover clock | Yellow – fail to recover clock (ex: LOS)
	A	**Sync**	Pattern sync | Blue – successfully lock pattern | Yellow – fail to lock pattern (ex: polarity inverted)
Ethernet	A	**Link Down**	There is a local/remote fault condition.
	A	**L Fault Det**	Local Fault Detected | Loss of bit sync, Loss of Block sync, Link Down, or High BER
	A	**L Fault Rcd**	Local Fault Received | Received data path contains Local Fault signal
	A	**Remote Fault**	Received data path contains Remote Fault status
	A	**LOA**	Loss of Alignment | Alignment of codeword marker not found
	A	**L Deg SER Det**	Local Degraded SER Detected | Local FEC degraded SER condition detected
	A	**L Deg SER Rcd**	Local Degraded SER Received | Local degraded SER signal received
	A	**R Deg SER**	Remote Degraded SER | Remote degraded SER signal detected
	E	**66B**	An invalid 64b/66b block code is received, and declared when synchronization field has a value of 00 or 11.
PCS	A	**LOAML**	Loss of Alignment Marker Lock | In lock mode, four consecutive marker values received do not match the AM that the lane is currently locked to. LOAML is cleared when the PCS lane is declared Lock and two valid AM 16384 blocks (66b) apart are received.
	A	**Exc. Skew**	Excessive Skew | Skew exceeds defined threshold.
	A	**Inv. Marker**	Invalid Marker | There are errors in 66-bit block AM.

Main Area - BER Monitor

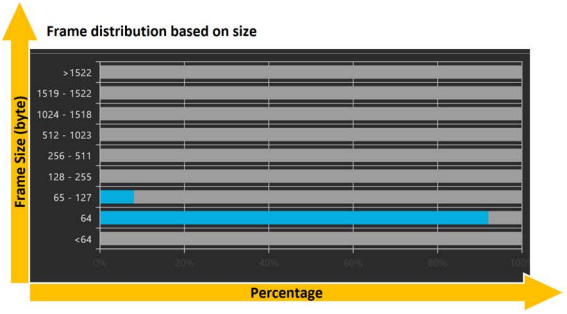
2

a BER Monitor

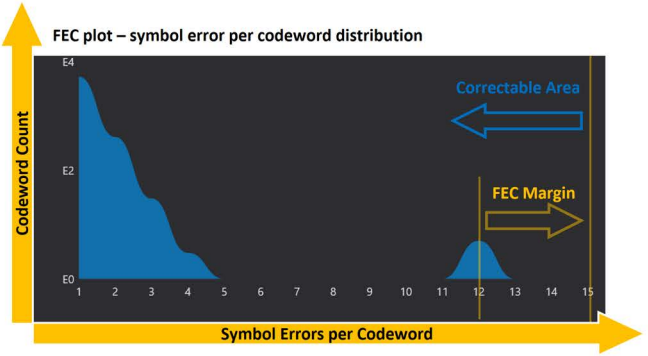
b Line Utilization



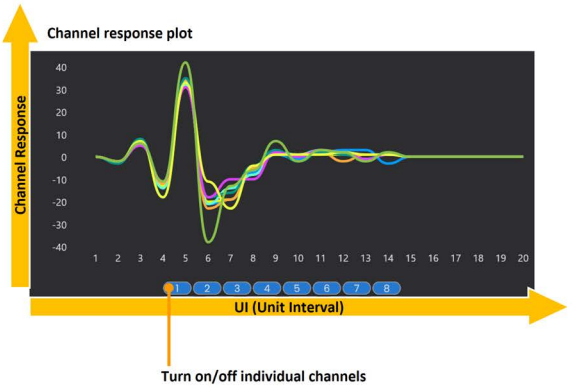
c Frame Distribution



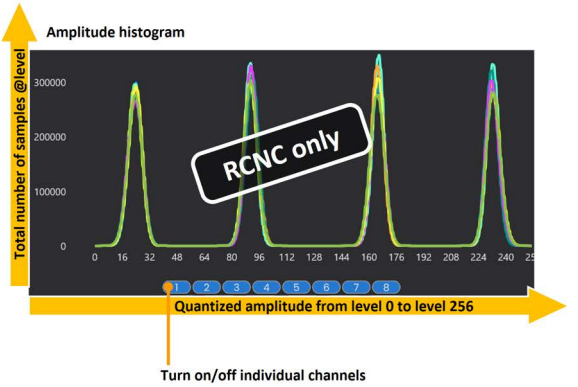
d FEC Margin



e RX Taps



f Histogram

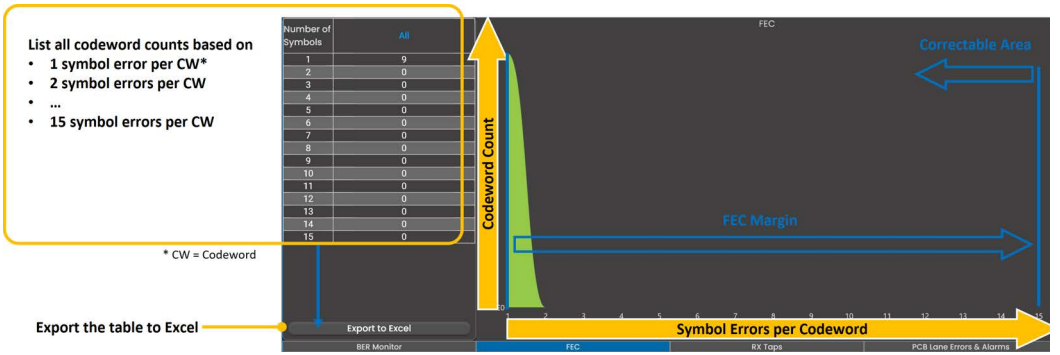


Main Area

2

FEC

The FEC plot of **Symbol Errors per Codeword** vs. **Codeword Count** helps you know the behavior of error distribution by getting a high or low FEC margin. There are symbol errors that are uncorrectable or not.



RX Taps

Intersymbol interference (ISI) affects BER. The less ISI, the better BER.

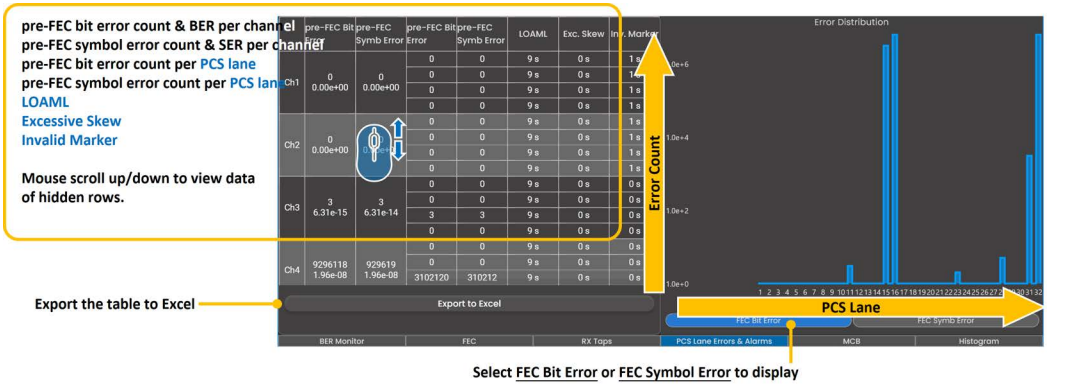
With the **Channel Simulator** function, you can know how serious the ISI of the input signal is. It provides impulse response within 8 pre-cursors, a main cursor, and 23 post-cursors. The 0 % axis is a reference. For all cursors except the main one, the further distance from 0 % axis, the worse signal quality.

The **Channel Simulator** lists all cursor values of 8 channels. Based on the table, users can tune taps of the transmitter to compensate ISI.

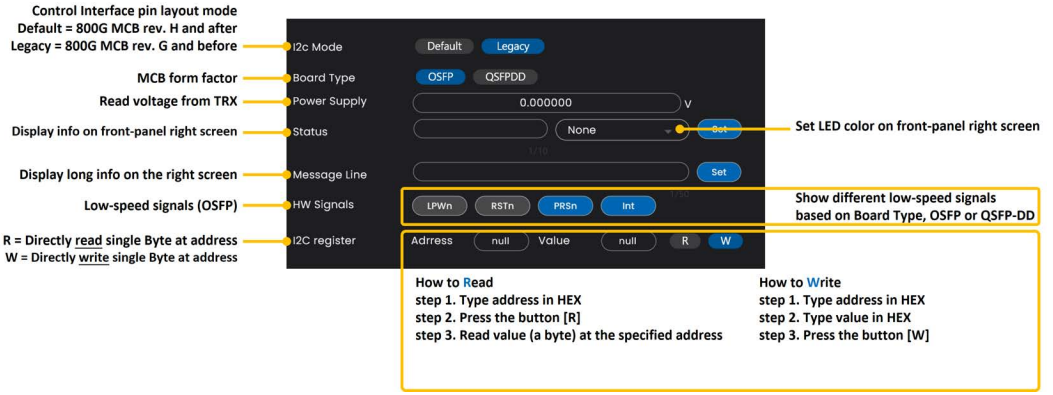
PCS Lane Errors & Alarms

This function displays the channel's bit error count, symbol error count, BER and SER in order to know error information.

It displays the PCS lane's bit error count, symbol error count, and LOAML, Excessive Skew and Invalid Marker values.

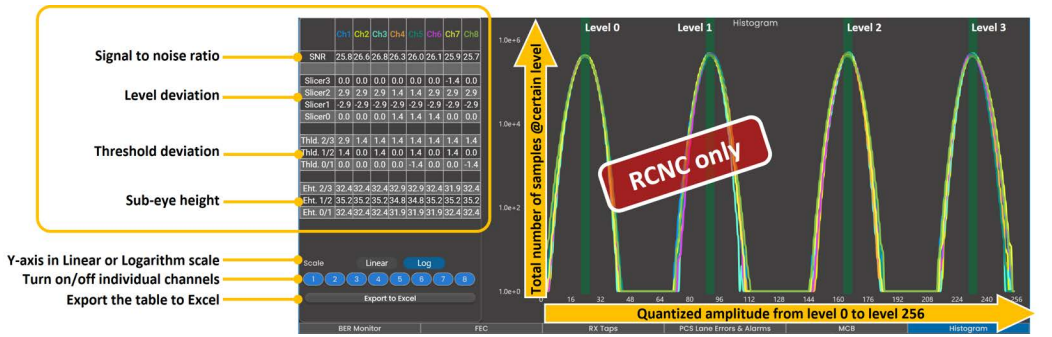


MCB



Histogram

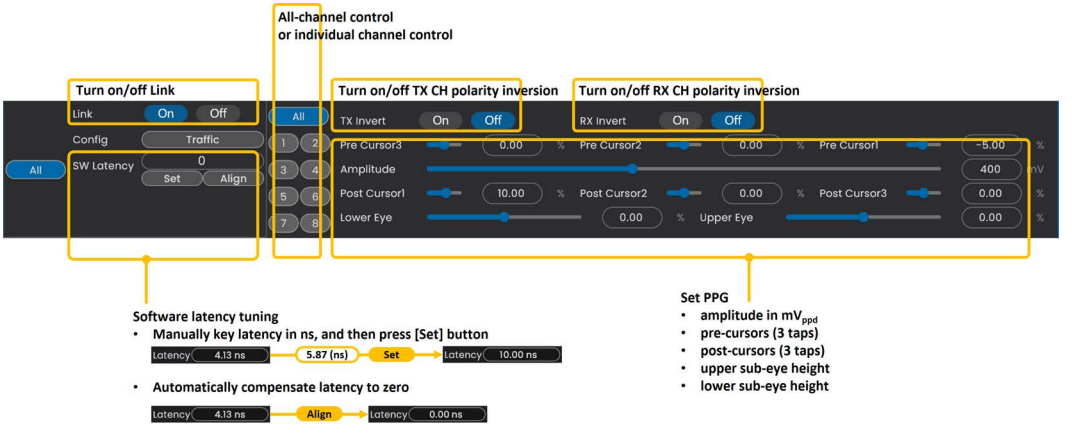
This function displays signal level distribution to get an idea of linearity.



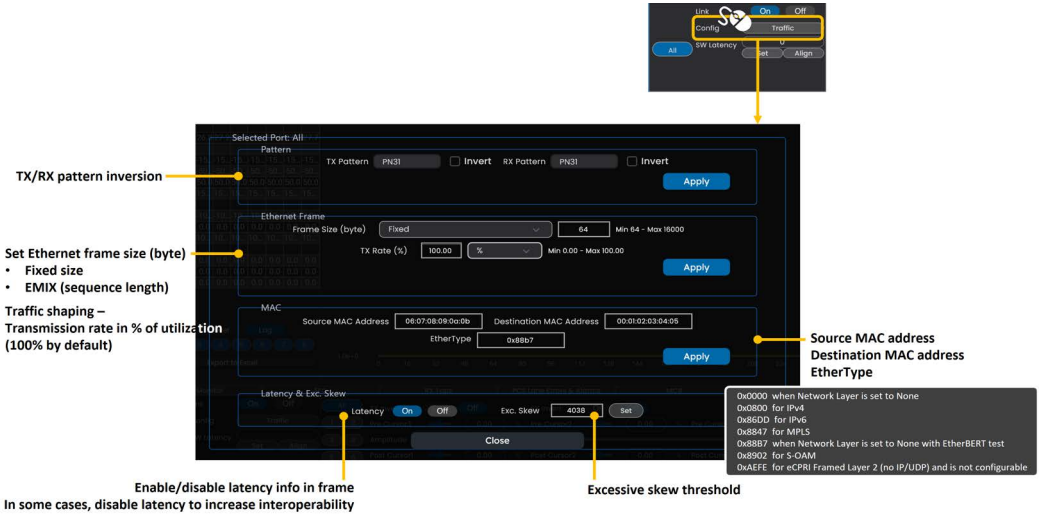
Sub Control Area

3

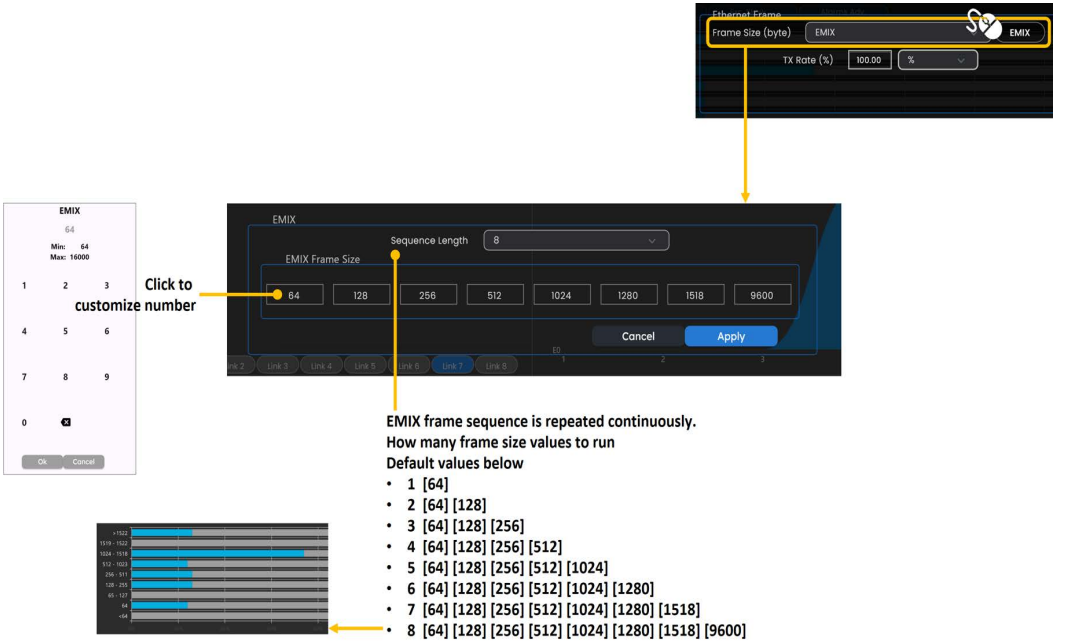
RX/TX Configuration (1/3)



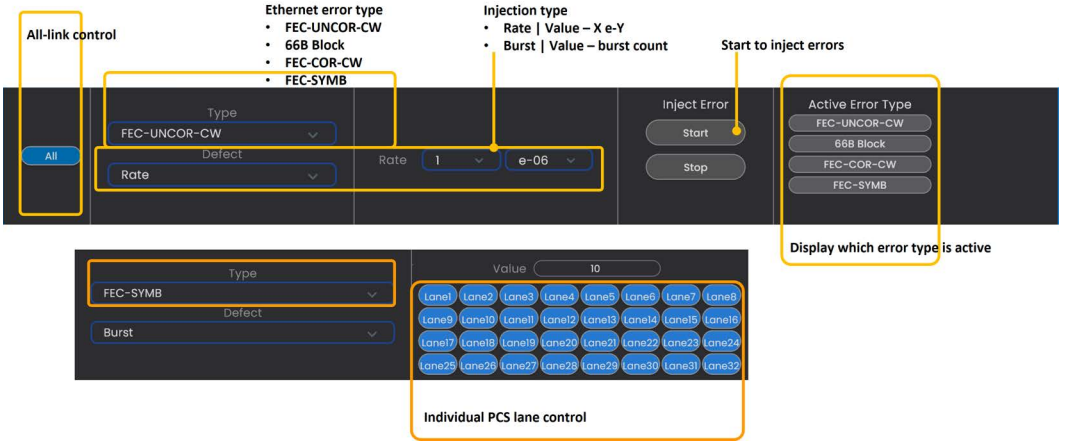
RX/TX Configuration (2/3)



RX/TX Configuration (3/3)

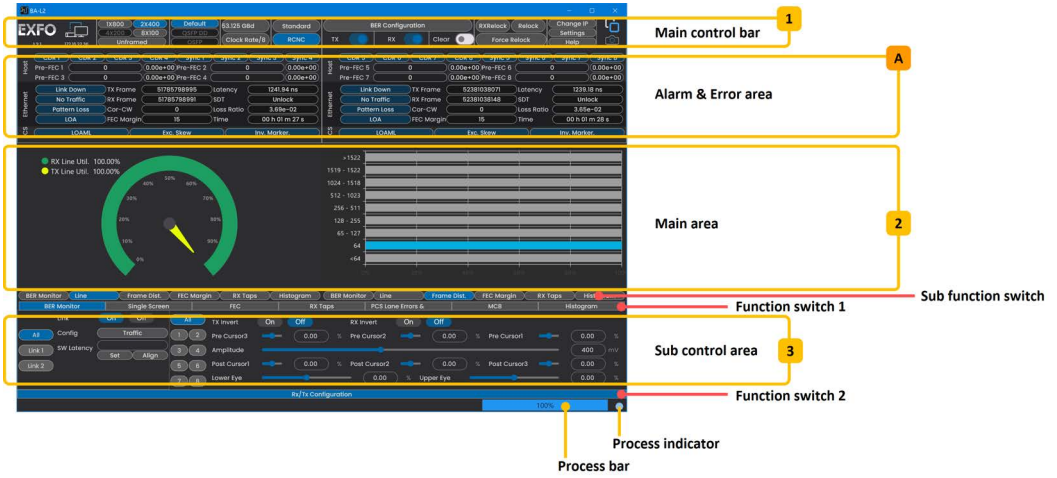


Error Injection

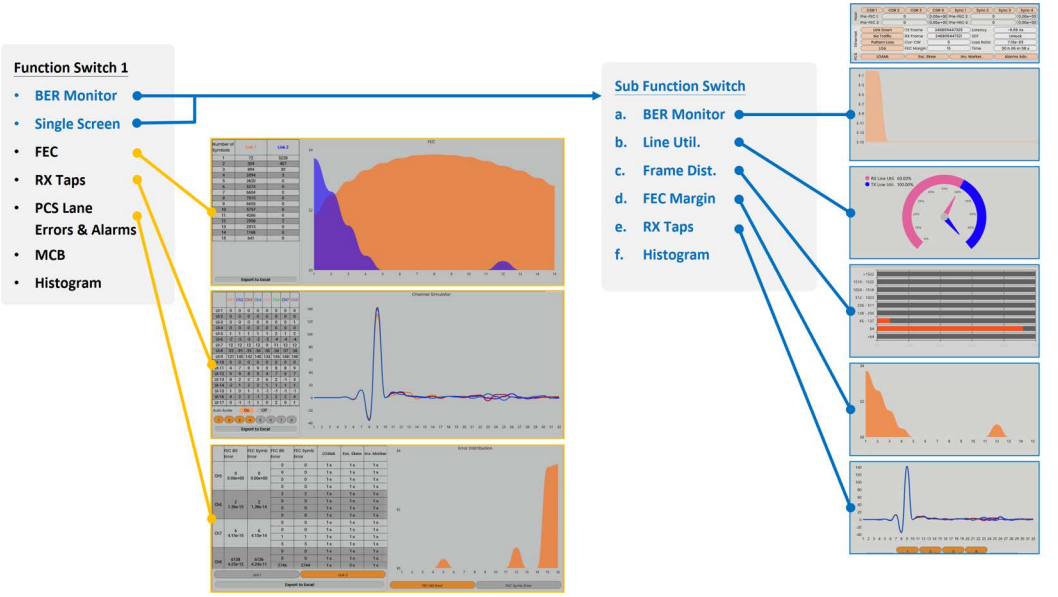


4 2x 400G Mode

GUI Sections

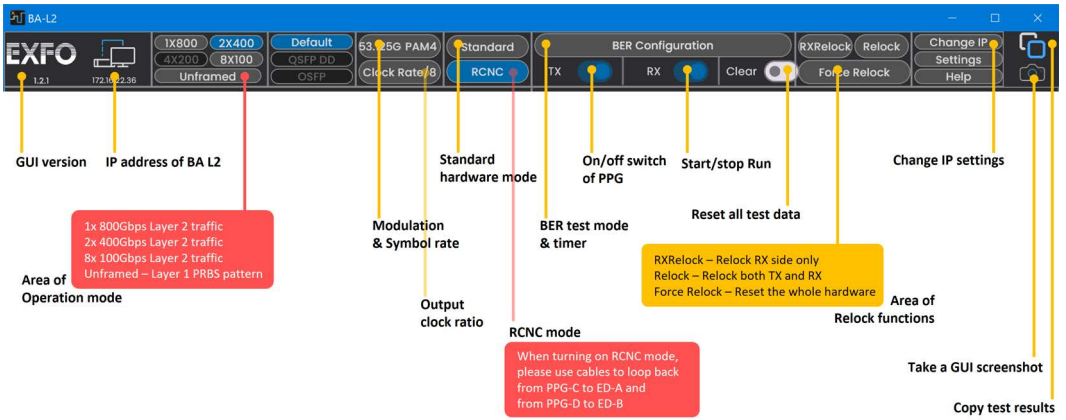


GUI Map

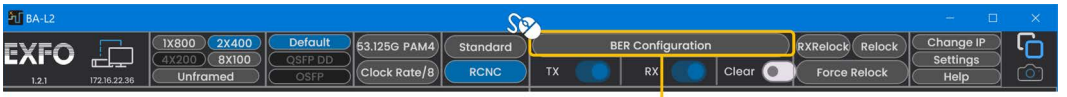

Function Switch 1
BER Monitor
Single Screen
FEC
RX Taps
PCS Lane Errors & Alarms
MCB
Histogram
Sub Function Switch
a. BER Monitor
b. Line Util.
c. Frame Dist.
d. FEC Margin
e. RX Taps
f. Histogram

Main Control Bar

1

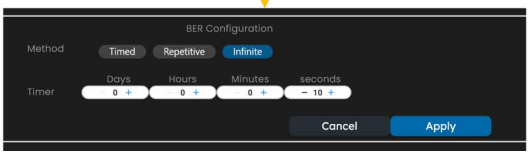


BER Configuration (1/2)



Click **BER Configuration** button and select test method:

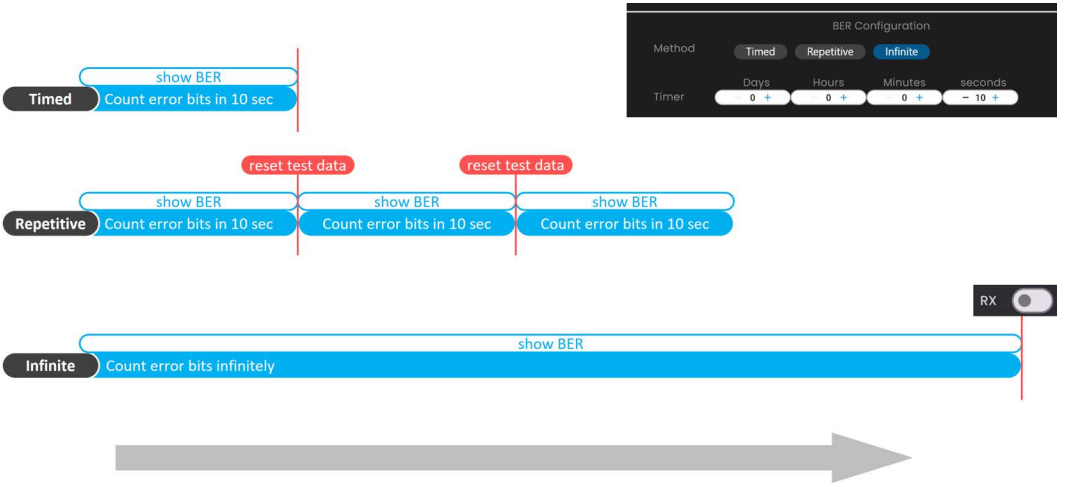
- **Timed**
- **Repetitive**
- **Infinite** (Nonstop until **RX** button is off)



Set **Timer** for **Timed** or **Repetitive** test method:

- **Days**
- **Hours**
- **Minutes**
- **Seconds**

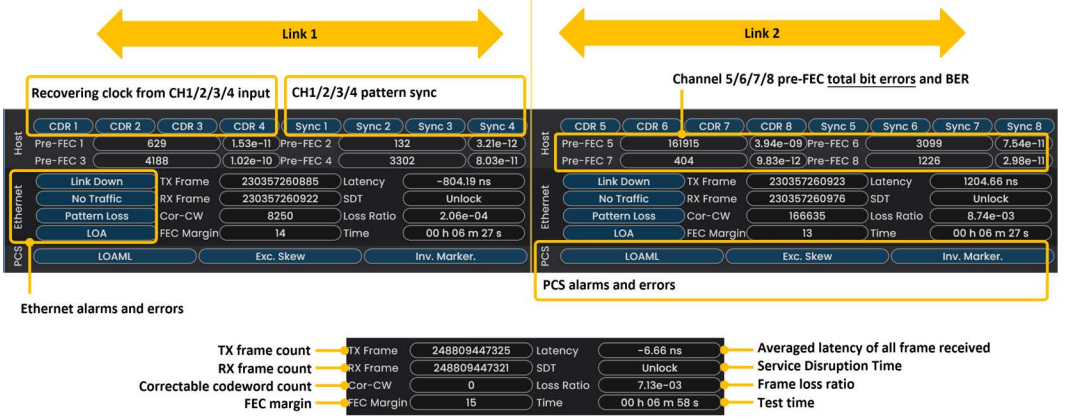
BER Configuration (2/2)



Alarm & Error Area

A

BER Monitor (1/2)



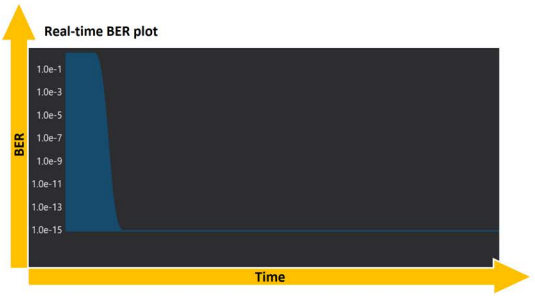
BER Monitor (2/2)

Layer	A/E	Alarm/Error	Note
Physical	A	**CDR**	Recover clock from input | Blue – successfully recover clock | Yellow – fail to recover clock (ex: LOS)
	A	**Sync**	Pattern sync | Blue – successfully lock pattern | Yellow – fail to lock pattern (ex: polarity inverted)
Ethernet	A	**Link Down**	There is a local/remote fault condition.
	A	**No Traffic**	Test is running but no pattern traffic received in the last second.
	A	**Pattern Loss**	>20% bit errors received | Reference sequence unambiguously identified as out of phase | Frame loss
	A	**LOA**	Loss of Alignment | Alignment of codeword marker not found
PCS	A	**LOAML**	Loss of Alignment Marker Lock | In lock mode, four consecutive marker values received do not match the AM that the lane is currently locked to. LOAML is cleared when the PCS lane is declared Lock and two valid AM 16384 blocks (66b) apart are received.
	A	**Exc. Skew**	Excessive Skew | Skew exceeds defined threshold.
	A	**Inv. Marker**	Invalid Marker | There are errors in 66-bit block AM.

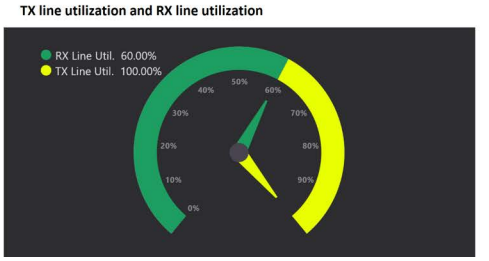
Main Area - BER Monitor

2

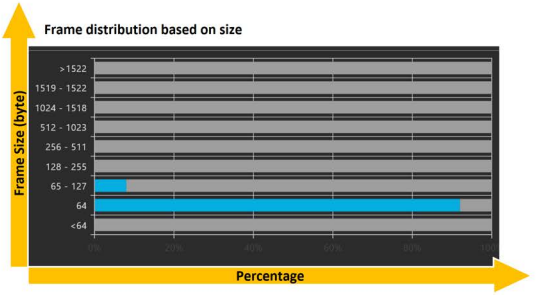
a BER Monitor



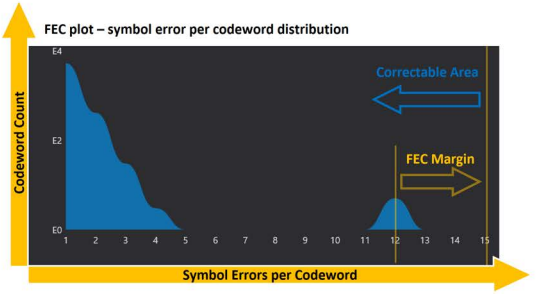
b Line Utilization



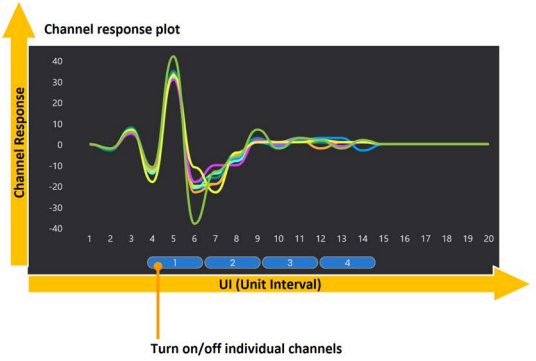
c Frame Distribution



d FEC Margin

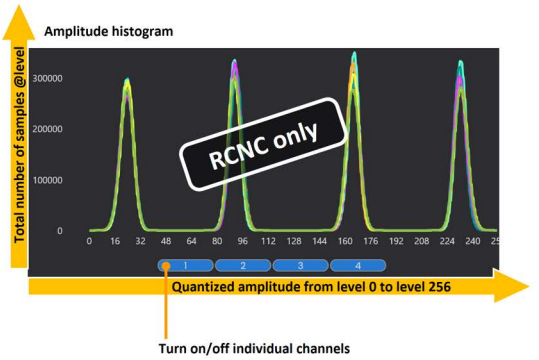


e RX Taps



f Histogram


BER Monitor
Line
Frame Dist.
FEC Margin
RX Taps
Histogram
BER Monitor
Line
Frame Dist.
FEC Margin
RX Taps
Histogram
BER Monitor
Single Screen
FEC
RX Taps
PCS Lane Errors &
MCB
Histogram

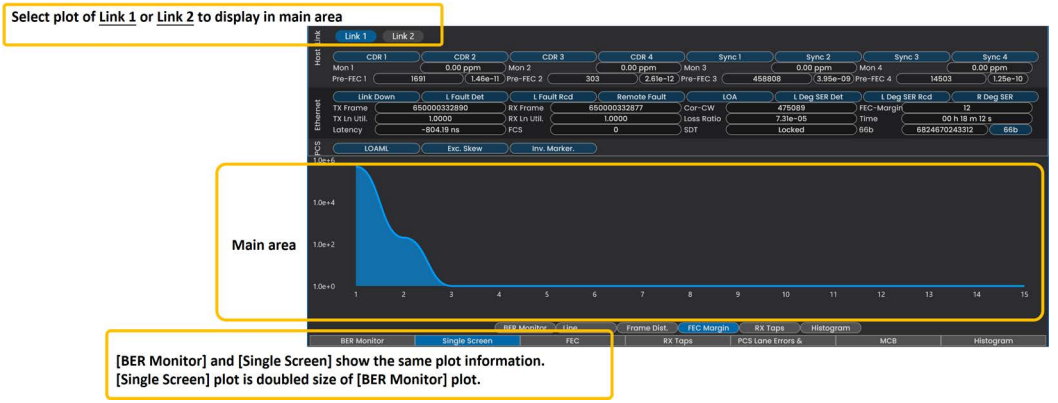

Amplitude histogram
Total number of samples @level
300000
200000
100000
0
0 16 32 48 64 80 96 112 128 144 160 176 192 208 224 240
RCNC only
1
2
3
4
Quantized amplitude from level 0 to level 256
Turn on/off individual channels

Main Area

2

Single Screen

BER Monitor and **Single Screen** display the same plot information. **Single Screen** plot is double in size of **BER Monitor** plot.



FEC

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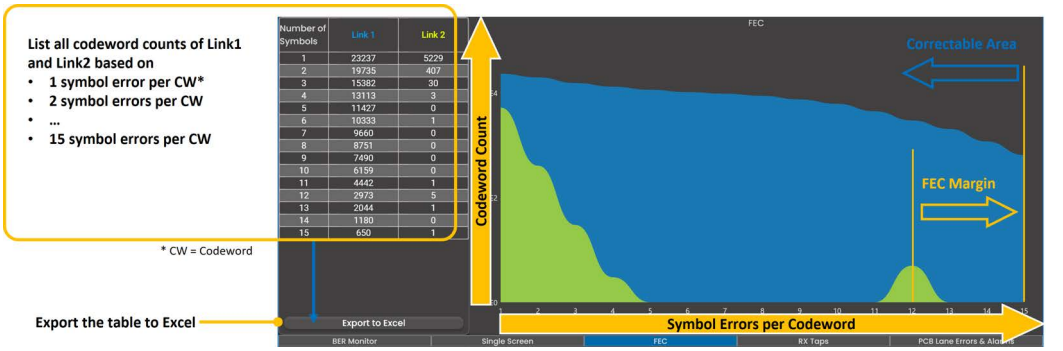

RX Taps

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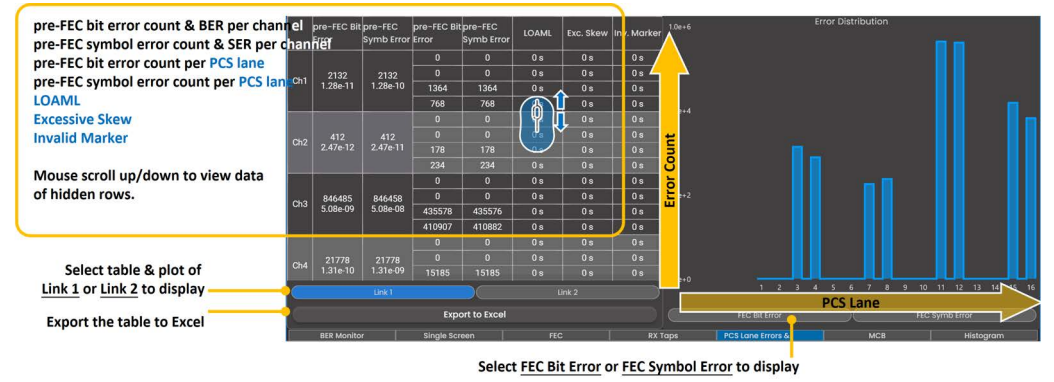
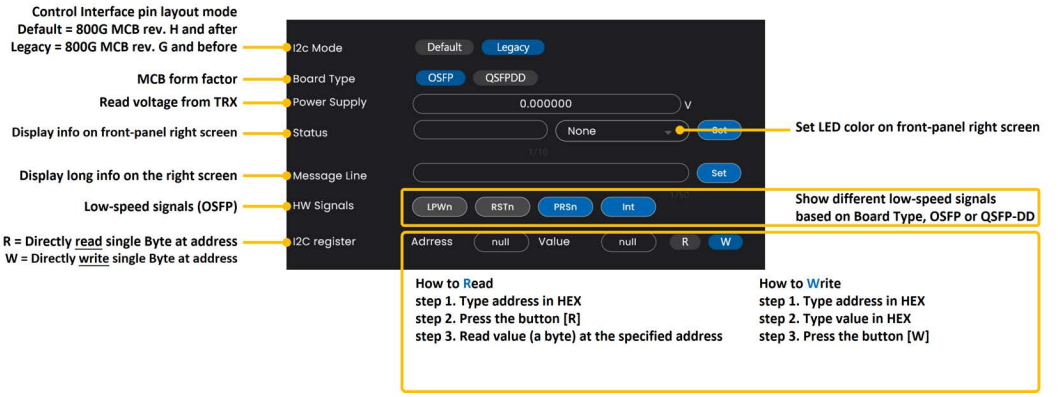
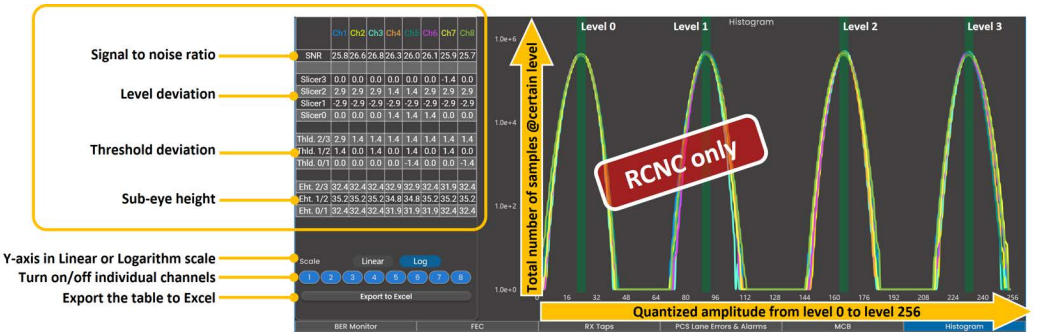


MCB



Histogram

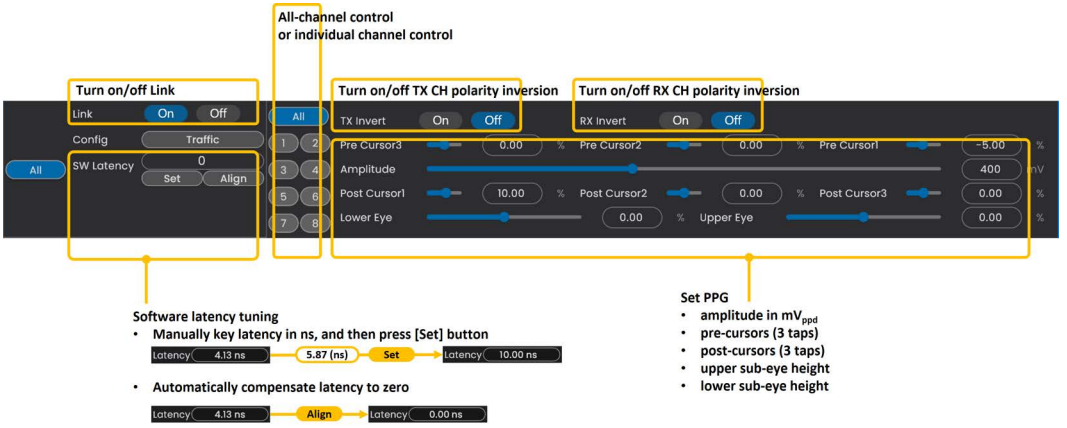
This function displays signal level distribution to get an idea of linearity.



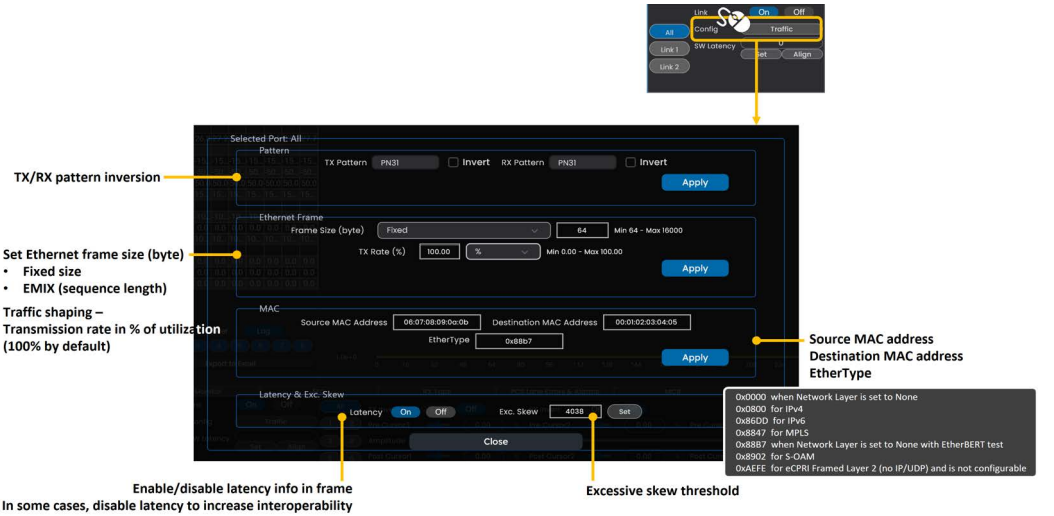
Sub Control Area

3

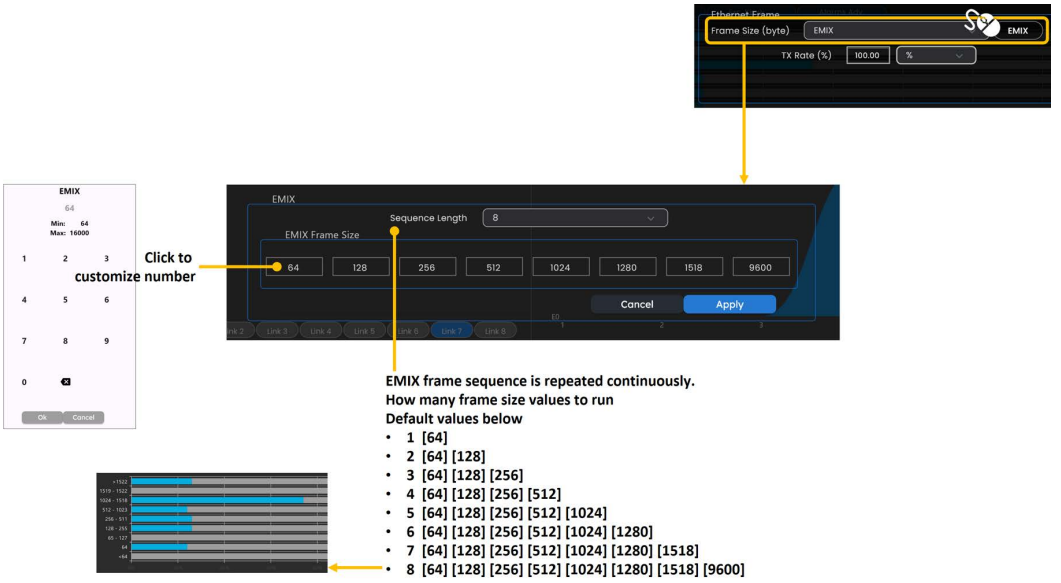
RX/TX Configuration (1/3)



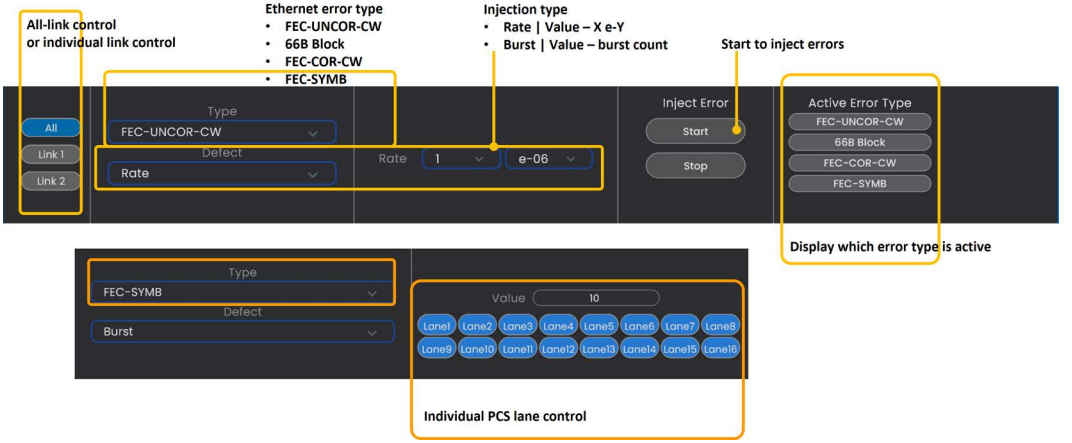
RX/TX Configuration (2/3)



RX/TX Configuration (3/3)

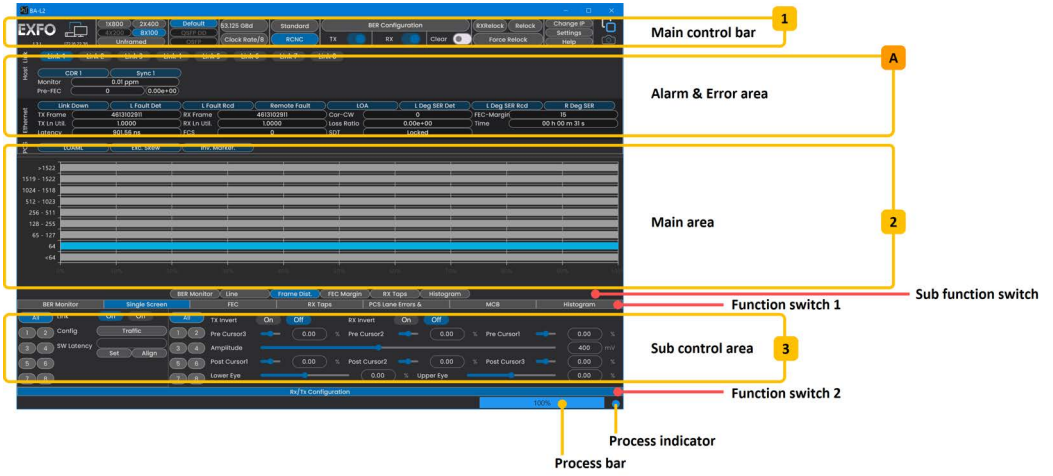


Error Injection

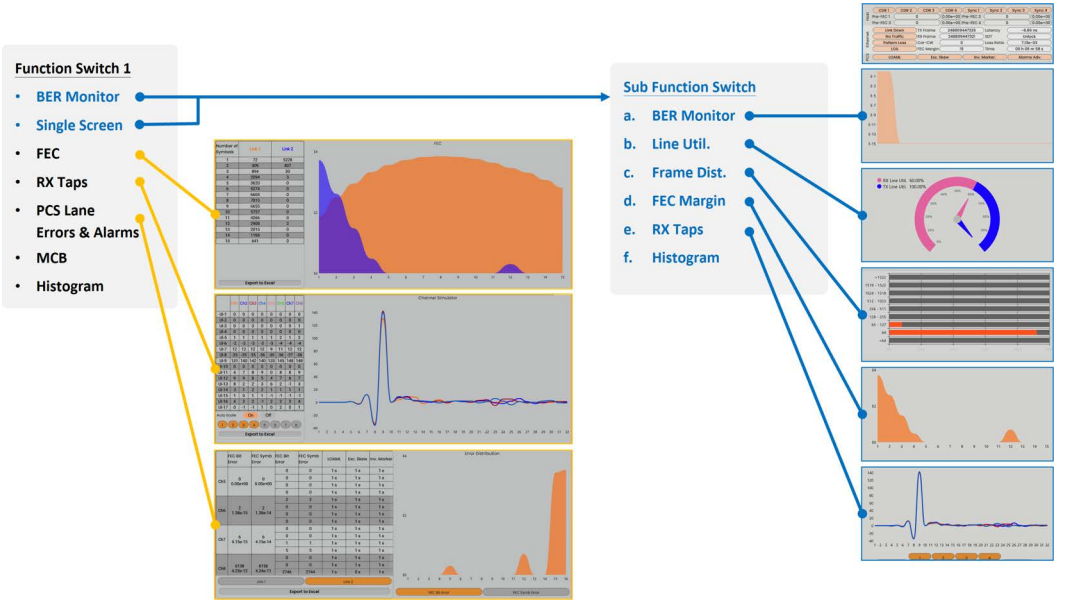


5 8x 100G Mode

GUI Sections

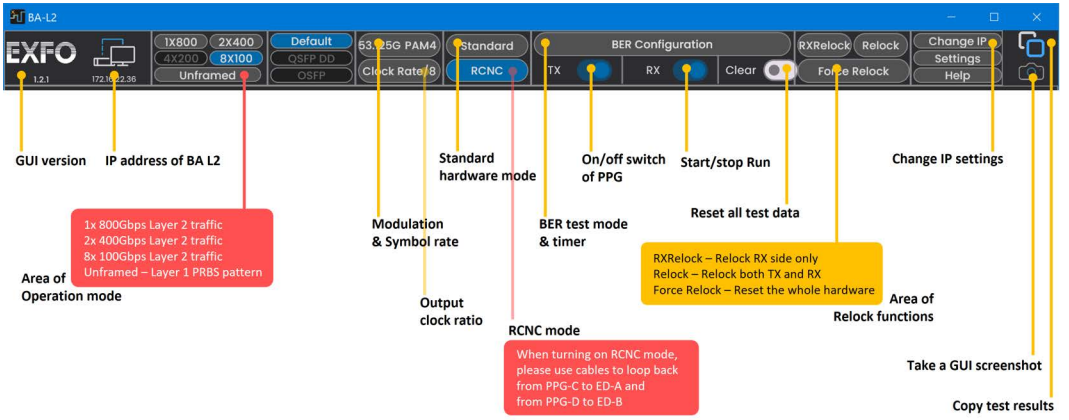


GUI Map


Function Switch 1
BER Monitor
Single Screen
FEC
RX Taps
PCS Lane Errors & Alarms
MCB
Histogram
Sub Function Switch
a. BER Monitor
b. Line Util.
c. Frame Dist.
d. FEC Margin
e. RX Taps
f. Histogram

Main Control Bar

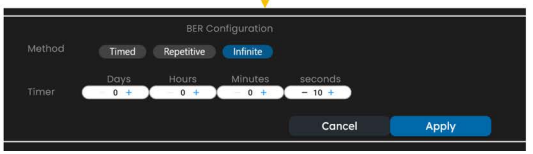
1



BER Configuration (1/2)

Click **BER Configuration** button and select test method:

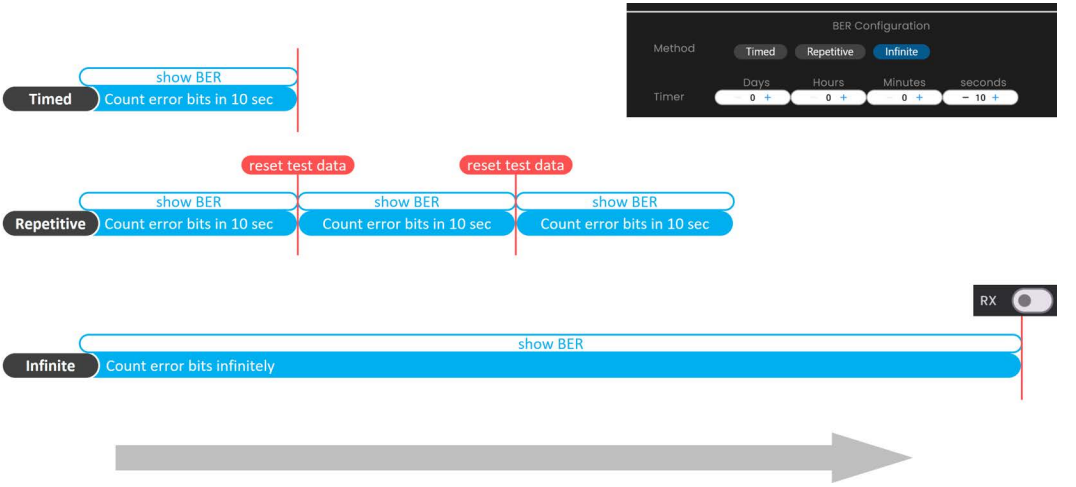
- **Timed**
- **Repetitive**
- **Infinite** (Nonstop until **RX** button is off)



Set **Timer** for **Timed** or **Repetitive** test method:

- **Days**
- **Hours**
- **Minutes**
- **Seconds**

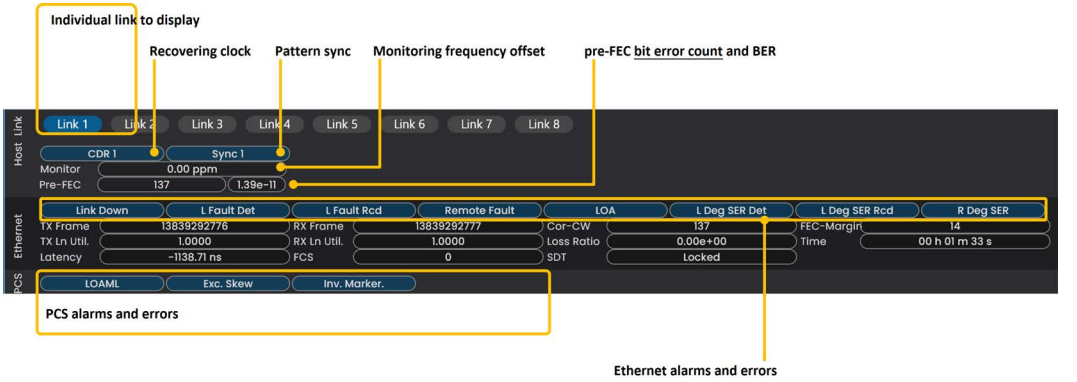
BER Configuration (2/2)



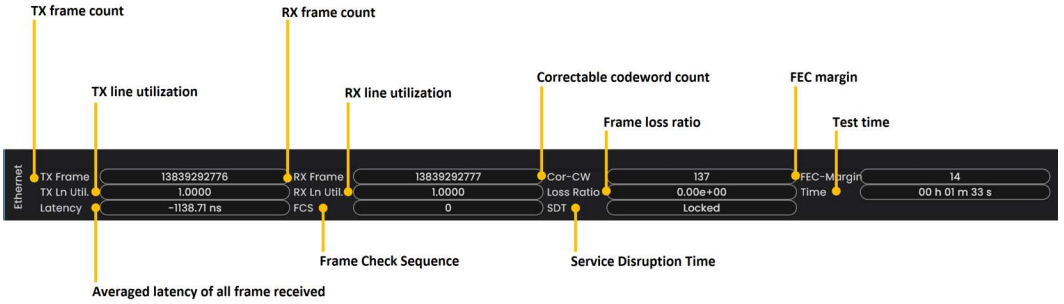
Alarm & Error Area

A

Single Screen (1/3)



Single Screen (2/3)



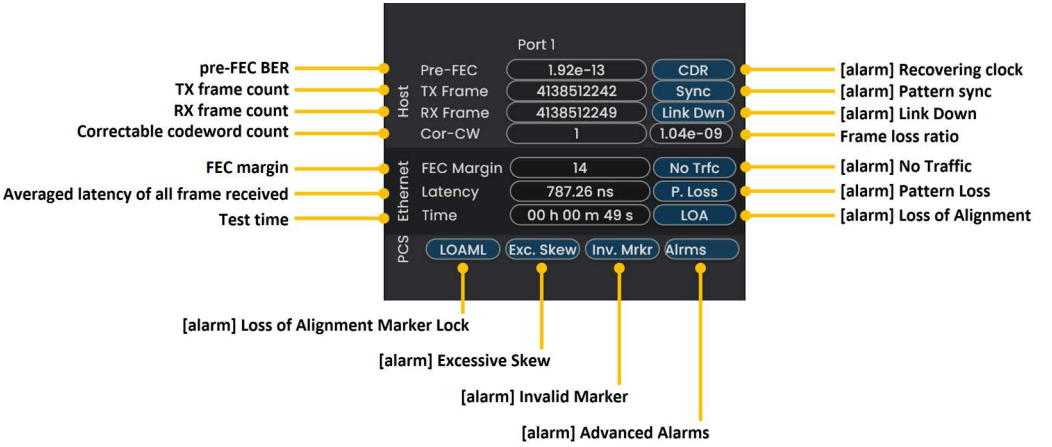
Single Screen (3/3)

Layer	A/E	Alarm/Error	Note
Physical	A	**CDR**	Recover clock from input | Blue – successfully recover clock | Yellow – fail to recover clock (ex: LOS)
	A	**Sync**	Pattern sync | Blue – successfully lock pattern | Yellow – fail to lock pattern (ex: polarity inverted)
Ethernet	A	**Link Down**	There is a local/remote fault condition.
	A	**L Fault Det**	Local Fault Detected | Loss of bit sync, Loss of Block sync, Link Down, or High BER
	A	**L Fault Rcd**	Local Fault Received | Received data path contains Local Fault signal
	A	**Remote Fault**	Received data path contains Remote Fault status
	A	**LOA**	Loss of Alignment | Alignment of codeword marker not found
	A	**L Deg SER Det**	Local Degraded SER Detected | Local FEC degraded SER condition detected
	A	**L Deg SER Rcd**	Local Degraded SER Received | Local degraded SER signal received
	A	**R Deg SER**	Remote Degraded SER | Remote degraded SER signal detected
PCS	A	**LOAML**	Loss of Alignment Marker Lock | In lock mode, four consecutive marker values received do not match the AM that the lane is currently locked to. LOAML is cleared when the PCS lane is declared Lock and two valid AM 16384 blocks (66b) apart are received.
	A	**Exc. Skew**	Excessive Skew | Skew exceeds defined threshold.
	A	**Inv. Marker**	Invalid Marker | There are errors in 66-bit block AM.

Main Area

2

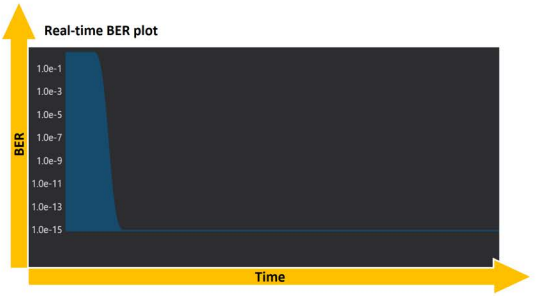
BER Monitor (1/2)



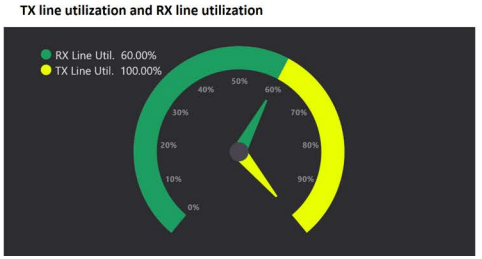
BER Monitor (2/2)

Layer	A/E	Alarm/Error	Note
Physical	A	**CDR**	Recover clock from input | Blue – successfully recover clock | Yellow – fail to recover clock (ex: LOS)
	A	**Sync**	Pattern sync | Blue – successfully lock pattern | Yellow – fail to lock pattern (ex: polarity inverted)
Ethernet	A	**Link Down**	There is a local/remote fault condition.
	A	**No Traffic**	Test is running but no pattern traffic received in the last second.
	A	**Pattern Loss**	>20% bit errors received | Reference sequence unambiguously identified as out of phase | Frame loss
	A	**LOA**	Loss of Alignment | Alignment of codeword marker not found
PCS	A	**LOAML**	Loss of Alignment Marker Lock | In lock mode, four consecutive marker values received do not match the AM that the lane is currently locked to. LOAML is cleared when the PCS lane is declared Lock and two valid AM 16384 blocks (66b) apart are received.
	A	**Exc. Skew**	Excessive Skew | Skew exceeds defined threshold.
	A	**Inv. Marker**	Invalid Marker | There are errors in 66-bit block AM.
	A	**Alarms Adv.**	Advanced Alarms

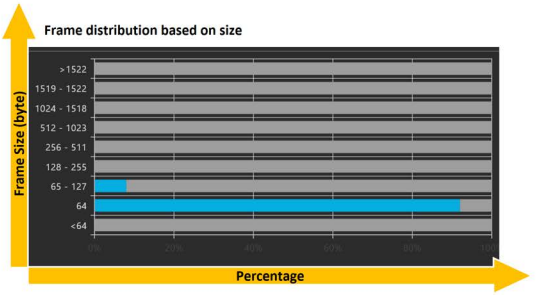
a Single Screen - BER Monitor



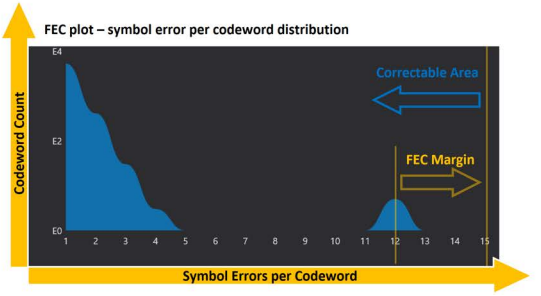
b Single Screen - Line Utilization



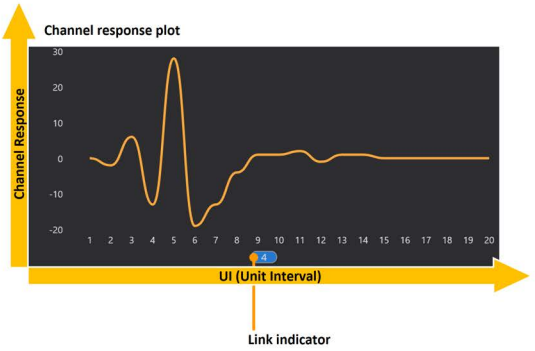
c Single Screen - Frame Distribution



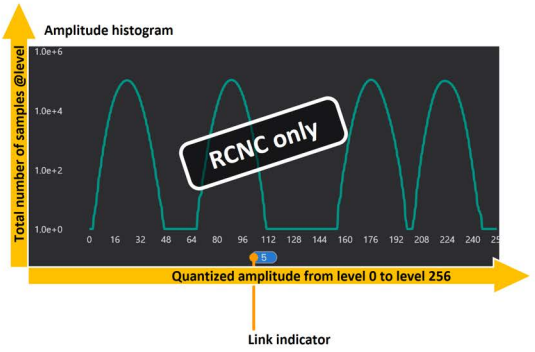
d Single Screen - FEC Margin



e Single Screen - RX Taps

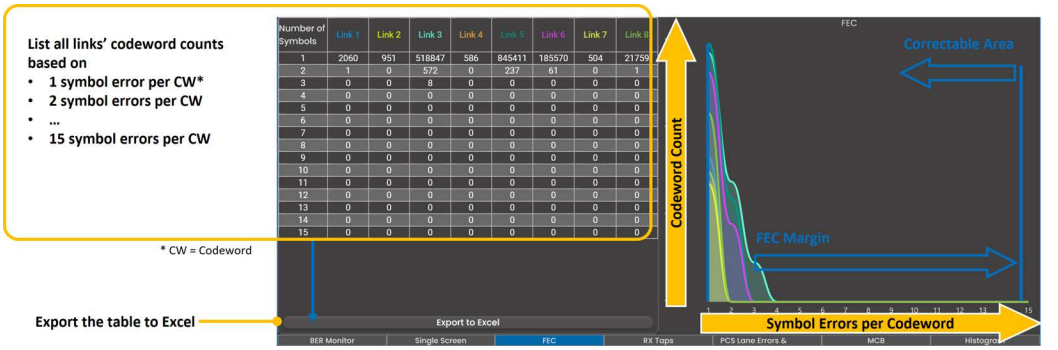


f Single Screen - Histogram (RNC Only)



FEC

The FEC plot of **Symbol Errors per Codeword** vs. **Codeword Count** helps you know the behavior of error distribution by getting a high or low FEC margin. There are symbol errors that are uncorrectable or not.



RX Taps

Intersymbol interference (ISI) affects BER. The less ISI, the better BER.

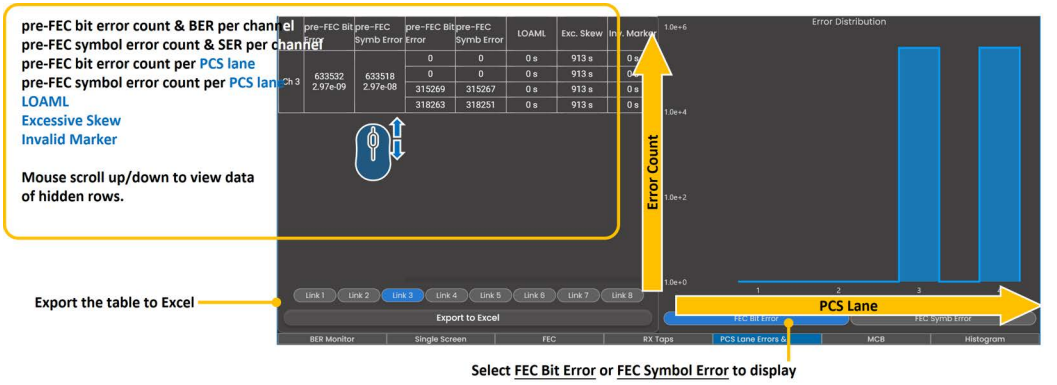
With the **Channel Simulator** function, you can know how serious the ISI of the input signal is. It provides impulse response within 8 pre-cursors, a main cursor, and 23 post-cursors. The 0 % axis is a reference. For all cursors except the main one, the further distance from 0 % axis, the worse signal quality.

The **Channel Simulator** lists all cursor values of 8 channels. Based on the table, users can tune taps of the transmitter to compensate ISI.

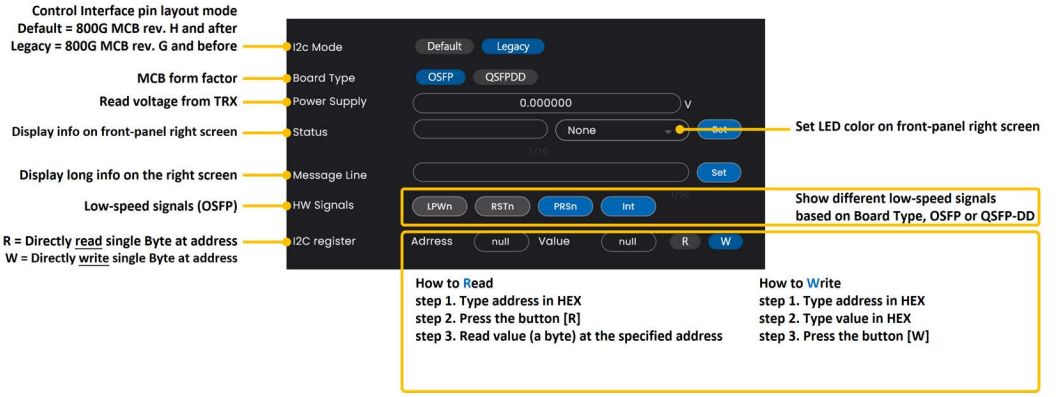
PCS Lane Errors & Alarms

This function displays the channel's bit error count, symbol error count, BER and SER in order to know error information.

It displays the PCS lane's bit error count, symbol error count, and LOAML, Excessive Skew and Invalid Marker values.

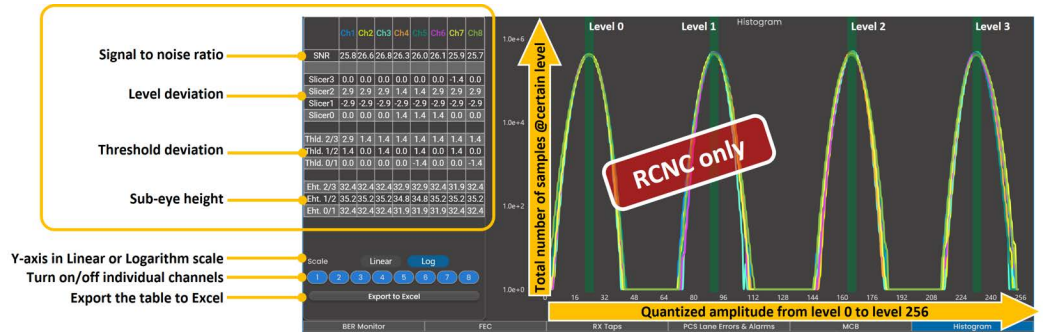


MCB



Histogram

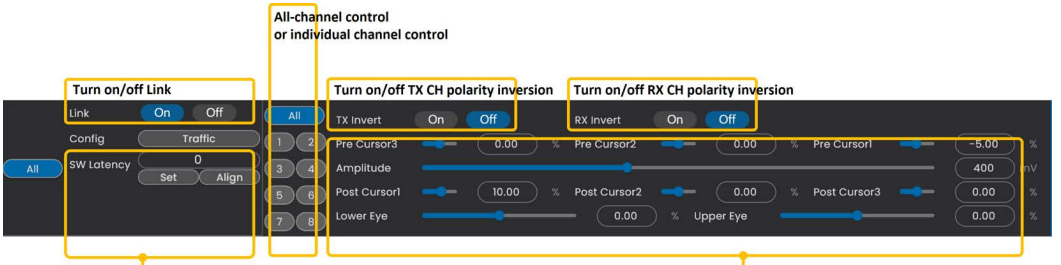
This function displays signal level distribution to get an idea of linearity.



Sub Control Area

3

RX/TX Configuration (1/3)



Software latency tuning

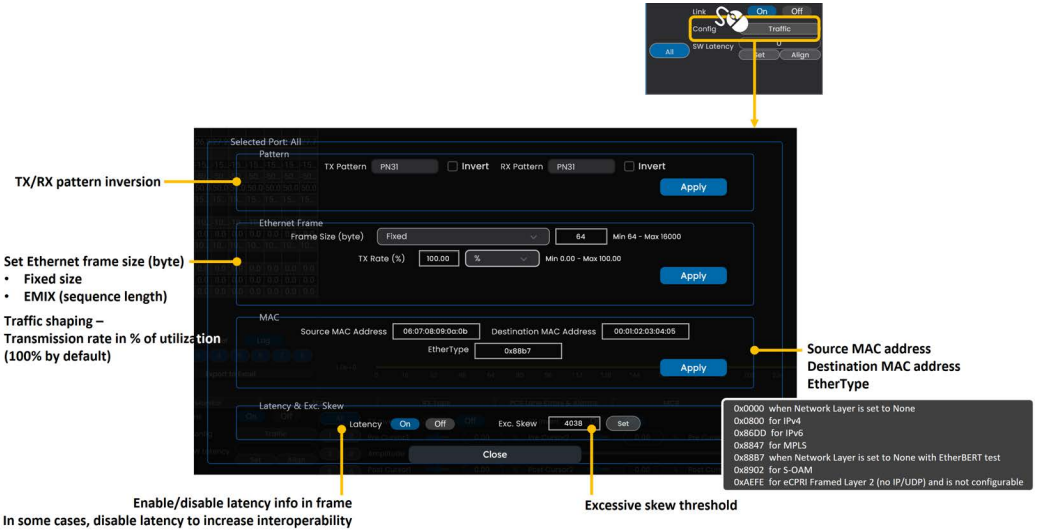
- **Manually key latency in ns, and then press [Set] button**

- **Automatically compensate latency to zero**

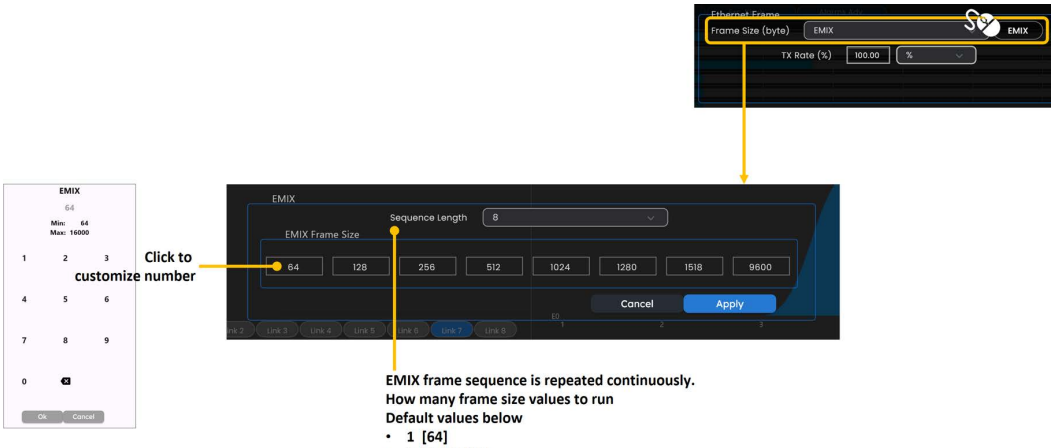
Set PPG

- **amplitude in mV_{ppd}**
- **pre-cursors (3 taps)**
- **post-cursors (3 taps)**
- **upper sub-eye height**
- **lower sub-eye height**

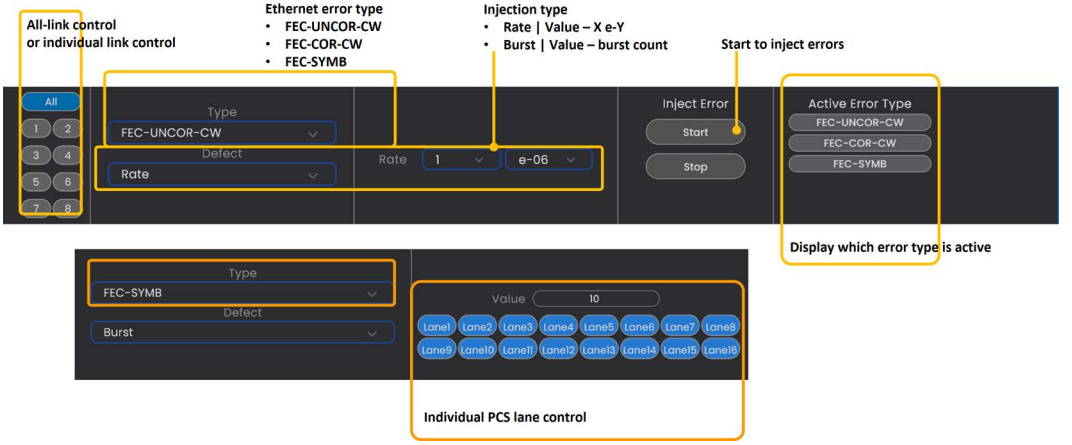
RX/TX Configuration (2/3)



RX/TX Configuration (3/3)



Error Injection

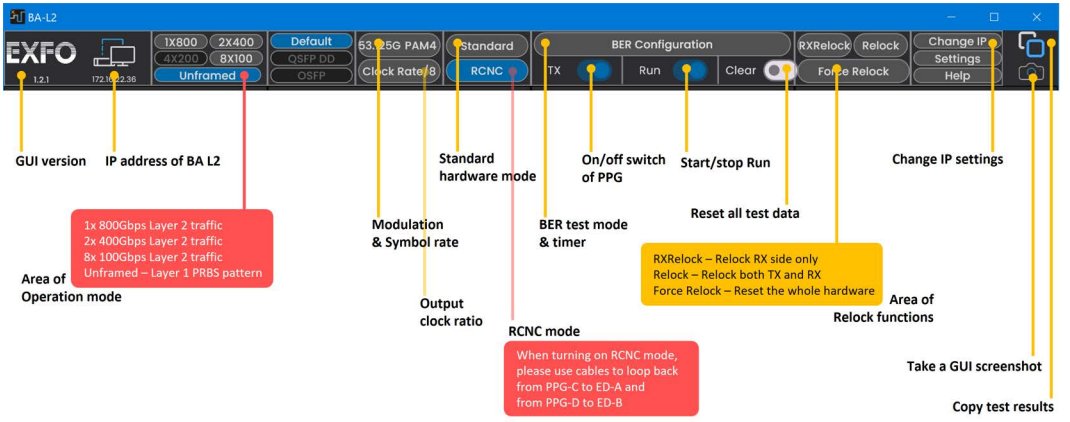


6 Unframed Mode

GUI Sections

Main Control Bar

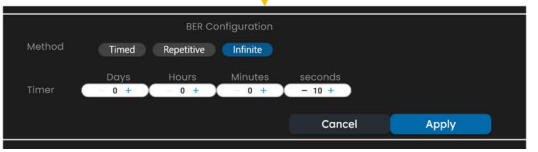
1



BER Configuration (1/2)

Click **BER Configuration** button and select test method:

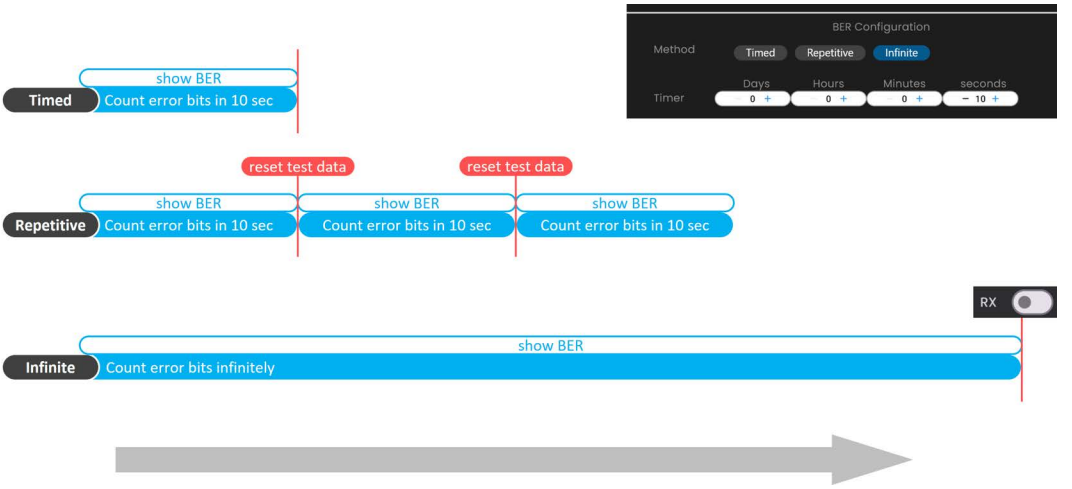
- **Timed**
- **Repetitive**
- **Infinite** (Nonstop until **RX** button is off)



Set **Timer** for **Timed** or **Repetitive** test method:

- **Days**
- **Hours**
- **Minutes**
- **Seconds**

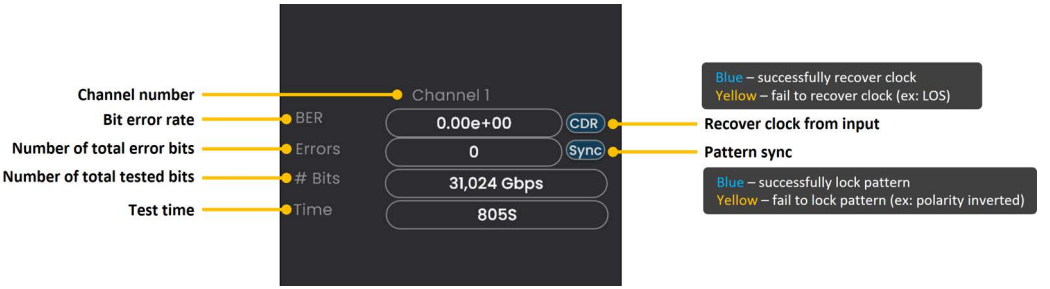
BER Configuration (2/2)



Main Area

2

BER Monitor



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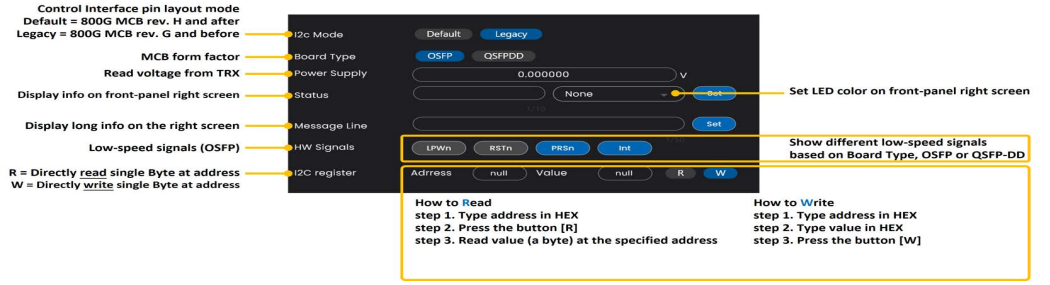
MCB



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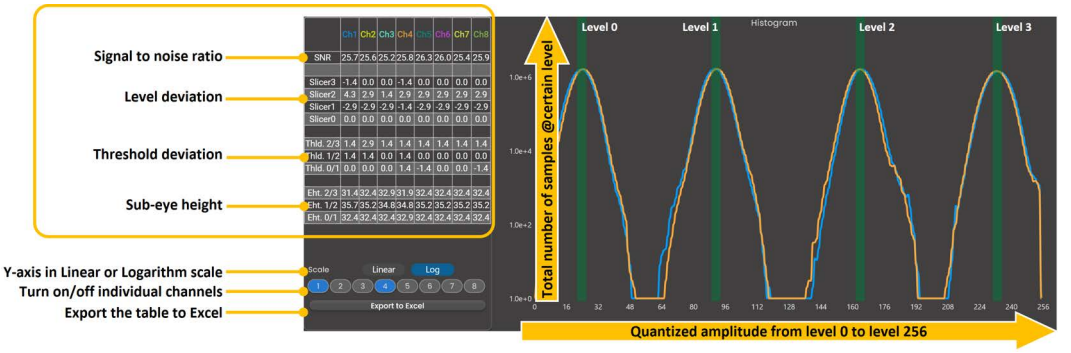
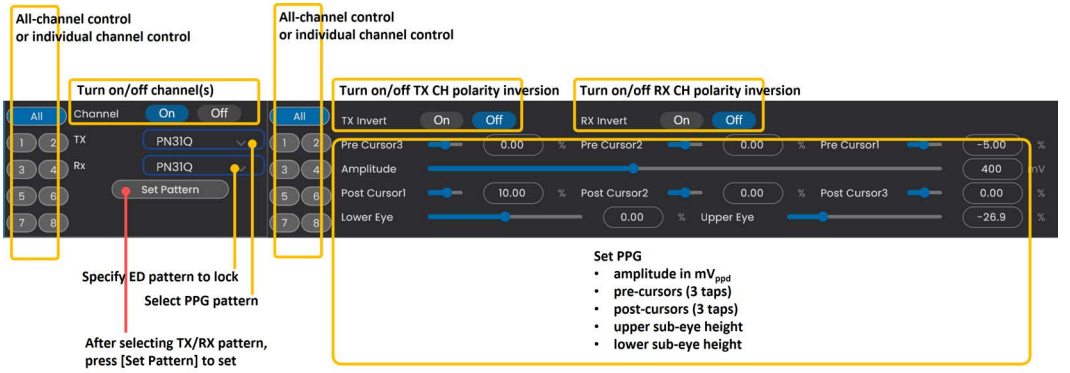


Sub Control Area

3

RX/TX Configuration



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P/N: 2.0.0.1

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Printed in Canada (2025-07)