multiLane

Innovation for the next generation

ML9004E

4-Lane PPG & AWG

4-Channel Differential Arbitrary Waveform Generator with 1-64 GBd selectable Baud Rate and User Defined Modulation | 2 Dual-Channel (I/Q) Differential Pulse Pattern Generators with 25-64 GBd selectable Baud Rate | NRZ/PAM4 Modulation | Independent 7-tap FFE on each transmitter

Summary

With the accelerated growth of hyperscale datacenters, Ethernet network infrastructure performance demands are increasing exponentially, and customer expectations for high-speed data throughput are at an all-time high. Other high-speed I/O protocols such as PCIe Gen 5 and 6 are also gaining momentum. Arbitrary Waveform Generators are the ideal general-purpose development tool for validating high-speed receivers and are extremely flexible instruments for coherent module development.

The ML9004E consists of 4 differential transmit channels that can be used as Arbitrary Waveform Generators (AWG) or as Pattern Pulse Generators (PPG). It comes standard with a library of waveforms such as sine, square, triangle, or sinc for example. It has an intuitive graphical user interface to create PRBS bit sequences with FFE or pre- and post-emphasis. It supports SSC (Spread-Spectrum Clocking) and generating compliance test patterns with programmable RJ and SJ (dual tones) jitter injection, ISI and Cross-Talk emulation for PHY testing of MIPI A/C/D/M-PHY, PCIe, USB and others.

ML9004E

Introduction

With 400ZR adoption around the corner, an affordable tool set that can support the development of this technology and prepare for mass adoption is essential. The ML9004E is a new instrument that allows development and validation of equipment for high-performance high-speed data center networking.

The ML9004E is a fully feature arbitrary waveform generator that can be configured as four channels of 64 GBd each. In this mode, programmable RJ/SJ jitter injection, ISI and Cross-Talk emulation are supported.

The AWG is also a PPG that generates various PRBS patterns to double as a BERT TX for either NRZ or PAM4. In this mode, the PPG offers an FFE pre-emphasis filter with 7 taps (1 tap/UI).

Key Features

- 4-Channel Differential Arbitrary Wave Form Generator with selectable Baud Rate in the range of 1-64 GBd, 8-bit DAC, and User Defined Modulation
- 2 Dual-Channel (I/Q) Differential Pulse Pattern Generators with selectable Baud Rate in the range of 25-64 GBd, NRZ/PAM-4 Modulation, and Independent 7-tap FFE on each transmitter.
- Ability to generate coherent signals for QAM modulation (horizontal and vertical I/Q pairs)
- The wide range of bitrate coverage allows PHY testing of Ethernet, PCIe Gen 4/5/6, USB and others
- Independent control of inner eye levels
- Ability to tune the bit rate in very fine steps to facilitate finding locking margin
- Library of pre-defined waveforms
- Ability to generate custom modulation like PAM6, PAM8, etc. in AWG mode

Main updates

- Equal trace length on TX
- New form factor

Target Applications

- High-speed SerDes, transceivers, amplifiers
- Validation Test
- Production Wafer Sort Test
- Production Package Test
- Production Multisite Testing

Mechanical Dimensions

- Length: 104.20 mm
- Height: 58.19 mm
- Depth: 306.00 mm

Cables

To connect the instrument to the device load board, some examples of cable sets are shown here. Contact MultiLane for the best cabling options for your application:

- SMPM to 2.4 Male or Female depending on the setup

Figure 1: MultiLane SMPM to 2.4 mm male cable

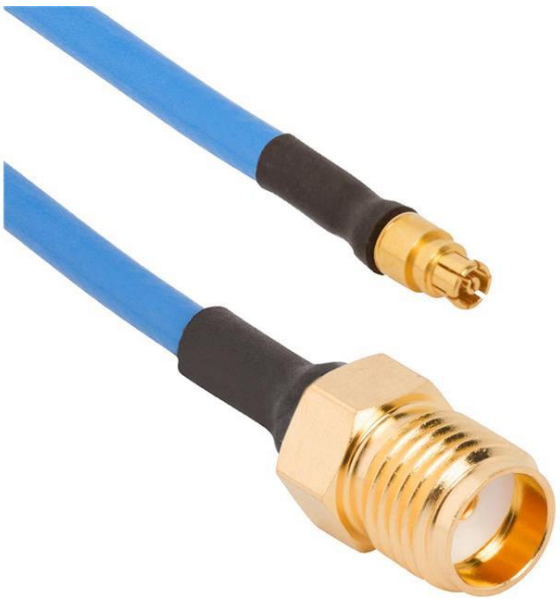

Figure 2: MultiLane SMPM to 2.4 mm female cable

Electrical Specifications

Parameter	Specifications
TX Coupling	AC coupled
Channel Impedance (Diff)	100 Ohm
Number of channels	4 differential channels
TX/RX connectors	SMPM (M)
TX 3dB Bandwidth	35 GHz
Reference clock Output	Baud Rate/48 or Baud Rate/24 (<1.2GHz max)
Clock out amplitude (SE/Diff)	0.6 Vpp
Clock input amplitude (SE/Diff)	0.5 Vpp
Clock Input Validated Range	150 - 160 MHz
Instrument Automatic Shutoff	85 °C
Recovery from over-temperature shutoff	Manual reboot of the system and instrument temperature below 85 °C
Setup time / Reboot	38 s
Normal Operating Temperature	0 - 40 °C
Air Supply Flow	See site preparation manual for system air supply requirements
Air Supply Temperature	See site preparation manual for system air supply requirements
Ambient Air Temperature	See site preparation manual for system air supply requirements
Power	2.3 A @ 12V

Table 1: General Specs

Parameter	Specifications
Tx Maximum Amplitude (Sine wave)	1050 mVppd[1]
Bit Rates	1 – 64 GBd
Vertical Resolution	8 bits
Modulation	User-defined
Pre-programmed Waveforms	PRBS 7, PRBS 9, Square wave, triangular Wave, sinewave, multi-tone, linear chirp, log chirp, sawtooth, exponential rise, exponential decay, Sinc, Lorentz, Surge, Damped Oscillation, Stairs, Serial Data, half-sine, Distorted sinewave and Gaussian.
Sampling rate	96 GSa/s max.
Memory Depth	33.6 kSa per channel

Table 2: Arbitrary Waveform Generator Specs

[1] For a two-tone signal, the amplitude will be half for each tone. For wideband signals, the amplitude will also be less than the sinewave amplitude since energy will be distributed among the fundamental and the overtones

Parameter	Specifications
Bit Rates	25 – 64 GBd
Modulation	NRZ and PAM4
Tx Maximum PRBS Amplitude at 26G	750 mVppd (350 mVppd in calibration mode)
Tx Maximum PRBS Amplitude at 53G	500 mVppd (300 mVppd in calibration mode)
Patterns	PRBS 7/9/11/15/20/23/29/31/35/39/41/47
TX Amplitude Adjustment	Steps of 1 mV
TX Equalization	FFE 3 taps or 7 taps
Pre-Emphasis Resolution	±168 steps
Equalizing Filter Spacing	1UI
Random Jitter RMS	290 fs
Rise/ Fall Time (20–80%)	12 ps[2]
Output Return Loss up to 10GHz	< -15dB
Output Return Loss (16-25GHz)	< -10dB

Table 3: PPG Specs

[2] With appropriate pre and post emphasis settings and 50 GHz scope

Appendix A: AWG Waveform Examples

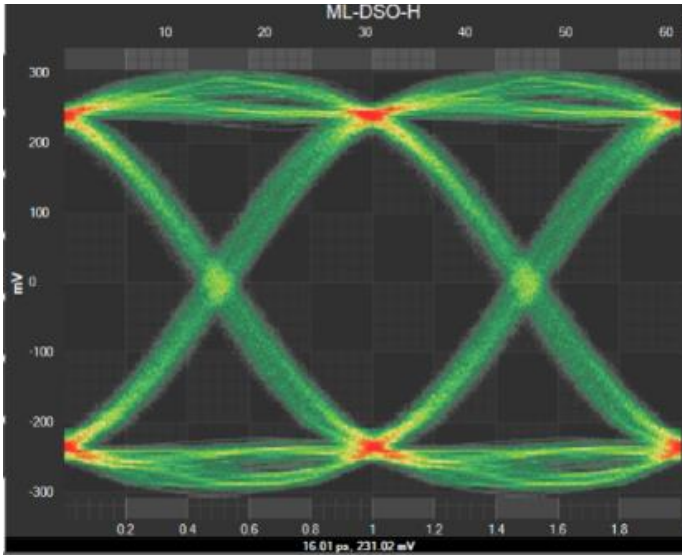

Figure 5: 32.5G NRZ Signal

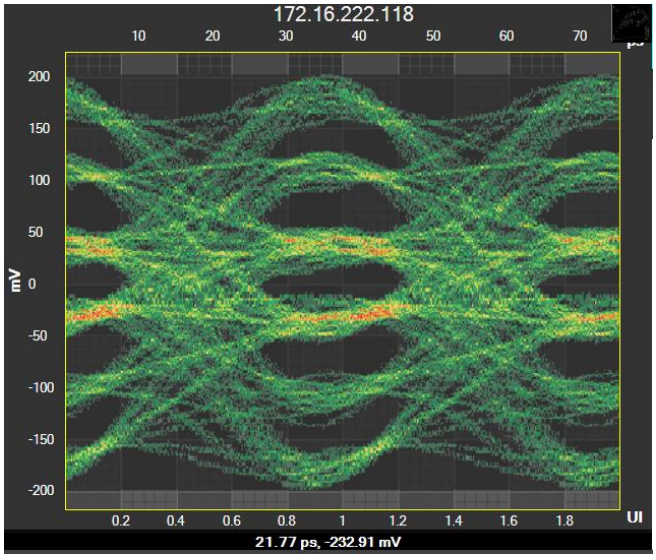

Figure 7: 26.5625G PAM6 Signal

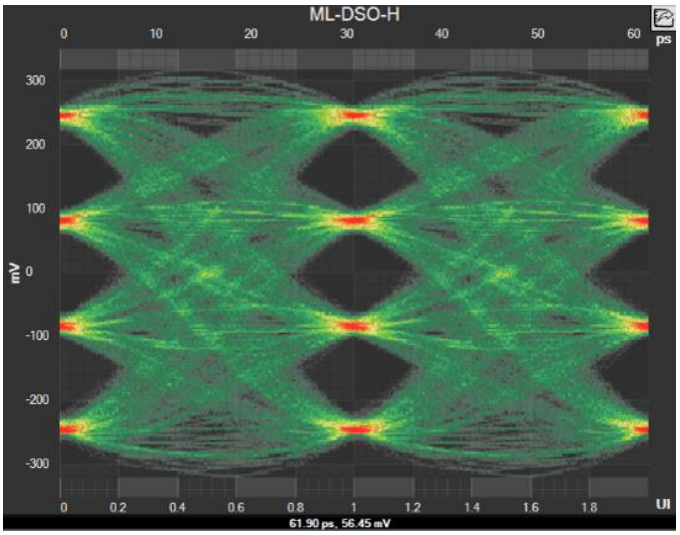

Figure 6: 32.5G PAM4 Signal

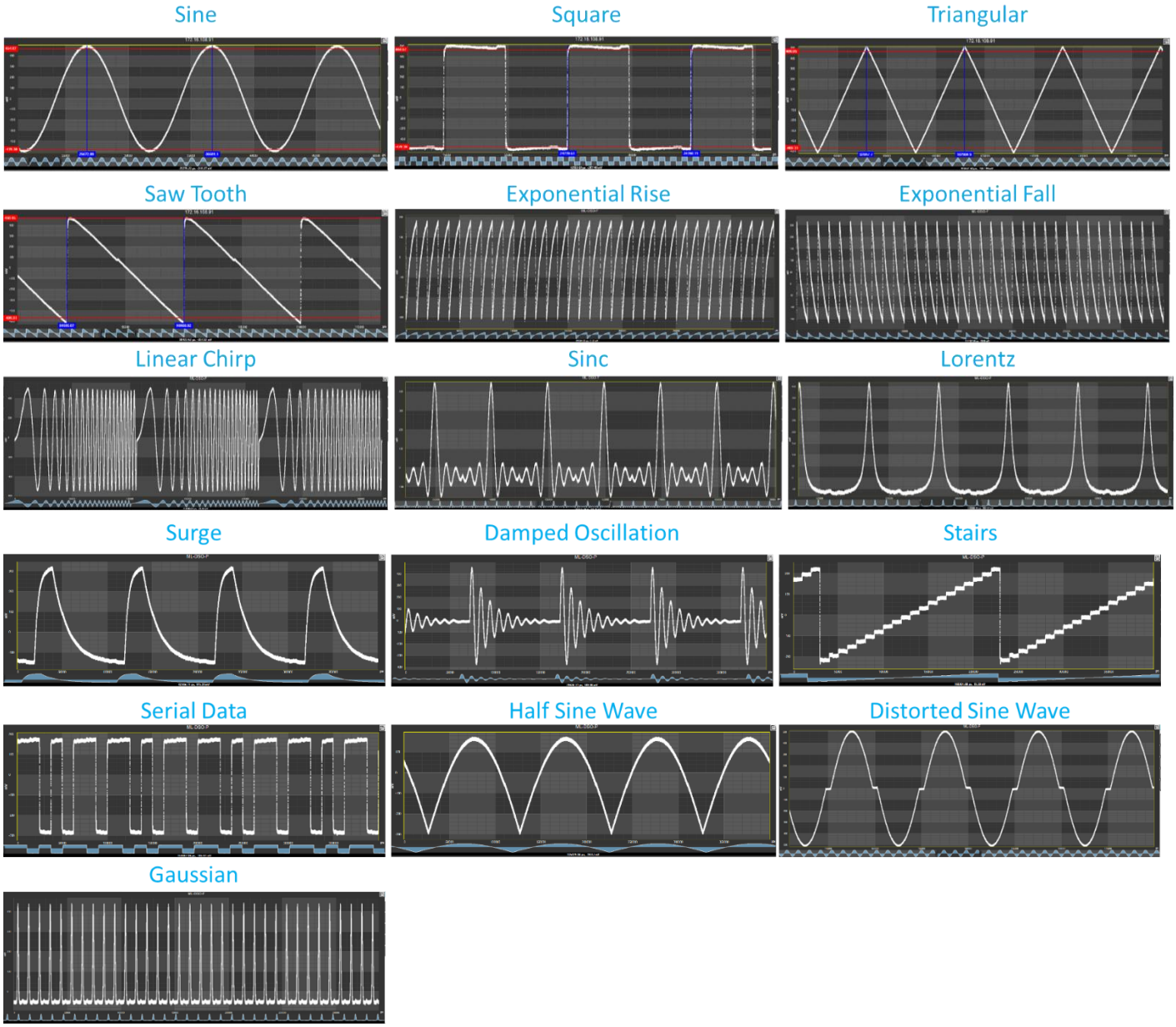

Figure 8: Arbitrary Waveforms, DAC rate 96 GigaSamples/second, Rep Rate 1GHz

Pinout

There's 4 connectors SMPM 1x2 for TX only in the ML9004E instrument.
Channel pinout is enumerated in the below picture, beginning by TX row with TX1-N, TX1-P to TX4-N, TX4-P.

Ordering Information

Option	Description
ML9004E	4-lane AWG
1YW	1-year standard warranty
3YW	3-year warranty
CAL	Single calibration
3YWC	3-year warranty + 3 annual calibrations

Please contact us at sales@multilaneinc.com