

Innovation for the next generation



ML4039E

4-Channel | 58 GBd PAM4 & NRZ | 400G BERT |

4 x 58 GBd NRZ/PAM4 BERT | SSPRQ, PRBS13Q & PRBS31Q | TX and RX Equalizers | Signal SNR and Histogram |

Summary

With the accelerated growth of hyperscale datacenters, the performance demands on Ethernet network infrastructure is increasing exponentially, and customer expectations for high-speed data throughput is at an all-time high. As a result, Bit Error Rate Testers (BERT) have become a cornerstone for physical layer testing, from qualifying bit transmission for fiber optic and copper-wire digital data transmission lines to testing signal integrity.

A BERT generates a sequence of bits through a communication channel and the received bits are then compared against the transmitted bits. A Bit Error Ratio (BER) evaluates the full end-to-end performance of a connectivity system and assures communication reliability.

The ML4039E is a 4x112 Gbps BERT that supports PAM4 signal generation required for 400G measurements as well as NRZ encoding. It is ideally suited for the validation and production testing of optical transceivers, in addition to functional and signal integrity testing. It supports the required test patterns defined by IEEE and OIF. Other features include signal-to-noise ratio (SNR) and histogram measurements, as well as transmitter and receiver equalizers.

ML4039E

4 x 56 GBd PAM4 BERT

Introduction

The ML4039E is a full featured 400G BERT that can be configured as four channels of 56 GBaud PAM4 or 56 Gbps NRZ. Also, half rates of 28 GBd are supported in PAM4 and NRZ modes.

The transmitters support all standard test patterns mandated by IEEE and OIF such as PRBS13Q, SSPRQ, PRBS31Q, etc. Additionally, the user may program the TX to output a user-defined pattern. In addition, the ML4039E supports transmitter and receiver equalization to overcome signal integrity impairments due to channel losses or reflections.

Key Features

Transmit

- Data Rates: 23-29 & 46-58 GBaud (116 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 0.8 Vppd output swing
- Supports Gray coding and polarity inversion
- Error injection
- 3-tap Pre- and Post-emphasis
- 7-tap linear FFE
- Real Hardware FEC implementation: KP(400G) – KR(100G) and KP(100G) on PAM4 modulation

Available patterns are:

- PRBS 7/9/9_4/11/13/15/16/23/31/58
- PRBS13Q, PRBS31Q
- SSPRQ, SQ16, SQ32, LIN, CJT, SSPRQ
- Square wave

Receive

- Programmable front-end attenuator
- SNR monitoring over time
- PAM4 and NRZ histogram monitor
- PAM4 slicer threshold adjustable
- Error-detection on following patterns:
 - PRBS7/9/11/15/16/23/31
 - PRBS13Q and PRBS31Q
- Automatic pattern detection
- LOS indicators.

General

- LabView driver and Python wrapper available
- API libraries with documentation.
- Same product available in ATE format for Advantest 93K system.

Target Applications

- Production testing of transceivers
- Functional and SI testing

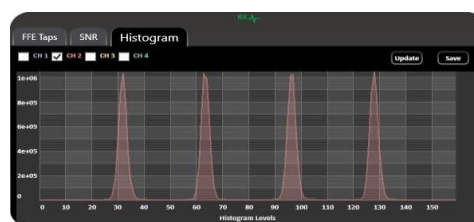


Figure 1: PAM4 eye histogram



Figure 2: RX FFE Taps

Using ThunderBERT GUI both accumulated and instantaneous BER measurements can be displayed and monitored simultaneously.

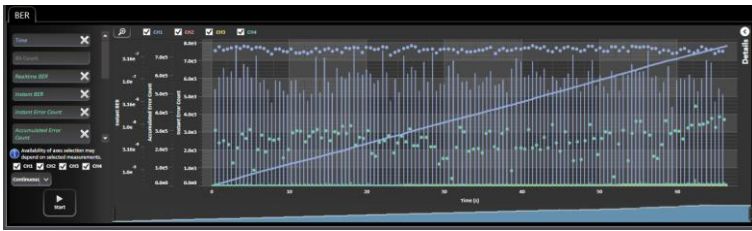


Figure 3: Instant and accumulated BER measurements over time

In addition, ThunderBERT GUI enables the FEC/SER measurements and analysis

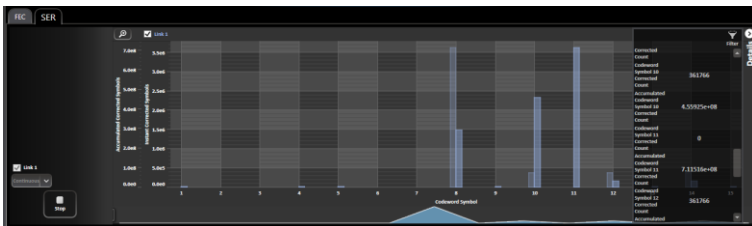


Figure 4: SER Count

Block Diagram

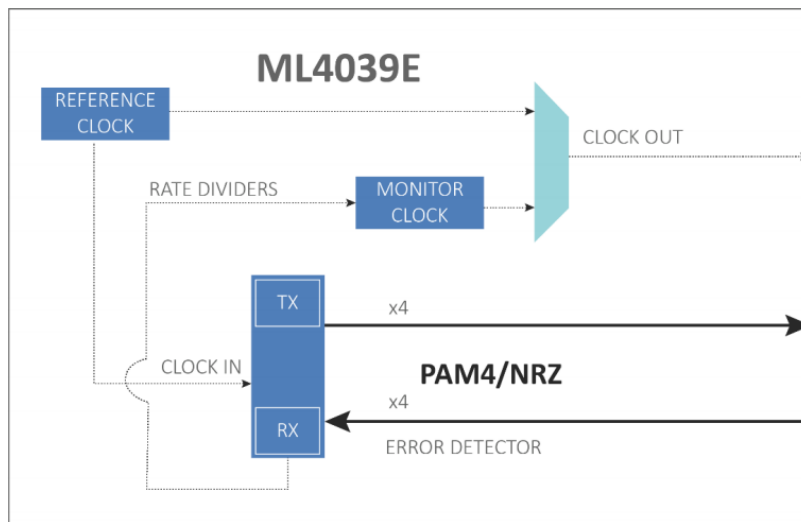


Figure 5: ML4039E Block Diagram

Specifications

Parameter		Specifications
Bit Rates		PAM4: 23 – 29 GBaud / 46 – 58 GBaud NRZ: 23 – 29 Gbps / 46 – 58 Gbps
TX Amplitude Differential		0 – 800 mVpp
Linear Region		50 mV – 800 mV
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		< 290 fs ¹
Rise / Fall Time (20–80%) ¹		12 ps / 14 ps
Coding		Gray coding supported
FEC (up to 400G stripes)		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 diff.
TX/RX connectors		2.4 mm connectors (2.92 mm optional)
Reference clock Output	Reference clock	156.25 MHz
	Monitor clock	Rate division 4/8/16/32/128
Diff. Input Return Loss		Better than 10 dB
Clock Input Range		Up to 2.5 GHz
Clock Input Amplitude		100 - 1000 mV
Input Impedance		50 Ω
Ambient Temperature		0-40 °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 ML4039E is a benchtop instrument that fits in a 19-inch 2U rack. Two ML4039Es arranged side by side take up one 2U slot in your rack. MultiLane also supplies the needed brackets.



Ordering Information

Option	Description
ML4039E	400G BERT (4 CH 58 GBd PAM4)
3YW	Total 3-year warranty
CAL	Single calibration
3YWC	Total 3-year warranty + 3 annual calibrations
FEC	Real hardware FEC
29	2.92 mm connectors

Recommended Accessories

Instruments	Recommended <i>Phase matched cable pairs</i>	Alternative <i>Phase matched cable sets</i>	Comments
ML4039E standard	8x MLCBPM-2.4-30	2x MLCBPM-2.4-30-8	2.4 mm connector 2x8 channel 30 cm
ML4039E standard	8x MLCBPM-2.4-60	2x MLCBPM-2.4-60-8	2.4 mm connector 2x8 channel 60 cm
ML4039E-29	8x MLCBPM-2.92-30	2x MLCBPM-2.92-30-8	2.92 mm connector 2x8 channel 30 cm
ML4039E-29	8x MLCBPM-2.92-60	2x MLCBPM-2.92-60-8	2.92 mm connector 2x8 channel 60 cm

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