multiLane

DATASHEET

Innovation for the next generation

ML4079EN

8 Channel | 61 GBd PAM4 & NRZ | 800G BERT | IEEE802.3ck Stress Testing Features | Real HW FEC

8 x 61 GBd NRZ/PAM4 BERT | SSPRQ, PRBS13Q & PRBS31Q | TX and RX Equalizers | Real FEC analysis| Jitter and Random Noise injection | Shallow Loopback Testing | Real HW FEC

Summary

The move to 8x112 Gbps/lane has brought previously marginal aspect of testing to the fore. The 800G generation sees devices that are more sensitive to signal disruption in the form of jitter and noise than ever before. Stress testing device resilience to jitter and noise to glean an understanding not only of failure points, but the degree to which they can withstand increased disruptions is becoming an increasingly integral part of the testing process.

The ML4079EN is an 800G BERT tailored to meet these new considerations. This BERT supports 8x100 Gbps fiber technology, real hardware FEC encoding/decoding with idle ethernet traffic, signal to noise ratio (SNR) and histogram measurements, also allowing users to implement flexible transmitter and receiver equalization.

Crucially, the ML4079EN also features a suite of jitter and noise injection capabilities not only ensuring designs can pass the performance specifications outlined in IEEE802.3-2018 but highlighting how much these specifications can be exceeded; an ideal solution for stringent Engineering Validation Test (EVT) and Design Validation Test (DVT) cycles.

The ML4079EN runs on the flagship Multilane ThunderBERT GUI, providing a comprehensive picture of every aspect of DUT performance.

ML4079EN

8 x 61 GBaud PAM4 BERT

Introduction

The ML4079EN is a fully featured 800G BERT that can be configured for eight channels of 18.5-29 and 37-61 G PAM4 or NRZ.

The transmitters support all standard test patterns mandated by IEEE802.3ck stress testing and OIF such as PRBS13Q, SSPRQ, PRBS31Q, etc. Tx can also be programed to output a user-defined pattern.

The ML4079EN supports transmitter and receiver equalization to overcome signal integrity impairments due to channel losses or reflections.

The ML4079EN supports Real Hardware FEC, with the following FEC modes:

- 400G line KP4
- 100G line KP1
- 100G line KR1

Once the FEC is enabled, the user will be able to see the post-FEC BER which indicates the bit error rate after enabling FEC and the number of errored bits being corrected in real time.

Additionally, users can opt to programmatically add an ISI channel equivalent to a frequency-dependent attenuator with 1 to 9 dB loss at Nyquist.

The ML4079EN is specifically designed to inject jitter and crosstalk noise (interference) into its signal generation. This capability is uniquely fully integrated into the BERT and does not require any external equipment.

Key Features

Transmit

- Data Rates: 20-29 & 36-61 GBaud (112 Gbps)
- Ability to tune the bit rate in steps of 100 kbps and find the RX PLL locking margin
- Independent control of inner eye levels
- Up to 1.2 Vppd output swing at high rates and up to 1.8 Vppd at low rates
- Supports Gray coding
- Error injection
- 3-tap Pre- and Post-emphasis or 7-tap linear FFE
- Real hardware FEC. SER and FEC measurements and margin available on channels individually as well as on 100G, 400G blocks
- Available patterns:
    - PRBS7/9/11/13/15/16/23/31/58
    - PRBS13Q, PRBS31Q
    - SSPRQ
    - Square wave
- Burst and random noise injection
- Jitter Injection in both FM and PM Mode and different jitter injection types: Sinusoidal Jitter (SJ), Random Jitter (RJ), and Bounded Uncorrelated Jitter (BUJ)
- Jitter and Interference tolerance and marginal automated testing following IEEE 802.3ck

Receive

- SNR monitoring over time
- Rx Polarity Inversion
- PAM histogram monitor
- Error-detection on following patterns:
    - PRBS 7/9/11/15/16/23/31
    - PRBS13Q and PRBS31Q
- Automatic pattern detection
- LOS indicators
- Rx Equalizers:
    - DFE: Decision Feedback Equalizer
    - RC: Reflection Canceller
    - MPICAN: Multipath Interference Canceller

General

- LabView driver and Python wrapper available.
- Shallow Loopback testing
- API libraries with documentation.

Target Applications

- Testing of copper and fiber-optic transmission lines
- Functional and SI testing of transceivers
- Characterization and Stress testing of LPO
- Receiver stress testing of hosts and pluggable (jitter & interference)

Using ThunderBERT GUI, both instant and accumulated BER, FEC and SER measurements can be displayed and monitored:

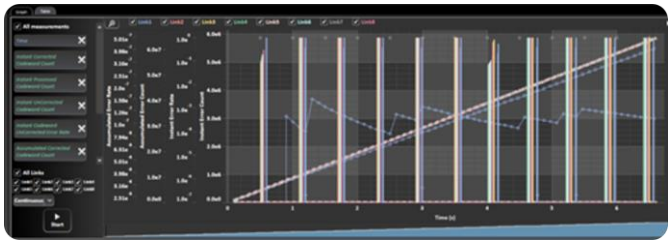


Figure 3: ThunderBERT GUI Screenshots Showing BER Measurements

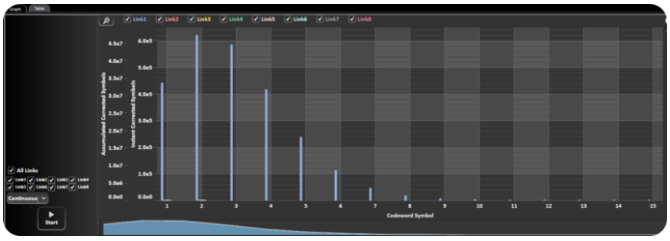


Figure 4: ThunderBERT GUI Screenshots Showing SER Measurements

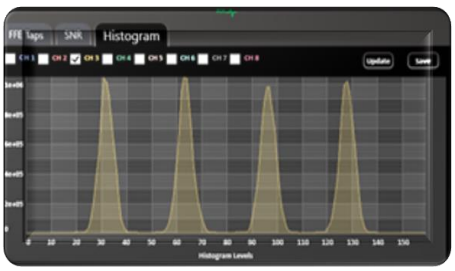


Figure 1: PAM4 eye histogram

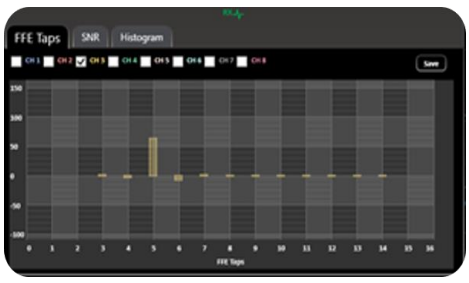


Figure 2: RX FFE Taps

Jitter Tolerance – JTOL Capabilities

When using high-speed signals, it is imperative to take into consideration the effect of jitter components coming from different sources and affecting the signal quality. For this reason, jitter tolerance is no longer an option but a hard requirement to characterize the DUTs.

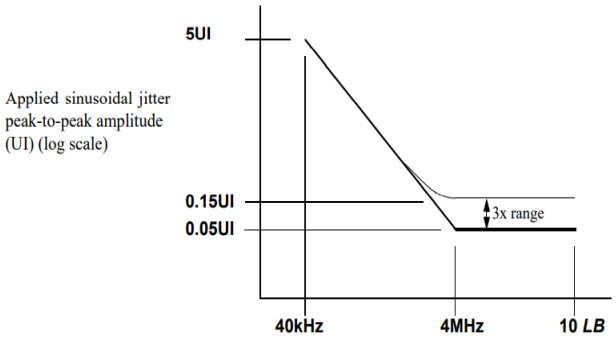


Figure 52–4—Mask of the sinusoidal component of jitter tolerance (informative)

Table 162–16—Receiver jitter tolerance parameters

Parameter	Case A	Case B	Case C	Case D	Case E	Case F	Units
Jitter frequency	0.04	0.4	1.333	4	12	40	MHz
Jitter amplitude (pk-pk)	5	0.5	0.15	0.05	0.05	0.05	UI

Figure 5: IEEE Standard 802.3ck Stress Testing

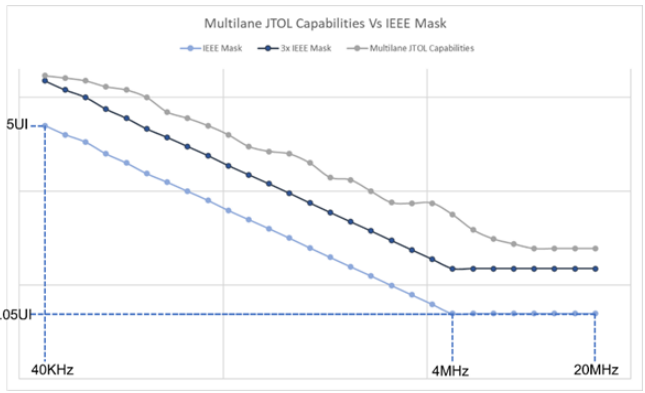
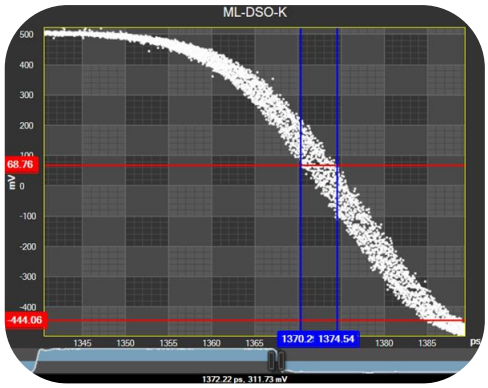


Figure 6: MultiLane Capability vs IEEE Mask



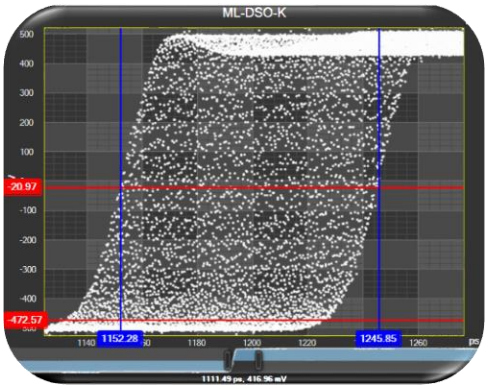


Figure 7: Jitter Measurements

Jitter Injection Capabilities:

- Frequency Modulation Mode:
  - Sinusoidal Jitter (SJ) Injection: FM modulation: sinusoidal jitter SJ injection on a PRBS pattern coming out of the BERT: Calibrated Jitter Injection up to 20MHz and 3x IEEE 802.3ck Mask
  - Random Jitter (RJ) Injection at different amplitudes
- Phase Modulation Mode: PM modulates the phase of the clock either in a sinusoidal way (SJ) , a random way (RJ) or as BUJ (Bounded Uncorrelated Jitter):
  - SJ: Calibrated Jitter Injection up to 20MHz and 3x IEEE 802.3ck Mask
  - Amplitude Control for RJ and BUJ

IEEE Automated JTOL

- IEEE Standard based on selected line rate
- JTOL Testing on all the required IEEE Frequencies at different amplitudes
- JTOL Result and Margin Testing based on selected Target BER and BER Time

Figure 8: Automated IEEE JTOL

Single Frequency Automated JTOL

- Single Frequency Selection from 1KHz to 20MHz
- Pass/Fail Verdict based on Selected BER

Figure 9: Automated Single Frequency JTOL

Both JTOL Options, offer a save as a CSV option, during the test the user can check all the results on a table or hover to any data point and check all the required information for your test

Figure 10: JTOL Table

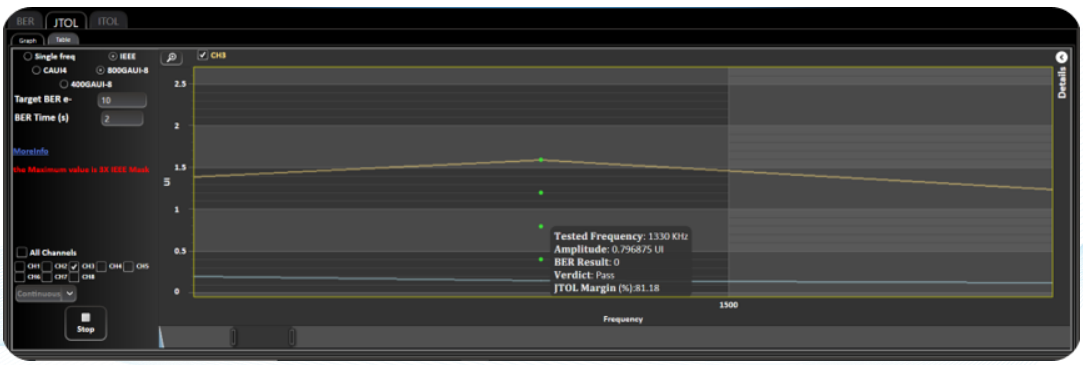


Figure 11: Test Point Information Details

Interference Tolerance – ITOL Capabilities

The ML4079EN enables a noise injection feature to emulate real-life crosstalk scenarios along with shallow loopback testing. Noise implementation can take the form of a continuous interference, burst crosstalk, or single shot noise and can be configured on each channel independently. The shallow loopback function works with a variety of traffic types including unframed PRBS, framed Ethernet and FEC traffic.

In addition, the ML4079EN follows the specifications of the IEEE Std 802.3-2018, IEEE Standard for Ethernet SECTION SIX, and Annex 93C stating that the noise shall be Gaussian white noise with a flat frequency response following the Mask in Figure 13, and a Crest Factor greater than 5.

Measurement	Value
Crest Factor	8.0686
Noise Flatness	2.4 dBm
V_{rms}	135.13 mV

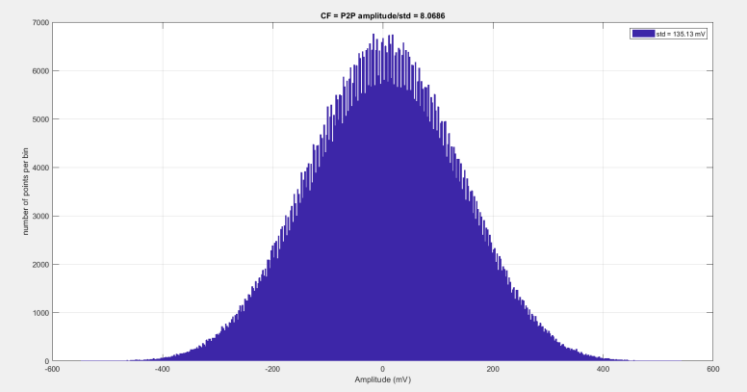


Figure 12: Crest Factor Measurement: Gaussian Noise

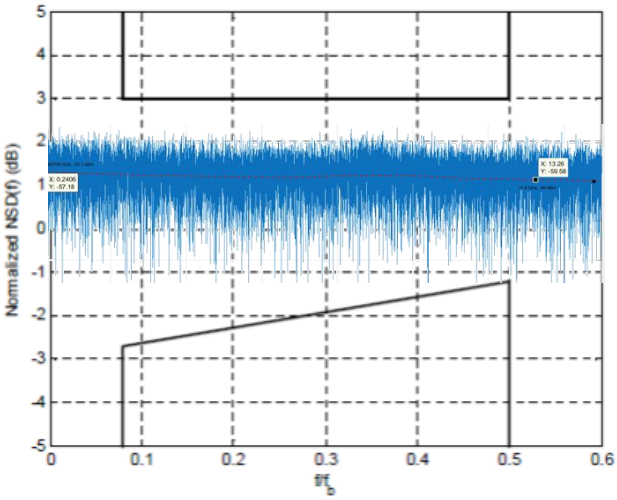


Figure 13: Noise Flatness

Random Noise Injection

- Independent Control on each channel
- Calibrated Noise Injection
- Up to 13mV Noise Injection

Interference Tolerance Automated Test ITOL:

- Random Noise Effect on BER
- Pass/Fail Verdict based on each noise step and selected BER

Shallow Loopback mode

Figure 15 depicts a ML4079EN accepting traffic from an external 800GE switch, looping the traffic internally and re-transmitting it back to the RX side of the host. This can be used to test the robustness of the host port, by adding an increasing amount of crosstalk noise and understanding where the receiver starts producing errors.

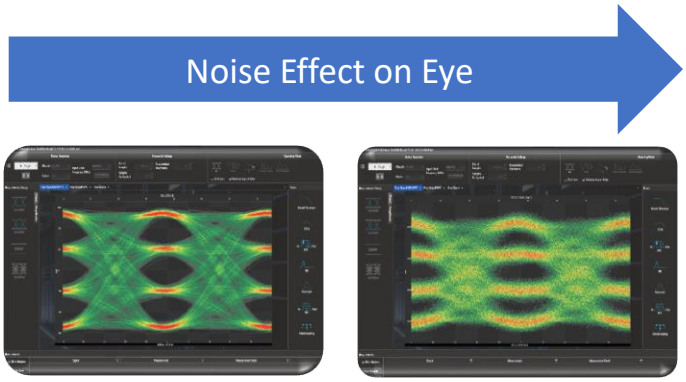


Figure 14: Eye Diagram before and after noise injection – PAM4 modulation

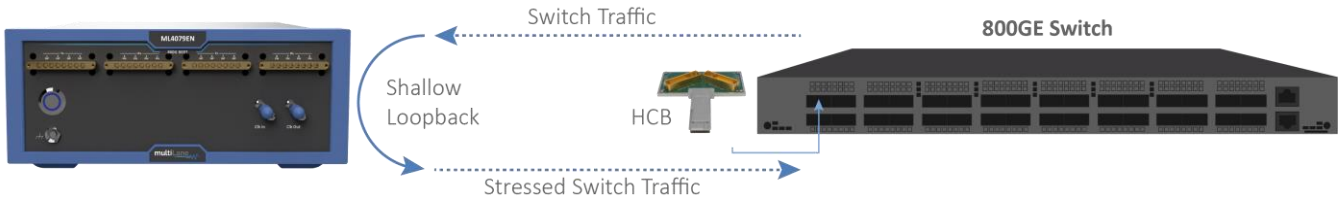


Figure 15: Shallow Loopback Using ML4079EN and 800G Switch

RLM Stress Test: Inner/Outer Eye Control on PAM4 Mode:

ML4079EN supports a full Inner and Outer Eye Control Range using the ThunderBERT GUI.
This feature enables the robustness testing of the transmitted signal by changing the Inner/Outer Eye settings and measuring the Level separation mismatch ratio RLM. The obtained value is compared to the IEEE 802.3 Transmitter Characteristics Value for Compliance Evaluation.
Figure 16 illustrates different Inner/Outer Eye settings using the ML4079EN.

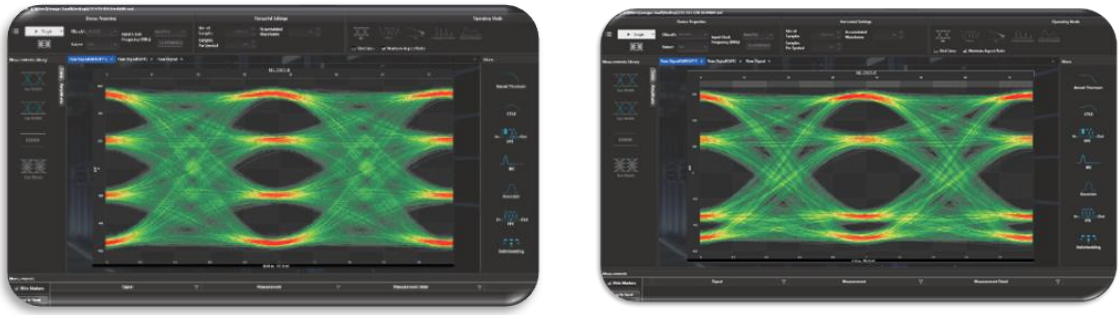


Figure 16: Inner/Outer Eye Control Using ML4079EN

Specifications

Parameter		Specifications
Bit Rates		PAM4: 18.5 – 29 GBaud / 37 – 61 GBaud NRZ: 18.5 – 29 Gbps / 37 – 61 Gbps
TX Amplitude Differential		0 – 1200 mVpp at High Rates & 0 – 1800 mVpp at Low Rates
Patterns		PRBS 7/9/11/13/15/16/23/31/58/9_4 SQ16, SQ32, LIN, CJT, JP0838, SSPRQ, User Defined
TX Amplitude Adjustment		Steps of 1 mV
Pre-emphasis resolution		1000 steps
Pre- / Post-emphasis		6 dB
Equalizing Filter Spacing		1 UI
Random Jitter RMS [1]		< 290 fs
Rise/ Fall Time (20–80%) [1]		< 10 ps
Coding		Gray coding supported
FEC (up to 800G)		KP (100G, 400G)
		KR (100G)
Output Return Loss up to 10 GHz		< -15 dB
Output Return Loss (16-25 GHz)		< -10 dB
Error Detector input range		50 – 800 mV differential
TX/RX connectors		4x 8 channel M-SMPM foot print on front channel
Reference clock Output	Reference clock	156.25 MHz
	Clean Clock	Used as high frequency trigger in clean (jitter disabled) or jitter mode: Reference Clock multiplied by an integer ranging from 2 to 30
Diff. Input Return Loss		Better than 10 dB
Eye monitor resolution		8 bits horizontal across 2 UI / 9 bits vertical
Clock Input Range		Up to 4.4 GHz
Clock Input Amplitude		200 – 1000 mV
Input Impedance		50 Ω
Ambient Temperature		0 – 75 °C
Power		110 V, 1.4 A or 220 V, 0.9 A – 50/60 Hz

[1] With appropriate pre and post emphasis settings and 50 GHz scope. Trigger from adjacent data channel rate/8

Mechanical Dimensions

The ML4079EN is a benchtop instrument that fits in a 19-inch 2U rack. Two ML4079ENs arranged side by side take up one 2U slot in a rack. MultiLane also supplies the needed brackets.

Ordering Information

Option	Description
ML4079EN	800G BERT (8 CH 56 GBd PAM4) with crosstalk noise injection
FEC	Real Hardware FEC analysis
SITOL	Stressed Input Tolerance: Jitter & Interference Tolerance capabilities, Margin Test
3YW	Total 3-year warranty
CAL	Single calibration
3YWC	Total 3-year warranty with 3 annual calibrations

Recommended Accessories

Instruments	Recommended	Comments
ML4079EN	4x MLCBMS-2.4-25-B-M	4x 8-channel 10-inch (25 cm) cable, M-SMPM type B male to 2.4 mm male connector
ML4079EN	4x MLCBMS-2.4-25-B-F	4x 8-channel 10-inch (25 cm) cable, M-SMPM type B male to 2.4 mm female connector
ML4079EN	4x MLCBMS-2.4-60-B-M	4x 8-channel 24-inch (60 cm) cable, M-SMPM type B male to 2.4 mm male connector
ML4079EN	2x MLCBMS-67G-25-B-LB	2x 8-channel 10-inch (25 cm) loopback cable, M-SMPM to M-SMPM with 67 GHz bandwidth connector
ML4079EN	4x MLCBMS-1.85-30-B-M	4x 8-channel 12-inch (30 cm) cable, M-SMPM type B male to 1.85 mm male connector
ML4079EN	4x MLCBMS-1.85-30-B-F	4x 8-channel 12-inch (30 cm) cable, M-SMPM type B male to 1.85 mm female connector
ML4079EN	4x MLCBMS-1.85-60-B-M	4x 8-channel 24-inch (60 cm) cable, M-SMPM type B male to 1.85 mm male connector

Please contact us at sales@multilaneinc.com