

Innovation for the next generation

# ML4035

4-Lane TDR | TDT | E-DSO  
4-Lane 56GBd PPG | ED  
400G BERT

Time Domain Reflectometry | S-Parameter  
Measurement | Eye Pattern Measurement |  
BER Measurement | Cable & TIA Evaluation



## Summary

In today's extremely competitive and fast-paced industry, time is the most expensive form of currency. Every second saved is a step ahead of the competition. This is what MultiLane is all about; with our high performance, automated and throughput optimized solutions, MultiLane completely redefines the status quo of large-scale production testing.

The state-of-the-art solutions we provide are fully automated and engineered for the sole purpose of providing our customers with accurate and reliable measurements while also saving them valuable time.

MultiLane's ML4035-TDR joined our large and diverse collection of successful products as a 3-in-1 400G BERT, 35 GHz electrical scope, and TDR instrument, allowing 400G BER tests, NRZ & PAM4 eye diagram measurements, as well as medium impedance characterization and S-parameter evaluation.

With a total of 24 ports, the ML4035-TDR allows simultaneous testing on 4-channels. Its diverse applications go from characterization and production testing of DACs and TIAs to compliance testing of transceivers and optical modules as well as switch tuning, cable matching, medium fault detection and various other industry essential applications.

The ML4035-32 is a 32 GHz variant that excludes TDR capability and can be used for applications such as TIA testing and for other BERT-Scope applications.

# ML4035-TDR

## 4x35 GHz TDR/TDT and DSO

### Introduction

The ML4035-TDR is a state-of-the-art combination of a TDR and Digital Sampling Oscilloscope. The DSO performs accurate eye-diagram analysis at 35 GHz to characterize the quality of transmitters and receivers, implementing a statistical under-sampling technique with comprehensive software libraries for eye measurements, jitter analysis and processing of NRZ/PAM4 data. The true-differential TDR can determine the impedance profile and reflection loss on 4 channels simultaneously. It is designed and suited both for characterization as well as manufacturing. The 4 differential PPG ports can generate pulse patterns up to 58 Gbps NRZ, enabling Sdd21 measurements beyond 32 GHz. The ML4035-TDR can be configured to measure TDR with a range of 10 meters. It has a pulse rise time of 12 ps that allows to resolve impedance discontinuities as close as 1.5 mm apart. The dynamic range is 40 dB. The ML4035-32 is a 32 GHz variant that excludes TDR capability and can be used for applications such as TIA testing and for other BERT-Scope applications.

### Key Features

#### TDR/TDT features

- High Resolution TDR/TDT measurements
- Low cost quadruple 35 GHz Time Domain Reflectometry / Transmission optimized for high speed tests and measurements
- Impedance Profile Measurement
- Determination of the magnitude and polarity of any back reflected signal
- 4 ports per module expandable up to 32+
- 4x35 GHz analog bandwidth
- Low power dissipation
- Sample aperture jitter below 60 fs

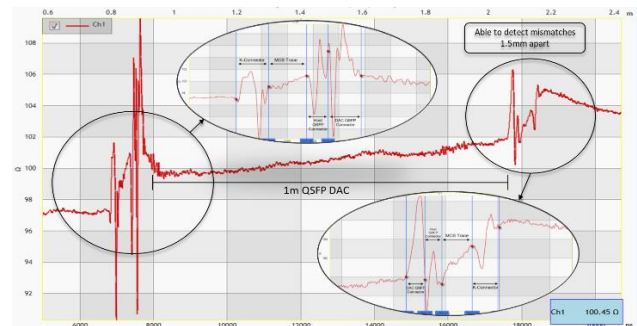


Figure 1: TDR Measurement on DAC + MCB

### S-parameters

- Return loss
- Insertion loss
- Crosstalk
- Accurate multiport S-parameters

### DSO features

- Low cost quadruple 35 GHz Digital Sampling Scope optimized for high speed data analysis
- High Fidelity Signal Capture
- Low intrinsic Jitter
- Control of multiple modules enabled through Fast Ethernet.
- User friendly GUI, high throughput APIs and libraries. The software supports both Linux and Windows.
- Supports external API calls from other software e.g. LabView.
- Repeatable performance and traceable to standards
- Single ended and differential electrical inputs for each of the four channels
- Color graded persistence in eye and pattern capture modes
- Ability to analyze and load captured data into the simulator
- Capability to save statistical measurement and data files for multiple DSOs
- Full eye measurements can be attained in the tens of milliseconds

## Pulse Pattern Generator

- Data Rates 23 – 29 GBd and 46 – 58 GBd
- Ability to tune the bit rate in steps of 100 kbps and find the RX PLL locking margin.
- High frequency clock out > 2.4 GHz
- Independent control of inner eye levels
- Up to 0.8 Vppd output swing
- Supports Gray coding and polarity inversion
- 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
  - Error injection
  - 3-tap FIR Pre- and Post-emphasis 6dB

## Error Detector

- Adaptive DFE and FFE with reflection canceller.
- SNR monitoring over time.
- PAM histogram 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.

## 4-Channel Digital Sampling Oscilloscope providing SerDes testing & characterization

### Software Filters

The ML4035 software enables de-embedding the effects of cables connected between scope and DUT by means of s2p / s4p files. It also provides SW filters such as FFE that can be applied easily for signal post-processing.

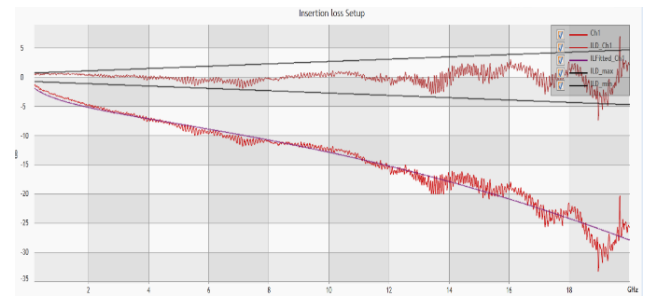


Figure 2: S21 + Mask

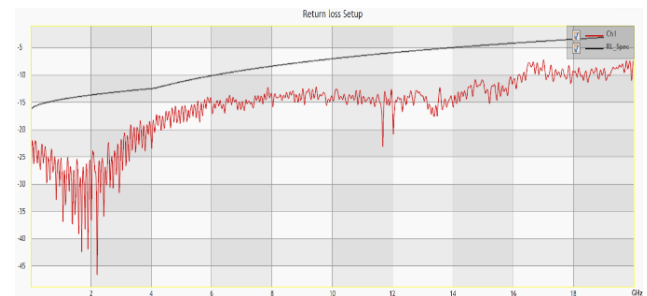
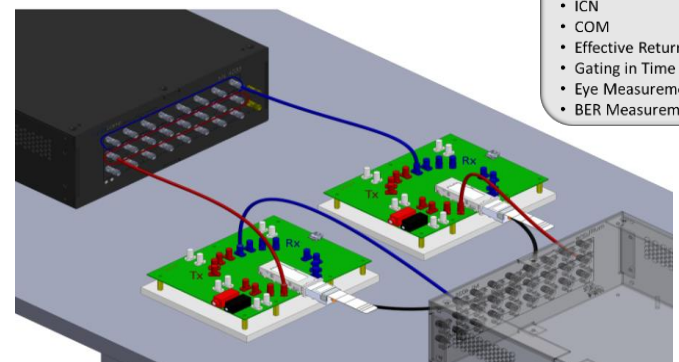


Figure 3: S11 + Mask

## Applications

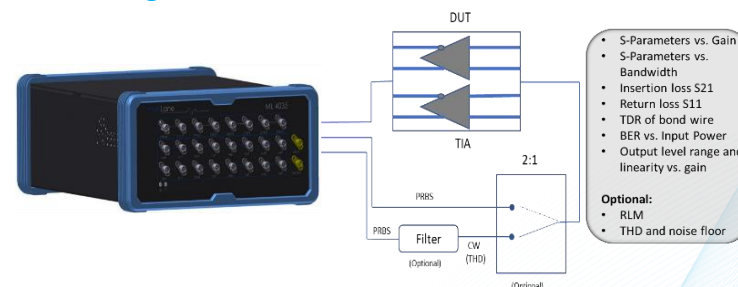
### Direct Attach Copper Cable Testing



- Impedance Profile
- Return Loss (S11)
- Insertion Loss (S21)
- Crosstalk (NEXT, FEXT)
- ICN
- COM
- Effective Return Loss
- Gating in Time Domain
- Eye Measurements
- BER Measurement

Figure 4: DAC Testing Using ML4035

### TIA Testing



- S-Parameters vs. Gain
  - S-Parameters vs. Bandwidth
  - Insertion loss S21
  - Return loss S11
  - TDR of bond wire
  - BER vs. Input Power
  - Output level range and linearity vs. gain
- Optional:
- RLM
  - THD and noise floor

Figure 5: TIA Testing Using ML4035

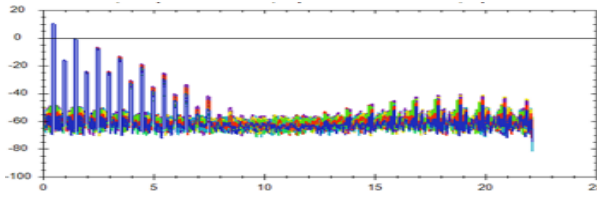


Figure 6: THD

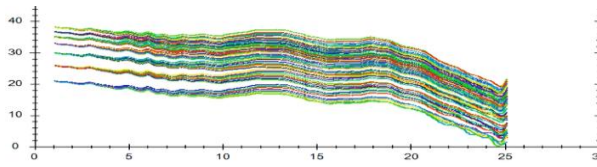


Figure 7: S21 vs. Gain

## DSO Applications

- High-Speed SerDes Testing & Characterization
- Design/Verification of Telecom and Datacom Components and Systems
- Electro-optical Transceiver Testing
- Multi-port system testing or Line Cards
- In-Situ testing of high port count systems
- Telecom Equipment Test for Installation and Maintenance.
- Fiber Channel, Ethernet, PON, Parallel Optics
- High port count burn-in test.

## DSO Measurements

### NRZ Mode

- Total Jitter decomposition (DJ, RJ)
- Mask Margin
- The mask margin can be extracted for a defined number of points that fail, thus allowing for DUT quality assessment, control and binning.
- Number of failing points for a region can be returned as well as the actual points that failed.
- Eye opening, eye height and width, eye amplitude, top, base, max, min, peak to peak
- Rise/ fall time, single edge measurement in pattern capture
- Statistics histograms and histogram measurements
- Crossing percentage
- Pre-emphasis positive & negative
- Advanced Pattern Measurements
- Zooming, markers, X and Y histograms, overlays, & multiple measurements, statistics.

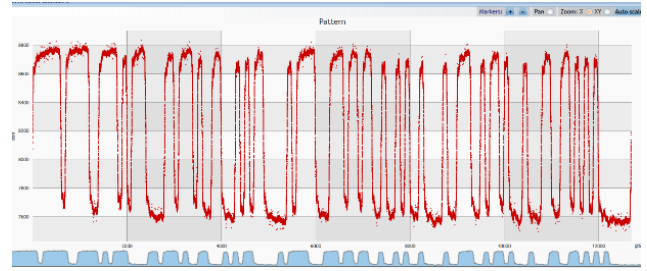


Figure 8: Pattern Capture

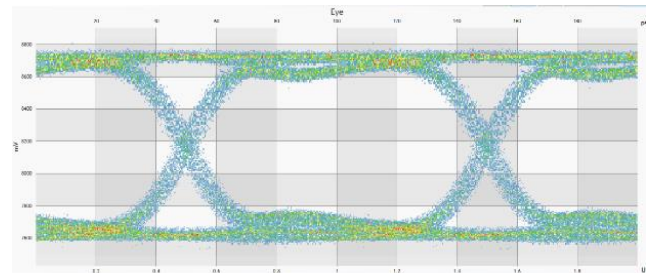
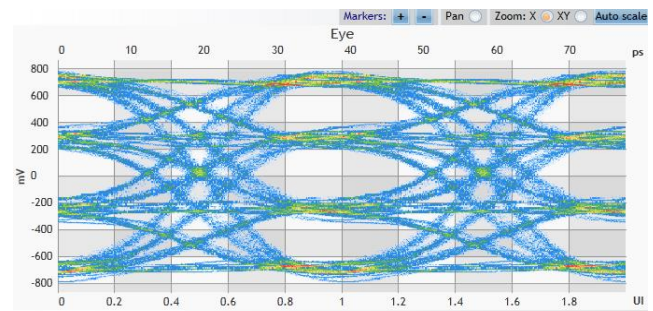


Figure 9: NRZ Eye Capture

## PAM4 Mode

PAM4 scope measurements are currently following the latest OIF contribution.



## PAM4 Measurements

Symbol Levels

Vertical Eye Amplitudes

Vertical Eye Openings

Horizontal Eye Openings

Vertical Eye Closure (dB)

Openings by BER

Max, Min, Peak-to-Peak...

Functionality	Parameter	Symbol	Condition	Min	Typ	Max	Unit	
DSO	Input Bandwidth (programmable)					35 (-TDR) 32 (-32)	GHz	
	Input Amplitude		S.E./Diff.			600/1200	mVpp	
	Input Rise / Fall Time (20% to 80%)	$t_{RT}, t_{FT}$			12		pS	
	Vertical Resolution				12		bits	
	Clock Input range (normal mode)			0.01		6.6	GHz	
	Clock Input Amplitude		SE	200		1000	mV	
	Input Impedance	Z			50		$\Omega$	
	Intrinsic Jitter (excluding DDJ)					200	fs <sub>rms</sub>	
	Amplitude Error (rms)				4		mV <sub>rms</sub>	
	Data Format support		NRZ, PAM4					
	PRBS Pattern Capture						PRBS16	
	Memory depth					>16M	Samples	
TDR (ML4035-TDR)	Bandwidth (S&H)					35	GHz	
	Input Voltage			-500		600	mV	
	S&H Gain Flatness			-0.5		0.5	dB	
	Diff Amplitude, step/PRBS		With 100 $\Omega$ DUT termination	100		1000	mVpp	
	TDR Resolution					1.5	mm	
	TDR Range					10	m	
	Input/ Output Return Loss		2 GHz				-19	dB
			5 GHz				-19	dB
			10 GHz				-12	dB
			20 GHz				-8	dB
	Step Response, rise/fall		20% to 80%			12	Ps	
	S&H Gain Flatness			-0.5		0.5	dB	
	Feedthrough Rejection, TH2 holding					60	dB	
	Clock Frequency		Square, >2 V/ns slew	0		250	MHz	
Random Aperture Jitter					60	fs		

Functionality	Parameter	Symbol	Unit
PPG & ED	Bit Rates	23 – 29 46 – 58	GBd/Gbps
	TX Amplitude Differential	0 - 800 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	mV
	Pre- / Post-emphasis	6	dB
	Equalizing Filter Spacing	1	UI
	Random Jitter RMS	95	fS
	Rise/ Fall Time (20–80%)	10	Ps
	Coding	DFE Pre-coding and Gray coding supported	
	Output Return Loss up to 10 GHz	< -15	dB
	Output Return Loss (16-25 GHz)	< -10	dB
	Error Detector input range	50 – 1000	mV diff.
	Total DFE/FFE/CTLE Equalization	Up to 13	dB
	Reference clock Output	Rate div 8/16/32/165	
	Diff. Input Return Loss	Better than 10	dB
Eye monitor resolution	8 bits horizontal across 2UI / 9 bits vertical		
Power Rating	1.6 A @ 12 Vdc		

## Ordering Information

Option	Description
ML4035-TDR	35 GHz E-DSO with TDR Capability
ML4035-32	32 GHz E-DSO without TDR Capability
3YW	Total 3-year warranty
CAL	Single calibration
3YWC	Total 3-year warranty with 3 annual calibrations
Option 29	2.92 mm connectors

## Recommended Accessories

Instruments	Recommended <i>Phase matched cable pairs</i>	Alternative <i>Phase matched cable sets</i>	Comments
ML4035 standard	12x MLCBPM-2.4-30/60	3x MLCBPM-2.4-30/60-8	2.4 mm connector 3x8 channel 30 or 60 cm
ML4035-29	12x MLCBPM-2.92-30/60	3x MLCBPM-2.92-30/60-8	2.92 mm connector 3x8 channel 30 or 60 cm

Please contact us at [sales@multilaneinc.com](mailto:sales@multilaneinc.com).

This equipment contains ESD sensitive components and may become damaged when contacted with an electrostatic charge. To prevent equipment damage, please use proper grounding techniques.



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