multiLane

Innovation for the next generation

ML4100L-AWG

4-Lane PPG & AWG

4-Channel Differential Arbitrary Waveform Generator with 1-64 GBd selectable Baud Rate and User Defined Modulation | Programmable SJ jitter and ISI injection | 2 Dual-Channel (I/Q) Differential Pulse Pattern Generators with 25-64 GBd selectable Baud Rate | NRZ/PAM4 Modulation | Independent 7-tap or 60-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 ML4100L-AWG 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.

ML4100L-AWG

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 ML4100L-AWG is a new instrument that allows development and validation of equipment for high-performance high-speed data center networking.

The ML4100L-AWG 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 Waveform Generators with selectable Baud Rate in the range of 0.5-64 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 Baud rate coverage allows PHY testing of Ethernet, PCIe 5/6, USB and others
- Independent control of inner eye levels
- Ability to generate compliance test patterns with injected RJ/SJ jitter and emulation of ISI and Cross-Talk for PHY testing of MIPI A/C/D/M-PHY, PCIe, USB and others
- Ability to tune the Baud rate in very fine steps to facilitate finding locking margin
- Library of pre-defined waveforms

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

Target Applications
- High-speed SerDes, transceivers, and amplifier validation
- General purpose R&D tool
- Coherent 400ZR module development and validation

Mechanical Dimensions

The ML4100L-AWG is a benchtop instrument that fits in a 19-inch 2U rack. One ML4100L-AWG takes up one 2U slot in your rack. MultiLane also supplies the needed brackets.

Figure 1: ML4100L – AWG GUI

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Electrical Specifications

Parameter	Specifications
TX Coupling	AC coupled
Channel Impedance (Diff)	100 Ohm
TX/RX connectors	2.4 mm connectors (2.92 mm optional)
TX 3dB Bandwidth	35 GHz
Reference clock Output	Baud Rate/48 or Baud Rate/24
Clock out amplitude	0.6 Vpp
Clock input amplitude	0.5 Vpp
Clock Input Validated Range	150 - 160 MHz
Diff. Output Return Loss	Maximum -10 dB
Ambient Temperature	0 - 40 °C
Power	110 V, 1.4 A or 220 V, 0.9 A – 50/60 Hz

Table 1: General Specs

Parameter	Specifications
Tx Maximum Amplitude (Sine wave)	1050 mVppd[1]
Baud Rates	0.5 – 64 GBd
DAC Rate	Up to 96 GS/s
Modulation	User-defined
Pre-programmed Waveforms	PRBS 7/9/11, 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.
Memory Depth	33600 points
SJ Jitter injection	SJ Frequency > 1 MHz (Generation of Dual SJ Tones is supported)
ISI injection	User-defined

Table 2: Arbitrary Waveform Generator Specs

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[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
Baud Rates	25 – 64 GBd
Modulation	NRZ and PAM4
Tx Maximum Amplitude at 26G	750 mVppd (350 mVppd in calibration mode)
Tx Maximum 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 (60-tap support planned)
Pre- / Post-emphasis	10 dB
Pre-Emphasis Resolution	±168 steps
Equalizing Filter Spacing	1UI (1/3 UI in 60-tap mode)
Random Jitter RMS	290 fs
Rise/ Fall Time (20–80%)[2]	12 ps
Output Return Loss up to 10GHz	< -15dB
Output Return Loss (16-25GHz)	< -10dB

Table 3: PPG Specs

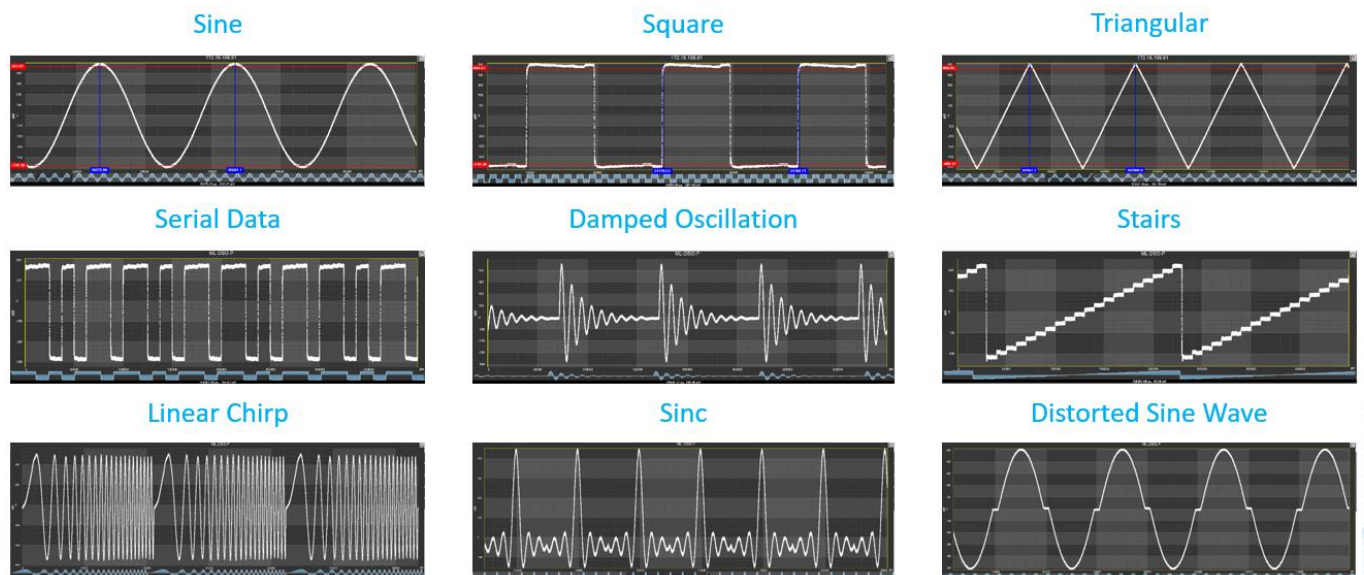# Appendix A: Examples of Classical AWG Output

Figure 2: Examples of available standard waveforms

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

4.5G NRZ Signal

4.5G PAM4 Signal

30G PAM6 Signal

32.5G NRZ Signal
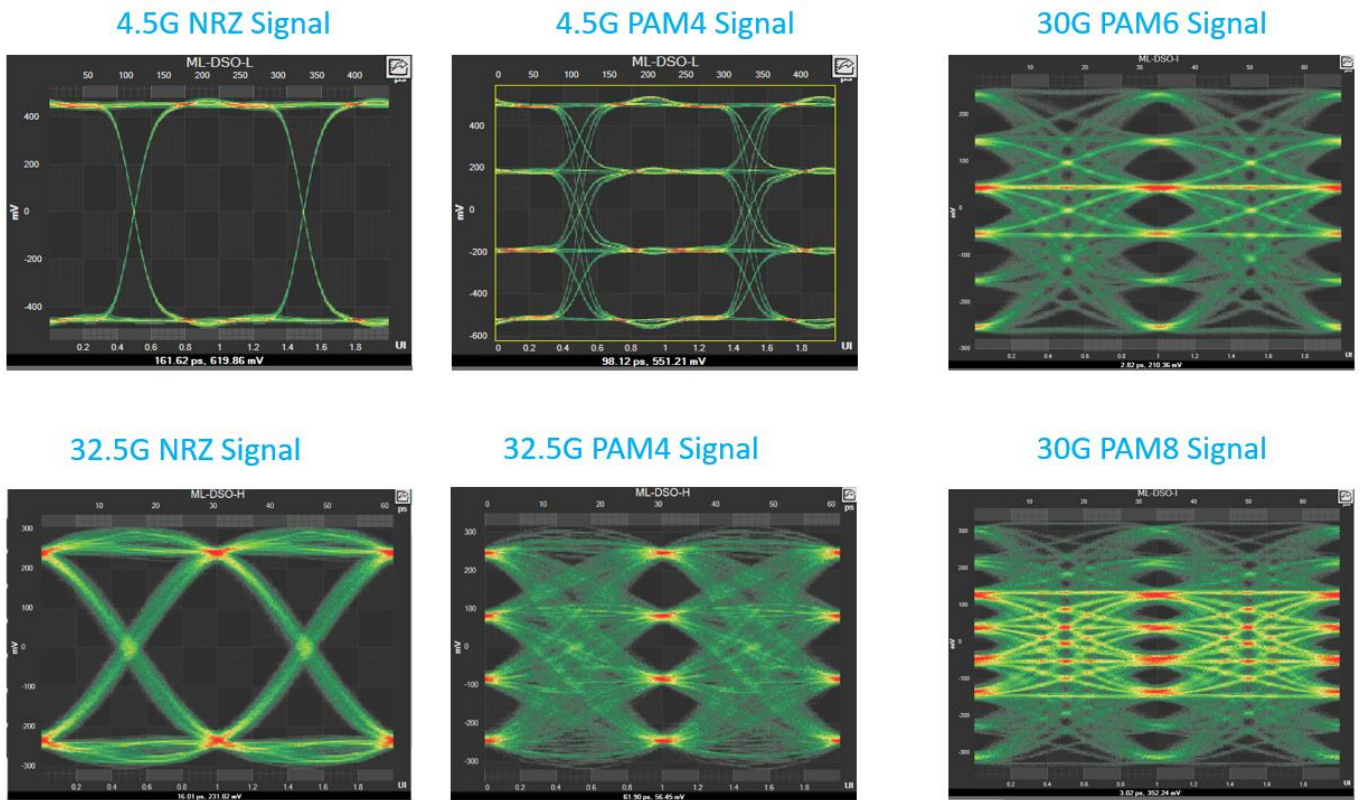
32.5G PAM4 Signal

30G PAM8 Signal

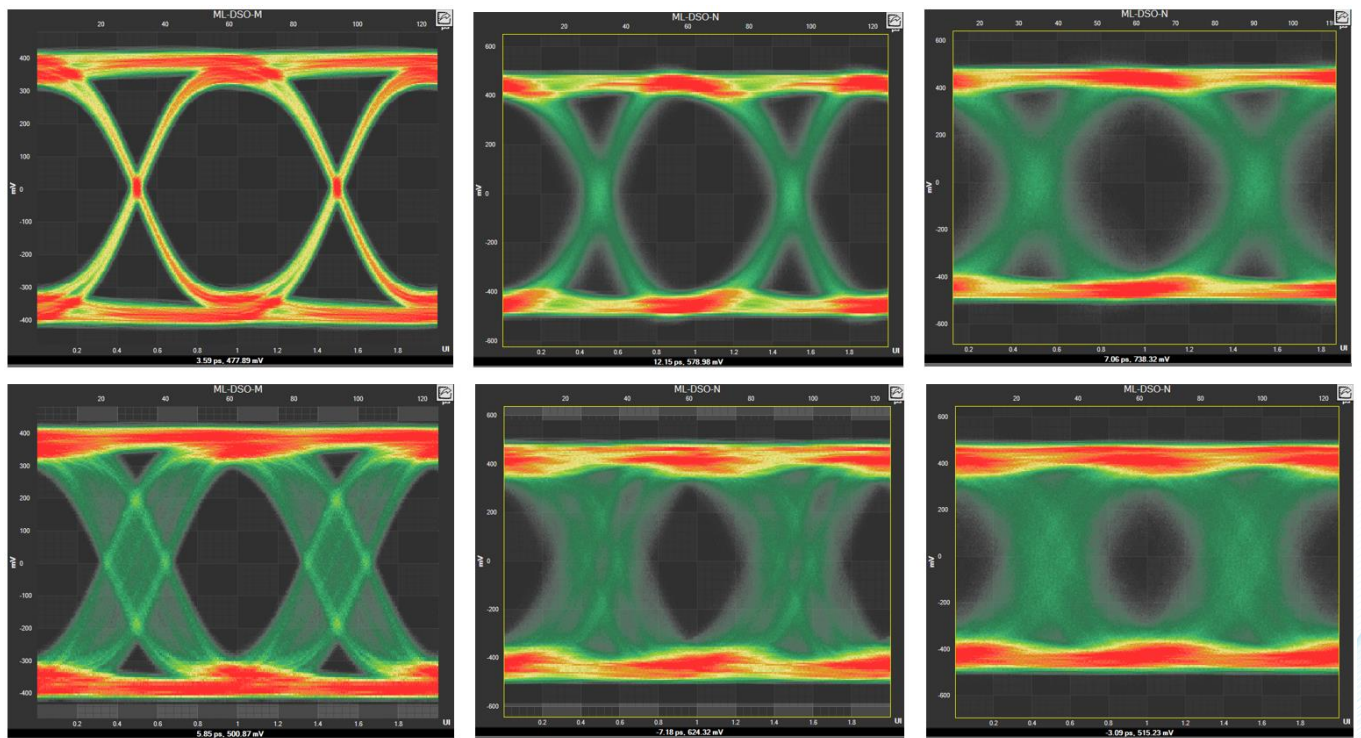**Figure 3: Examples of PAM signals generated at different rates**

Figure 4: Examples of RJ and SJ Jitter Injection by Software at 16 Gbps PRBS11 NRZ

Ordering Information

Option	Description
ML4100L-AWG	4-lane PPG & AWG with 1-year standard warranty
-3YW	Additional p/n suffix. Extended 3-year standard warranty
-3YWC	Additional p/n suffix. Extended 3-year standard warranty + 3 annual calibrations

Please contact us at sales@multilaneinc.com