

M8194A 120 GSa/s Arbitrary Waveform Generator

Version 0.9



M8194A in a 2-slot AXIe chassis

M8194A at a glance

The Keysight Technologies, Inc. M8194A arbitrary waveform generator (AWG) has the highest sample rate and the widest bandwidth in its class with up to four synchronized channels operating simultaneously in one module

- Sample rate up to 120 GSa/s (on all 4 channels simultaneously)
- Analog bandwidth: 45 GHz (typical), generate signals with frequency components up to 50 GHz ¹
- 8 bits vertical resolution
- 512 kSa of waveform memory per channel
- 1, 2, or 4 differential channels per 1-slot AXIe module (number of channels is software upgradeable)
- Amplitude up to 0.8 V_{pp}(se) / 1.6 V_{pp}(diff.), voltage window -1.0 to +2.5 V
- Transition time (20%/80%): 11 ps without corrections / 6 ps with corrections applied (typical)
- Built-in frequency and phase response calibration for clean output signals

Coherent Optical Applications

400 G and 1 Terabit applications demand a new class of generators that provide high speed, precision and flexibility at the same time. The M8194A is the ideal solution to test different optical systems from discrete components like optical power amplifiers to more complex dual polarization systems like optical modulators or optical receivers.

With up to 4 channels per 1-slot AXIe module, each running at up to 120 GSa/s with 45 GHz of analog bandwidth, it allows dual polarization testing in a small form factor and the generation of complex signals with multiple modulation schemes (PAM-4, PAM-8, QPSK, nQAM) up to 100 GBaud.

Compensation for distortions generated e. g. by cables and amplifiers can be realized by embedding/de-embedding the S-parameters of the respective circuits or by performing an in-situ calibration using the Keysight Technologies vector signal analysis software.

Combined with the 81195A optical modulation generator software, the M8194A makes it easy to generate optical impairments (e.g. PMD) for stressing the optical receiver over multiple test scenarios.

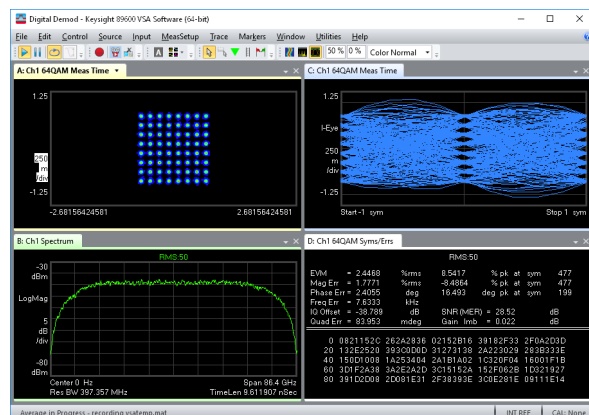


Figure 1. 64-QAM at 64 GBaud (electrical)

¹ At 50 GHz, attenuation is approx. 7.5 dB (refer to figure 3) – can be compensated by digital pre-distortion

Multi-Level/Multi-Channel Digital Signals

The M8194A is also ideally suited to address multi-level/multi-channel interfaces using any standard or custom data format, for example high-speed backplane connections using PAM-4 or PAM-8 format, as well as technologies in the mobile application space.

The flexibility of the waveform generation at its highest speeds, combined with excellent intrinsic jitter performance makes the M8194A a truly future-proof instrument.

At data rates of multiple Gb/s, the effect of cables, board traces, and connectors etc. has to be taken into account in order to generate the desired signal at the test point of the device under test. The M8194A incorporates digital pre-distortion techniques for frequency- and phase-response compensation of the AWG output and any external circuit to generate the desired signal at the device under test. Channels can be embedded/de-embedded if the S-parameters of the respective circuits are provided.

In conjunction with the 81195A optical modulation generator software various kinds of distortions can be added to the signal.

With its high channel density, the M8194A is well-suited to affordably and precisely stimulate multi-lane high-speed interfaces.

Physics, Chemistry and Electronics Research

With the M8194A AWG it is possible to generate any arbitrary waveform you can mathematically describe and download it directly to the M8194A. This includes ultra-short yet precise pulses down to 16 ps pulse width or extremely short, yet wideband RF pulses and chirps which are needed to investigate in live time chemical reactions and elementary particle excitation.

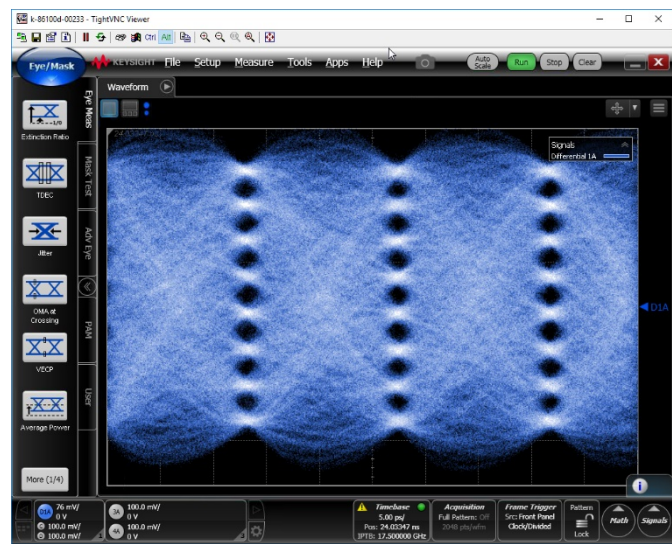


Figure 2. 70 GBaud PAM8 signal

Configuration

Product number	Description	Comment
M8194A-001	Arbitrary waveform generator module 1 channel, 120 GSa/s, 512 kSa per channel	Includes local start-up assistance
M8194A-002	Arbitrary waveform generator module 2 channels, 120 GSa/s, 512 kSa per channel	
M8194A-004	Arbitrary waveform generator module 4 channels, 120 GSa/s, 512 kSa per channel	
M8194A-BU2	Pre-configured system consisting of one M9502A 2-slot AXIe Chassis with USB Option	
M8194A-BU3	Pre-configured system consisting of one M9502A 2-slot AXIe Chassis with USB Option and one M9537A AXIe Embedded PC Controller	

Upgrade options

Product number	Description	Comment
M8194AU-U02	Upgrade from 1 channel to 2 channels	Software license
M8194AU-U04	Upgrade from 2 channels to 4 channels	Software license

Accessories

In order to be operational, an AXI chassis plus either an embedded controller or external PC or laptop are required in addition to one or more M8194A modules: (See <http://www.keysight.com/find/AXIe> for more details)

Product number	Description
M9502A-U20	2-slot AXIe chassis with USB Option
M9505A-U20	5-slot AXIe chassis with USB Option
M9537A	AXIe embedded controller
8121-1243	Cable assembly USB Type A-MINI B
M9048A	PCIe® desktop card adapter Gen 2 x8
Y1202A	PCIe cable for M9048A desktop adapter
M8194A-810	Matched cable pair for M8194A AWG, 1.85 mm
M8194A-820	Termination 50-Ohm, 1.85 mm

Software

Product number	Description	Comment
81195A	Optical Modulation Generator Software	Free to download
81195A-OSP	Optical Signal Properties	requires 81195A
M8070A-0TP	System Software for M8000 Series of BER Test Solutions, Transportable, Perpetual License	
M8070A-0NP	System Software for M8000 Series of BER Test Solutions, Network/Floating, Perpetual License	
M8070A-1TP	DUT Control Interface, Transportable, Perpetual License	
M8070A-1NP	DUT Control Interface, Network/Floating, Perpetual License	
N6171A-M02	MATLAB license (standard)	
N6171A-M03	MATLAB license (extended)	

Specifications

General characteristics

Sample rate	115.2 to 120.2 GSa/s 107.2 to 112.2 GSa/s 95.6 to 100.2 GSa/s
DAC resolution	8 bits
Number of channels per M8194A module	1, 2, or 4 (corresponds to Opt. 001, 002, and 004) Additional number of channels can be enabled via user-installable software license
Frequency accuracy (at 1 GHz, at output)	±30 ppm

Sample memory

Sample memory	512 kSa per channel. The waveforms in each channel can have different length
Waveform granularity	128 samples. The length of waveform segments must be a multiple of the granularity
Minimum waveform length	128 samples

Out 1, 2, 3, 4

Output type	Single-ended ² or differential
Analog bandwidth (3 dB, excl. sin(x)/x roll-off)	45 GHz (typ)
Rise/fall time (20%/80%) ^{3,4}	6 ps (typ) corrected ³ 11 ps (typ) uncorrected
Impedance	50 Ω (nom)
Amplitude	75 mV _{pp} (se) to 0.8 V _{pp} (se) into 50 Ω 150 mV _{pp} (diff.) to 1.6 V _{pp} (diff.) into 50 Ω
Amplitude resolution	400 μV (nom)
DC amplitude accuracy ⁴	±(2.5% +10 mV) (typ)
Voltage window	-1.0 to +2.5 V single-ended into 50 Ω
Offset resolution	400 μV (nom)
DC offset accuracy ⁵	±20 mV (typ)
Differential offset	Adjustable
Termination voltage window	-1.5 to +3.5 V (low level -400 mV) to (high level +400 mV)
Termination voltage resolution	300 μV (nom)
Skew between any pair of outputs	
Within channel pairs 1/2 and 3/4	0 ps ±7 ps (typ)
Between channels 1/2 and 3/4	0 ps ±TBD ps (typ)
Skew between normal and complement	0 ps ±3 ps (nom)

² Unused output must be terminated with 50 Ω to GND

³ Frequency response corrected up to 50 GHz

⁴ Termination voltage = 0 V; adjusted at 23 °C ambient temperature, amplitude increases by 0.4%/°C (typical) for ambient temperature below 23 °C

⁵ Termination voltage = 0 V

Total Jitter, with pre-distortion	
Within channel pairs 1/2 and 3/4	TBD pS _{peak-peak} at 64 Gb/s PRBS (typ)
Between channels 1/2 and 3/4	TBD pS _{peak-peak} at 64 Gb/s PRBS (typ)
Random jitter, RMS	TBD pSRMS (typ)
Harmonic distortions	
2nd harmonic	-35 dBc (typ), f _{out} ≤ 20 GHz -30 dBc (typ), f _{out} > 20 GHz
3rd harmonic	-30 dBc (typ), f _{out} ≤ 10 GHz -25 dBc (typ), f _{out} > 10 GHz
SFDR (excluding harmonic distortions)	-35 dBc (typ), f _{out} = DC... 10 GHz -30 dBc (typ), f _{out} = 10 GHz... 40 GHz -25 dBc (typ), f _{out} = 40 GHz... 45 GHz
Amplitude flatness (at RF output connector, compensated for sin(x)/x)	±1 dB (typ), f _{out} = DC ... 5 GHz ±2 dB (typ), f _{out} = 5 GHz ... 40 GHz ±3 dB (typ), f _{out} = 40 GHz ... 45 GHz
Total Harmonic Distortion	1.3 % (typ), f _{out} = 1 GHz 1.5 % (typ), f _{out} = 2 GHz 1.8 % (typ), f _{out} = 5 GHz 2.3 % (typ), f _{out} = 10 GHz
Connector type	1.85 mm (female)

Frequency response

Frequency response measured with a sample rate of 120 GSa/s, differential output, 500 mV amplitude. No sin(x)/x corrections has been applied to the graph.

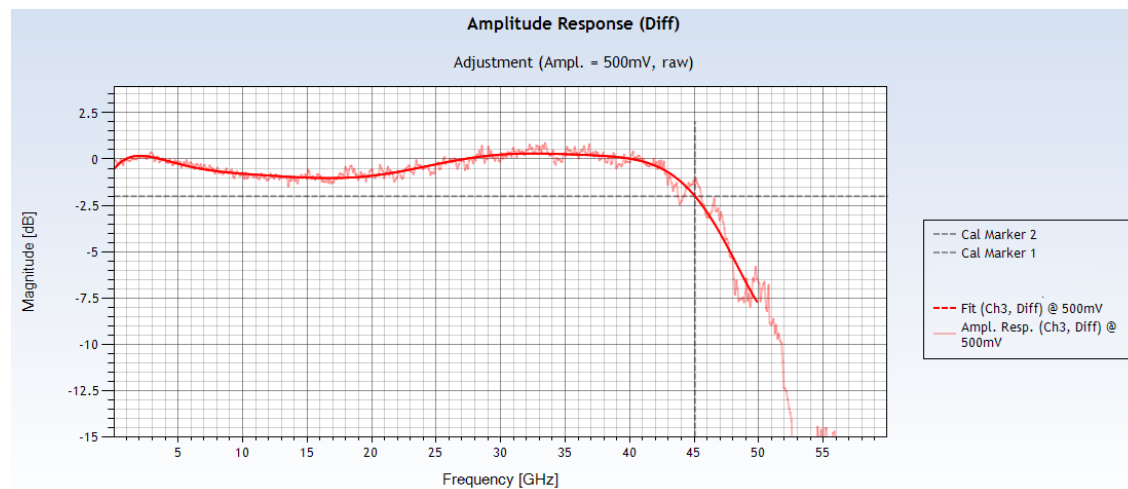


Figure 3.

ENOB

ENOB measured with a sample rate of 120 GSa/s, differential output, 500 mV amplitude, according to IEEE 1658-2000, with noise and distortions up to the Nyquist frequency (60 GHz) considered.

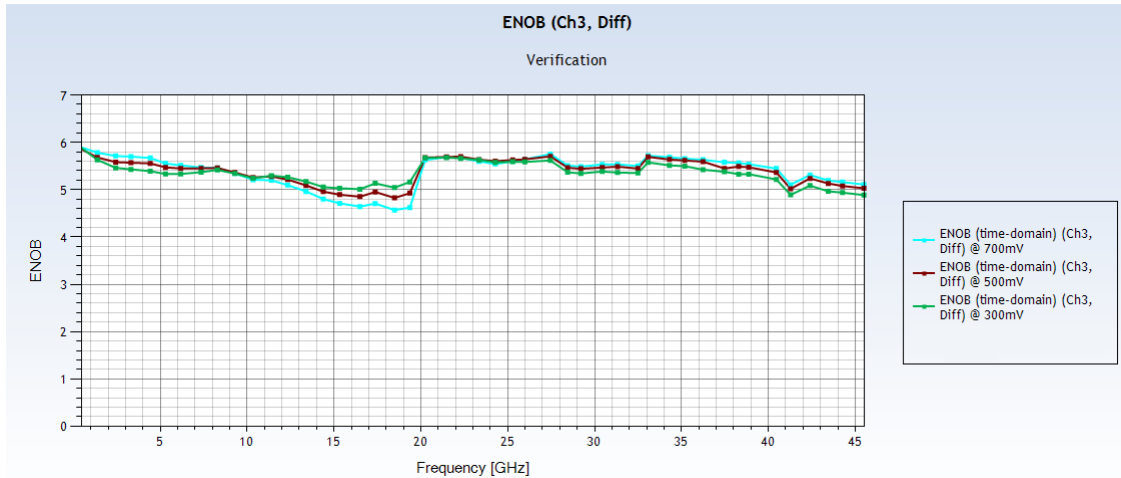


Figure 4.

This information is subject to change without notice.

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