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Innovation for the next generation

ML4054E

800G BERT Production Tester for Pluggables| QSFP-DD, OSFP MSA Compliant Interfaces | CMIS 3.0/4.0 | SITOL | IEEE802.3ck Stress Testing

8 x 56 GBd NRZ/PAM4 BERT |Stream and Lite version | Power Integrity control on MCB | Real FEC analysis| Jitter and Crosstalk noise injection | Replaceable adapters

Summary

Preliminary datasheet

The ML4054E is an 800G BERT with a seamless design to eliminate external cabling. The ML4054E includes a removable MSA compliant adapter, which can be configured for QSFP-DD and OSFP. These adapters drive the signals from the BERT to the host connectors and support all QSFP-DD or OSFP features and pin mapping. Adapters are easily replaceable after exceeding the insertion lifetime of the connector making the ML4054E ideal for volume testing of pluggables, such as transceivers, active and passive cables.

As part of MultiLane's Stressed Input Tolerance (SITOL) range, the ML4054E not only ensures that your design can pass the performance specifications outlined in IEEE802.3-2018 and IEEE802.3ck, but also determines the margins by which they pass, thereby giving you the clearest possible picture DUT's increased durability.

The ML4054E runs on the flagship MultiLane ThunderBERT GUI, providing a comprehensive picture of every aspect of the testing process. Different versions of the ML4054E are available: the regular version, - ideal for thermal validation, and the lite version - an economic solution for manufacturing testing.

ML4054E

800G Manufacturing BERT

Introduction

The ML4054E is a fully featured 800G BERT with an integrated module interface, ideal for product development and validation, plug-and-play characterization and production testing of QSFP-DD, and OSFP transceivers.

This instrument is equipped with a field-replaceable, MSA-compliant adapter making it ideal for production and volume testing.

Two versions of the ML4054E are available. The regular with cables optimized for thermal stream testing and full features and the Lite version – like the regular, but with limited features.

Additionally, the user can individually control each Tx level, equalization, eye balance, pattern, coding, and inject error sequences into the stream. The receiver features CTLE and FFE equalization for up to 14 dB of loss at Nyquist along with advanced troubleshooting capabilities.

The ML4054E is specifically designed to add jitter and crosstalk noise (interference). This capability is uniquely fully integrated into the BERT and does not require any external equipment. In addition, full CMIS control and compliance testing is enabled in this versatile BERT.

Key Features

- High-value, instrument-grade bit error rate tester optimized for high-speed data analysis of 800G transceivers and pluggables
- QSFP-DD, OSFP adapters are available, with other types upon request
- Integrated BERT and host controller enable:
  - o RX CTLE tuning
  - o TX Equalization control
  - o Current and voltage sense

- Powerful Tx/Rx Equalization control for link optimization and minimizing power consumption
- Excellent insertion loss characteristics of the connector saver
- TP1a performance is compliant per IEEE802.3ck
- Real hardware FEC. SER and FEC measurements and margin available on channels individually as well as on 100G, 400G blocks
- Supports PRBS13Q/31Q and user-defined patterns
- Provides full CMIS control in terms of I2C configuration, monitoring and other functions, and enables CMIS 3.0/4.0 compliance testing
- Burst and random noise injection
- Jitter and Interference tolerance

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

Target Applications
- Production testing of transceivers
- Active Electrical Cables and Active Copper Cable Compliance Testing
- Functional and SI testing of transceivers
- On-the-go testing of transceivers in the field
- Thermal testing of transceivers
- Transceiver functional tester, for simple validation
- Pluggable stress testing (jitter & interference)

Figure 1: Digital Diagnostic Monitoring (DDM) tab

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.
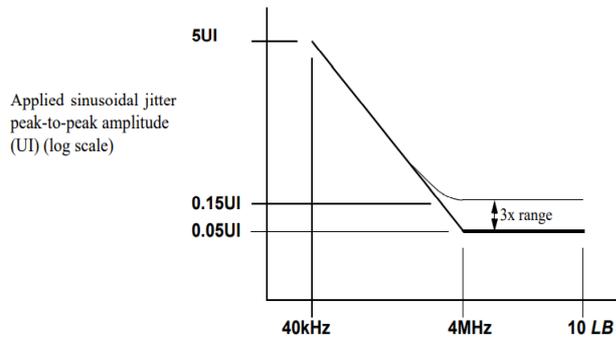

Figure 52–4—Mask of the sinusoidal component of jitter tolerance (informative)

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

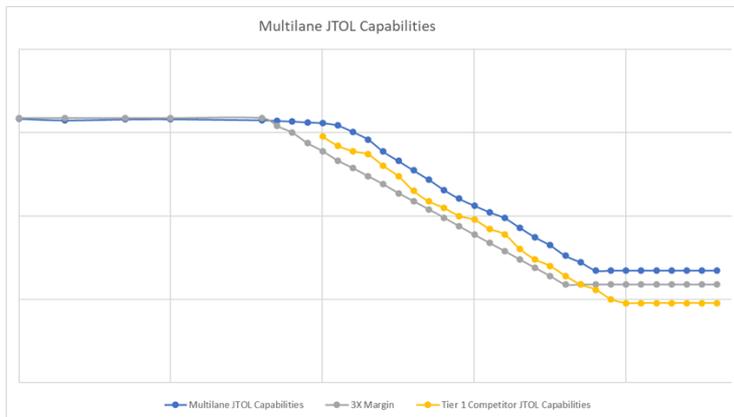**Figure 2: IEEE Standard 802.3ck Stress Testing**

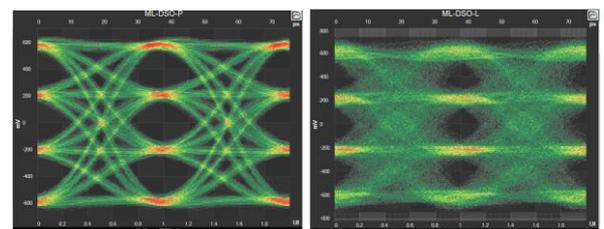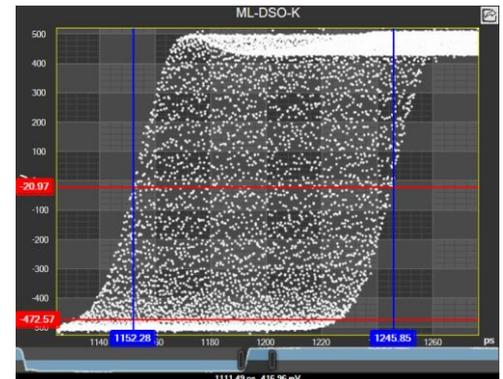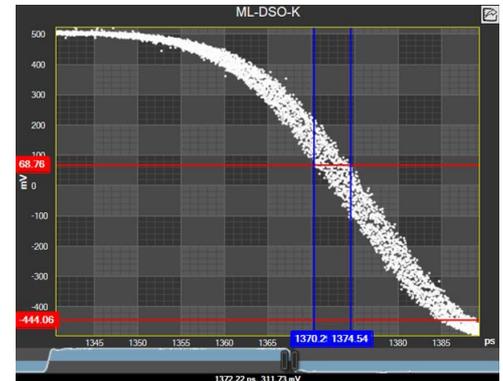**Figure 3: MultiLane Capability vs IEEE Mask**

Figure 4: Jitter Measurements

Jitter Injection Capabilities:

- Frequency Modulation Mode:
    - Sinusoidal Jitter (SJ) Injection: FM modulation is the basis for injecting sinusoidal jitter SJ 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 amplitude
- 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

IEEE Automated JTOL

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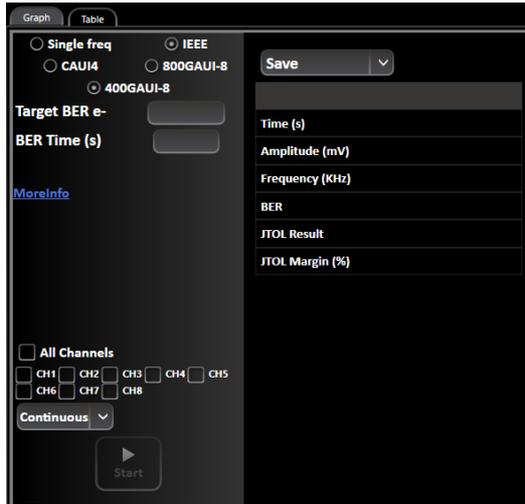- JTOL Result and Margin Testing based on selected Target BER and BER Time

Figure 5: Automated IEEE JTOL

Single Frequency Automated JTOL

- Single Frequency Selection from 1KHz to 20MHz
- JTOL and Margin Test on selected amplitude
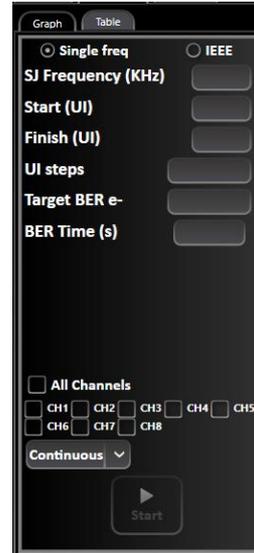- Pass/Fail Verdict based on Selected BER

Figure 6: Automated Single Frequency JTOL

Interference Tolerance – ITOL Capabilities

The ML4054E 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.

In addition, the ML4054E 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 8, and a Crest Factor greater than 5.

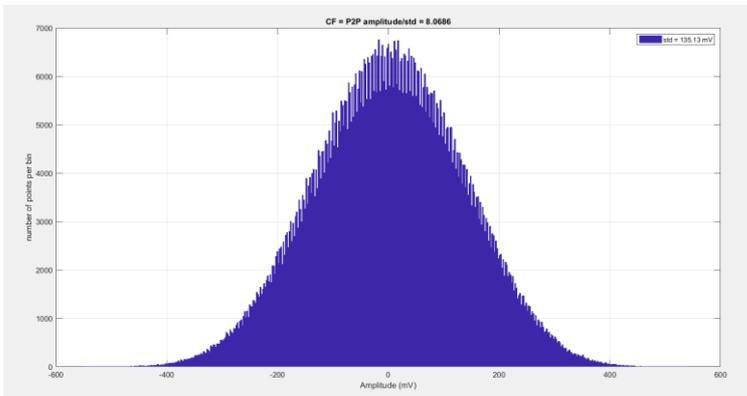| Measurement	Value
Crest Factor	8.0686
Noise Flatness	2.4 dBm
V_{rms}	135.13 mV

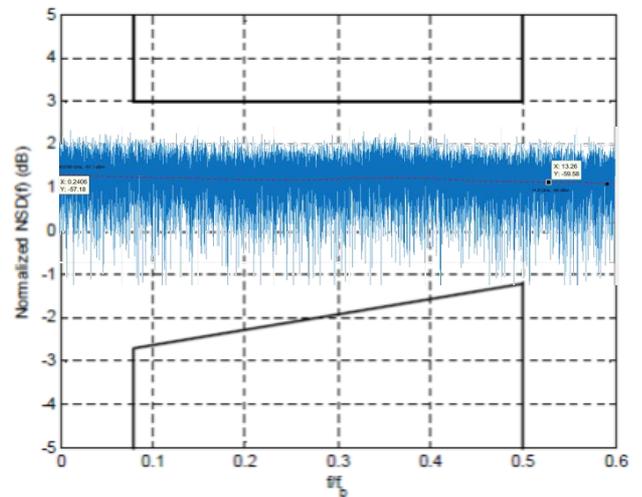**Figure 7: Crest Factor Measurement: Gaussian Noise**

Figure 8: Noise Flatness

Random Noise Injection

- Independent Control on each channel
- Calibrated Noise Injection
- Up to 100mV Noise Injection

Interference Tolerance Automated Test ITOL:

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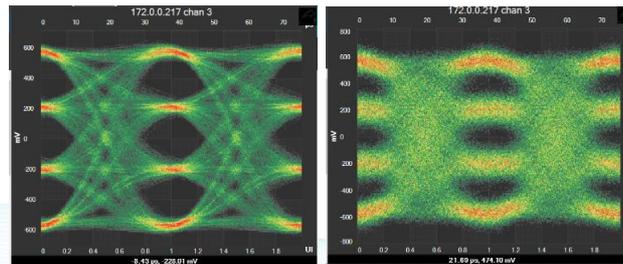- Pass/Fail Verdict based on each noise step and selected BER

Noise Effect on Eye

Figure 9: Eye Diagram before and after noise injection – PAM4 modulation

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

ML4054E 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.
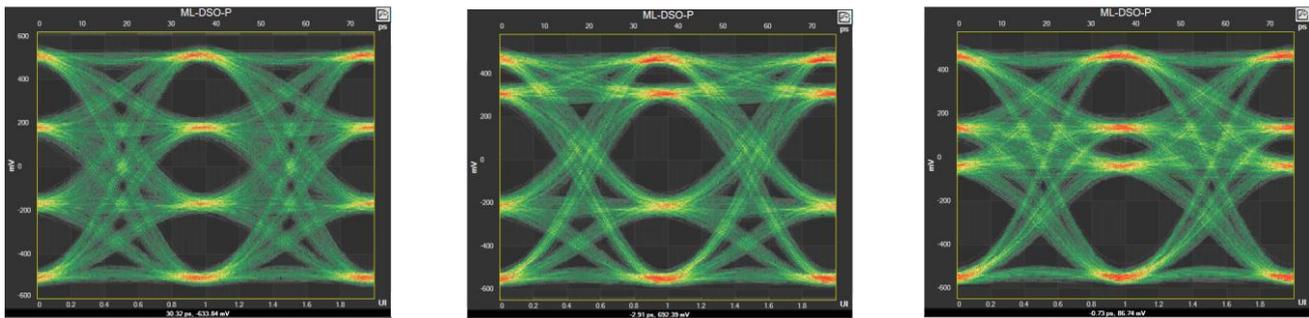Figure 14 illustrates 3 different Inner/Outer Eye settings using the ML4054E.

Figure 10: Inner/Outer Eye Control using ML4054E

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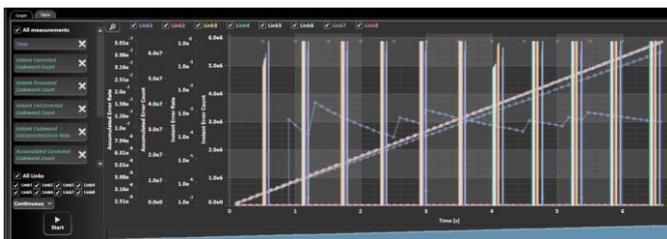

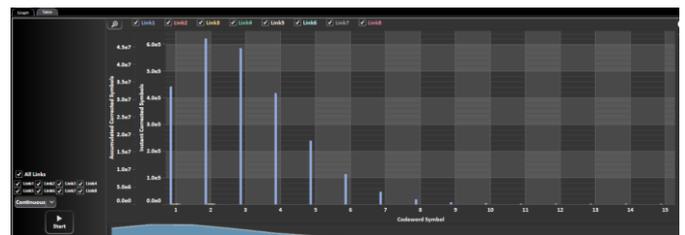**Figure 11: ThunderBERT GUI Screenshots showing BER measurements**

Figure 12: ThunderBERT GUI Screenshots showing SER measurements

ML4054E Feature Set

Feature	ML4054E-L Lite version	ML4054E-S Stream version
Image		
Connector	OSFP/QDD Adapter	Extended OSFP/QDD Adapter Cables and extender included
Baud rates	25.78G NRZ 26.56/53.125 GBd PAM4	All
HW FEC	Optional	Optional
SITOL	NA	Optional

Table 2: ML4054E versions and features

Specifications

Parameter	Specifications*
Bit Rates	PAM4: 20 – 29 GBaud / 36 – 61 GBaud NRZ: 20 – 29 Gbps / 36 – 61 Gbps
TX Amplitude Differential	0 – 800 mVpp (defined at the pins of the adapter)
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

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

* ML4054E-L: the Lite-version has a limited feature set (see table 2)

Output Return Loss (16-25 GHz)		< -10 dB
Error Detector input range		50 – 800 mV differential
TX/RX connectors		QSFP-DD, OSFP, or other MSAs upon request
Reference clock Output	**Reference clock**	156.25 MHz
	Monitor clock	Rate division 4/8/16/32/128/256
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
Adapter mating cycles		300 cycles

Mechanical Dimensions

The ML4054E is a benchtop instrument that fits in a 19-inch 2U rack. Two ML4054Es arranged side by side take up one 2U slot in your rack. MultiLane also supplies the needed brackets.

ML4054E-S: L x W x H: 53 x 23 x 12.5 cm

Ordering Information

Option	Description
ML4054E	800G BERT with crosstalk noise injection with external structure and cabling
ML4054E-L	Lite Version Limited feature set (table 2)
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

Part Number	Description
ML4054E-QDD	QSFP-DD adapter
ML4054E-OSFP	OSFP adapter

Please contact us at sales@multilaneinc.com