

Innovation for the next generation

# ML4079D

8x 28 Gbaud PAM4 & NRZ | 400G Bit Error Rate Tester

8 x 28 GBd NRZ/PAM4 BERT | SSPRQ, PRBS13Q & PRBS31Q | FEC Estimation | 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 ML4079D is a 8x28 GBd PAM4 & NRZ BERT that supports signal generation required for 400G measurements. It is ideally suited for the validation and production testing of systems, components, and Electro-Optical Modules. 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.

# ML4079D

## 8x 28 GBd BERT

### Introduction

The ML4079D is a full feature 400G BERT that can be configured as an eight-channel PAM4 29.5 GBaud or eight-channel NRZ 29.5 Gbps lane.

The receivers support FEC decoding (802.3bj KR4/scaled KP4) and will return the frame loss ratio for FEC scenarios and BER for unframed data. The receivers also show the eye's histogram and the channel's SNR over time.

The transmitters support all standard test patterns mandated by IEEE and OIF such as PRBSQ13, SSPRQ, PRBSQ31, QPRBS13-CEI, etc..

The user may also program the TX to output a user-defined pattern up to 32 kb long.

The transmit power is adequate for testing up to 10 Km SMF links.

### Key Features

#### Transmit:

- Data Rates in NRZ mode 9 – 14.3 and 22 – 29.5 Gbps
- Ability to tune the bit rate in steps of 100 kbps and find the RX PLL locking margin.
- Data Rates in PAM4 mode 9 – 14.3 and 22 – 29.5 Gbps
- High frequency clock out > 2.4 GHz
- Independent control of inner eye levels
- Up to 1.5 Vppd output swing
- Supports Gray coding and polarity inversion
- 3-tap FIR Pre- and Post-emphasis up to 6dB
- Error injection

Available patterns are:

- PRBS 7/9/11/13/15/16/23/31/58 and their inverses
- PRBS13Q, PRBS31Q
- SSPRQ and SSPR
- Square wave, JP03A/B, CID JTOL pattern

#### Receive:

- Adaptive equalizer and channel IL estimator up to 14 dB (FFE+DFE).
- User-selectable CTLE 0 – 9 dB in 64 steps.
- SNR monitoring over time.
- Eye monitor.
- PAM slicer threshold adjustable.

Error-detection on following patterns:

- PRBS 7/9/11/13/15/16/23/31
- PRBS13Q and PRBS31Q
- Automatic pattern detection.
- LOS indicators.
- KR4/KP4 FEC emulator calculates the frame loss ratio, and returns BER with and without FEC.

#### General:

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

### Target Applications

- Production testing of transceivers.
- Functional and SI testing.

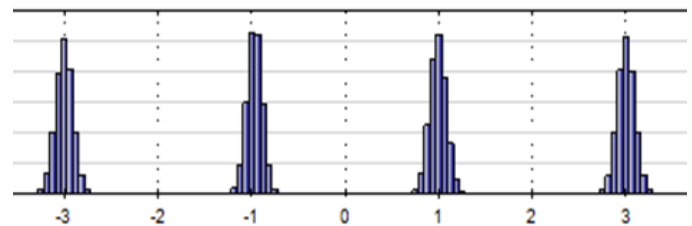


Figure 1: PAM eye histogram

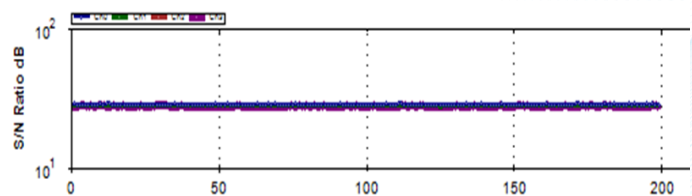


Figure 2: S/N Ratio over 200 captures

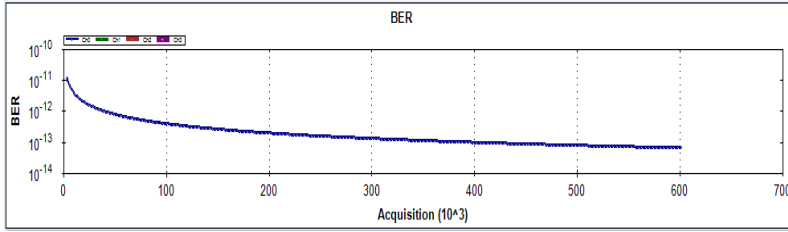


Figure 3: BER curves for one channel with 1 error inserted at the MSB and LSB respectively

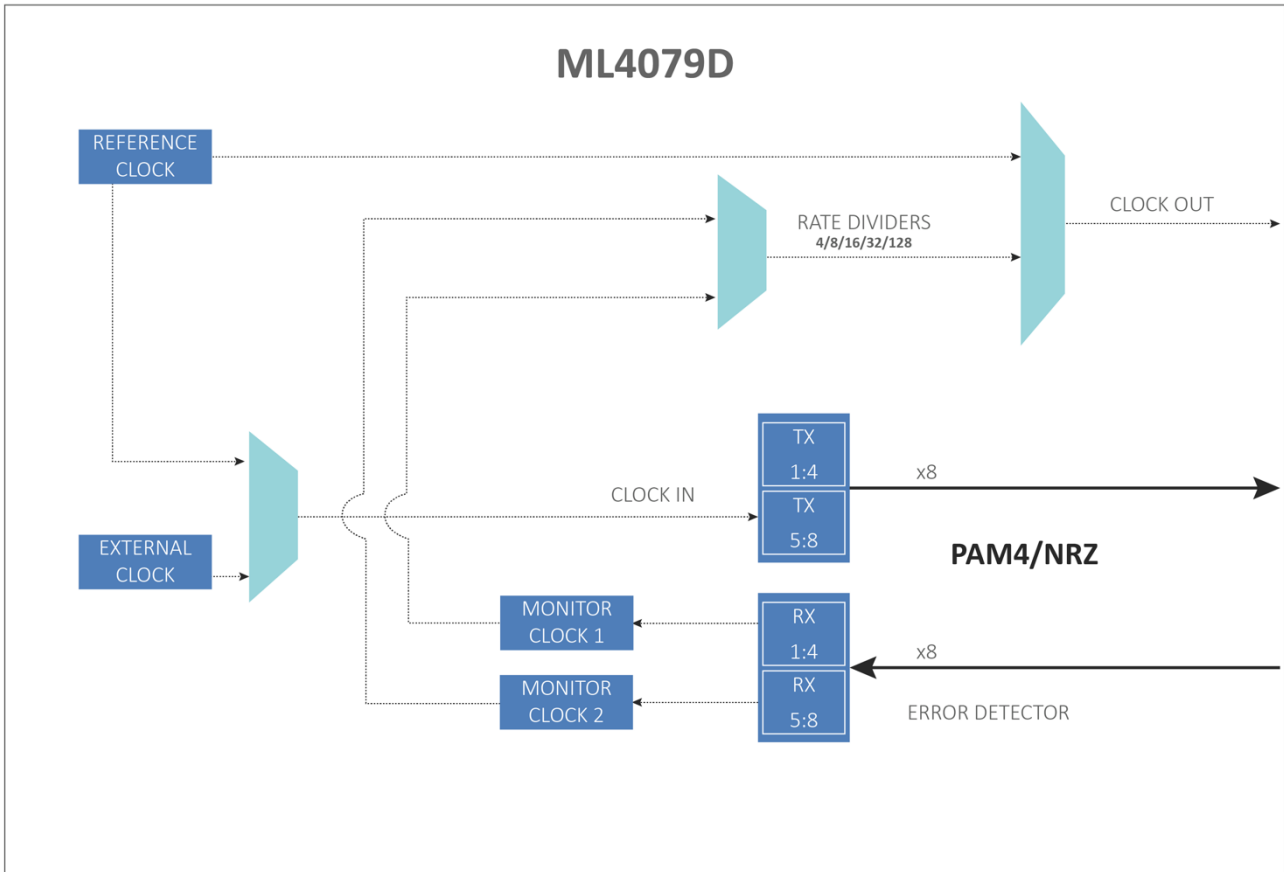


Figure 4: Block Diagram

## Electrical Specifications

	Parameter	Specifications
PPG	Bit Rates	PAM4: 9 – 14.3 Gbps and 22 – 29.5 Gbps NRZ: 9 – 14.3 Gbps and 22 – 29.5 Gbps
	TX Amplitude Differential	0-1200 mVpp
	Patterns	PRBS 7/9/11/13/15/16/23/31/58 PRBS13Q, 31Q and SSPRQ Square wave, JP03A/B, CID JTOL pattern
	TX Amplitude Adjustment	Steps of 1.5 mV
	Pre- / Post-emphasis	6 dB
	Pre-Emphasis Resolution	1000 steps
	Equalizing Filter Spacing	1 UI
	Random Jitter RMS	230 fs
	Rise/ Fall Time (20–80%)	16 ps
	Coding	DFE Pre-coding and Gray coding supported
	J4	1 ps
PPG	Output Return Loss up to 10GHz	< -15 dB
	Output Return Loss (16-25GHz)	< -10 dB
	Error Detector input range	50 mV– 1200 mV diff.
	Diff. Input Return Loss	Better than 10 dB
	Input CTLE Dynamic Range	1 - 9 dB
GENERAL	Total DFE/FFE/CTLE Equalization	More than 14 dB
	TX/RX connectors	2.92 mm connectors (2.4 mm optional)
	Monitor clock Output	Rate 4/8/16/32/128
	Clock Input Range	50 - 550 MHz
	Clock Input Amplitude	200 - 1000 mV
	Input Impedance	50 Ω
Temperature range	0-75 °C	



## Mechanical Dimensions

The ML4079D is a 19-inch 2U instrument with 43.7x8.9x30 cm



## Ordering Information

Option	Description
ML4079D	400G BERT (8 CH 28 GBd PAM & NRZ)
3YW	Total 3-year warranty
CAL	Single calibration
3YWC	Total 3-year warranty with 3 annual calibrations
Option 24	2.4 mm connectors

## Recommended Accessories

Instruments	Recommended <i>Phase matched cable pairs</i>	Alternative <i>Phase matched cable sets</i>	Comments
ML4079D standard	16x MLCBPM-2.92-30	2x MLCBPM-2.92-30-16	2.92 mm connector 2x16 channel 30 cm
ML4079D standard	16x MLCBPM-2.92-60	2x MLCBPM-2.92-60-16	2.92 mm connector 2x16 channel 60 cm
ML4079D-24	16x MLCBPM-2.4-30	2x MLCBPM-2.4-30-16	2.4 mm connector 2x16 channel 30 cm
ML4079D-24	16x MLCBPM-2.4-60	2x MLCBPM-2.4-60-16	2.4 mm connector 2x16 channel 60 cm

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