

Innovation for the next generation

ML4035

4-Differential Channels TDR | TDT
| E-DSO | 4- Lanes 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 allows simultaneous testing on 4-Differential 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.

ML4035

4x35 GHz TDR/TDT and DSO

Introduction

The ML4035 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 can be configured to measure TDR with a range of 8 meters. It has a pulse rise time of 12ps that allows to resolve impedance discontinuities as close as 1.5mm apart. The dynamic range is 40dB.

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-Differential Channels per module expandable up to 32+.
- 4x35 GHz analog bandwidth.
- Low power dissipation.
- Sample aperture jitter below 60 fs.

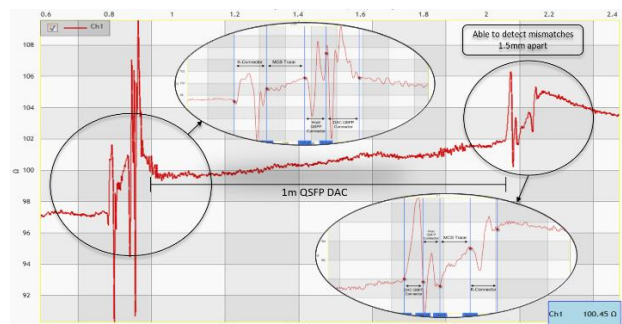


Figure 1: TDR Measurement on DAC + MCB

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.

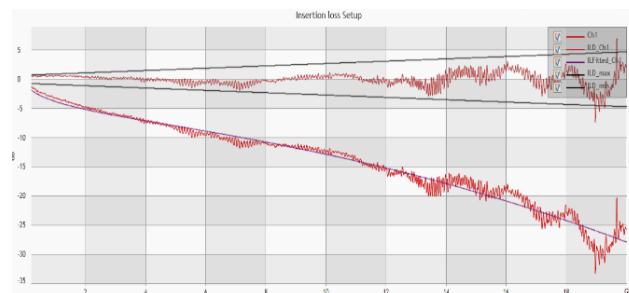


Figure 2: S21 + Mask

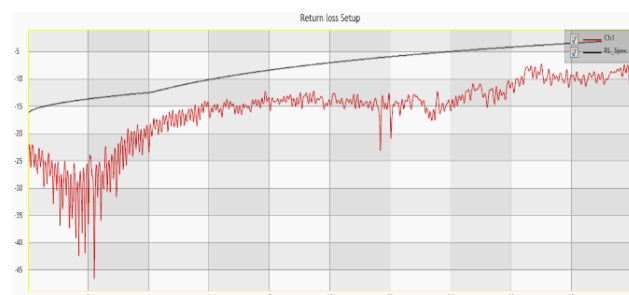


Figure 3: S11 + Mask

Applications

Direct Attach Copper Cable Testing

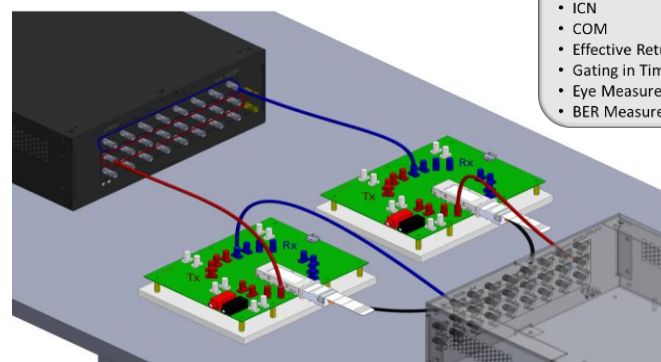


Figure 4: DAC Testing Using ML4035

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

TIA Testing

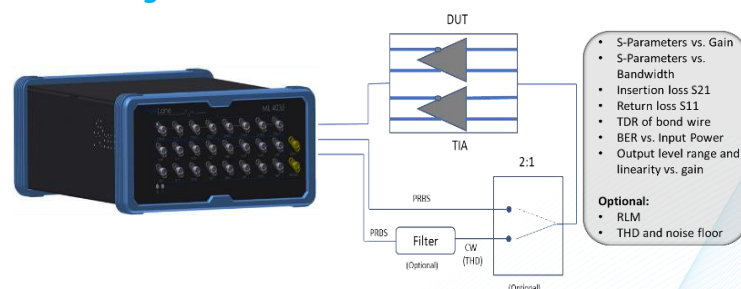


Figure 5: TIA Testing Using ML4035

- 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

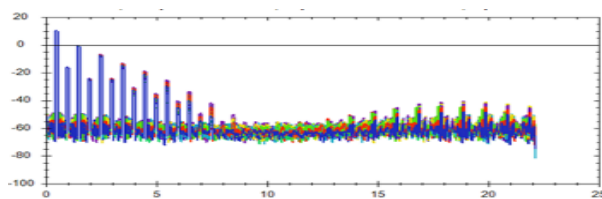


Figure 6: THD

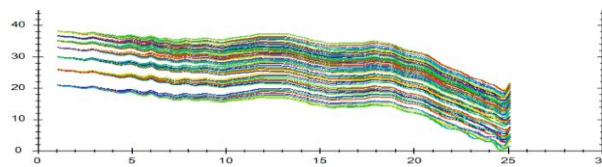


Figure 7: S21 vs. Gain

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.

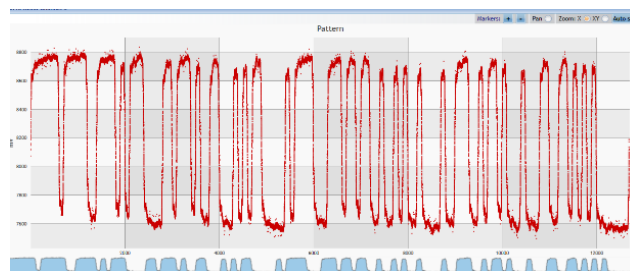


Figure 8: Pattern Capture

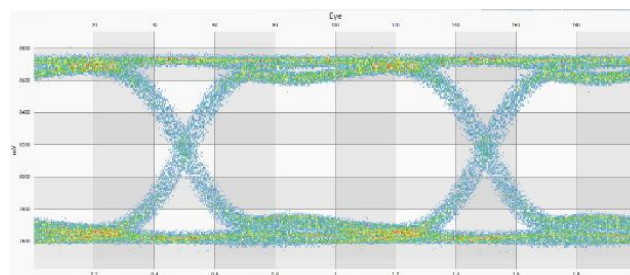
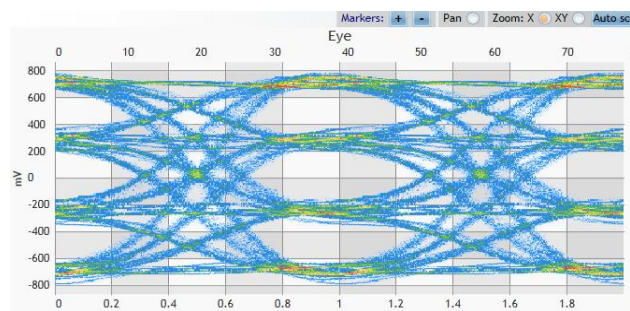


Figure 9: NRZ Eye Capture

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	Condition	Min	Type	Max	Unit
DSO	Input Bandwidth (programmable)				35	GHz
	Input Amplitude	S.E./Diff.			600/1200	mVpp
	Input Rise / Fall Time (20% to 80%)	400 mV		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			50		Ω
	Intrinsic Jitter (excluding DDJ)				200	fs _{rms}
	Amplitude Error (rms)			4		mV _{rms}
	Data Format support	NRZ, PAM4				
	PRBS Pattern Capture				PRBS16	
	Memory depth			>16 M		Samples
TDR	Bandwidth (S&H)				35	GHz
	Diff Amplitude, step/PRBS	With 100 Ω DUT termination	100		1000	mVpp
	TDR Resolution				1.5	mm
	TDR Range				8	m
	Step Response, rise/fall	20% to 80%			12	Ps
	Random Aperture Jitter				60	fs
	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
			-0.5		0.5	dB
	Feedthrough Rejection, TH2 holding	Clock Vppd = 0.5 V		60		dB
	Clock Frequency		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	1.6A @ 12 Vdc		

Ordering Information

Option	Description
ML4035-2.9mm	ML4035 with 2.92mm connectors
ML4035-2.4mm	ML4035 with 2.4mm connectors
3YW	Total 3-year warranty
CAL	Single calibration
3YWC	Total 3-year warranty with 3 annual calibrations

Recommended Accessories

Instruments	Part Number	Qty	Description
ML4035-2.4mm	MLCC-240MST-F08630-240MST-2-P	12	Coaxial Cable Assembly, 2.40 mm (M) ST. to 2.40 mm (M) ST., 60cm, Flexible 086, Phase Matched Pair to +/- 1ps
ML4035-2.4mm	MLCC-240MST-F08630-240MST-2-8	3	Coaxial Cable Assembly, 2.40 mm (M) ST. to 2.40 mm (M) ST., 60cm, Flexible 086, Set of 8 phased matched to +/- 1ps
ML4035-2.9mm	MLCC-292MST-F12430-292MST-2-P	12	Coaxial Cable Assembly, 2.92 mm (M) ST. to 2.92 mm (M) ST., 30cm, Flexible 124, Phase Matched Pair to +/- 1ps
ML4035-2.9mm	MLCC-292MST-F12430-292MST-2-8	3	Coaxial Cable Assembly, 2.92 mm (M) ST. to 2.92 mm (M) ST., 30cm, Flexible 124, Set of 8 phased matched to +/- 1ps

Instruments	Part Number	Qty	Description
ML4035-2.4mm	MLCC-240MST-F08660-240MST-2-P	12	Coaxial Cable Assembly, 2.40 mm (M) ST. to 2.40 mm (M) ST., 60cm, Flexible 086, Phase Matched Pair to +/- 1ps
ML4035-2.4mm	MLCC-240MST-F08660-240MST-2-8	3	Coaxial Cable Assembly, 2.40 mm (M) ST. to 2.40 mm (M) ST., 60cm, Flexible 086, Set of 8 phased matched to +/- 1ps
ML4035-2.9mm	MLCC-292MST-F12460-292MST-2-P	12	Coaxial Cable Assembly, 2.92 mm (M) ST. to 2.92 mm (M) ST., 60cm, Flexible 124, Phase Matched Pair to +/- 1ps
ML4035-2.9mm	MLCC-292MST-F12460-292MST-2-8	3	Coaxial Cable Assembly, 2.92 mm (M) ST. to 2.92 mm (M) ST., 60cm, Flexible 124, Set of 8 phased matched to +/- 1ps

Please contact us at 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.

