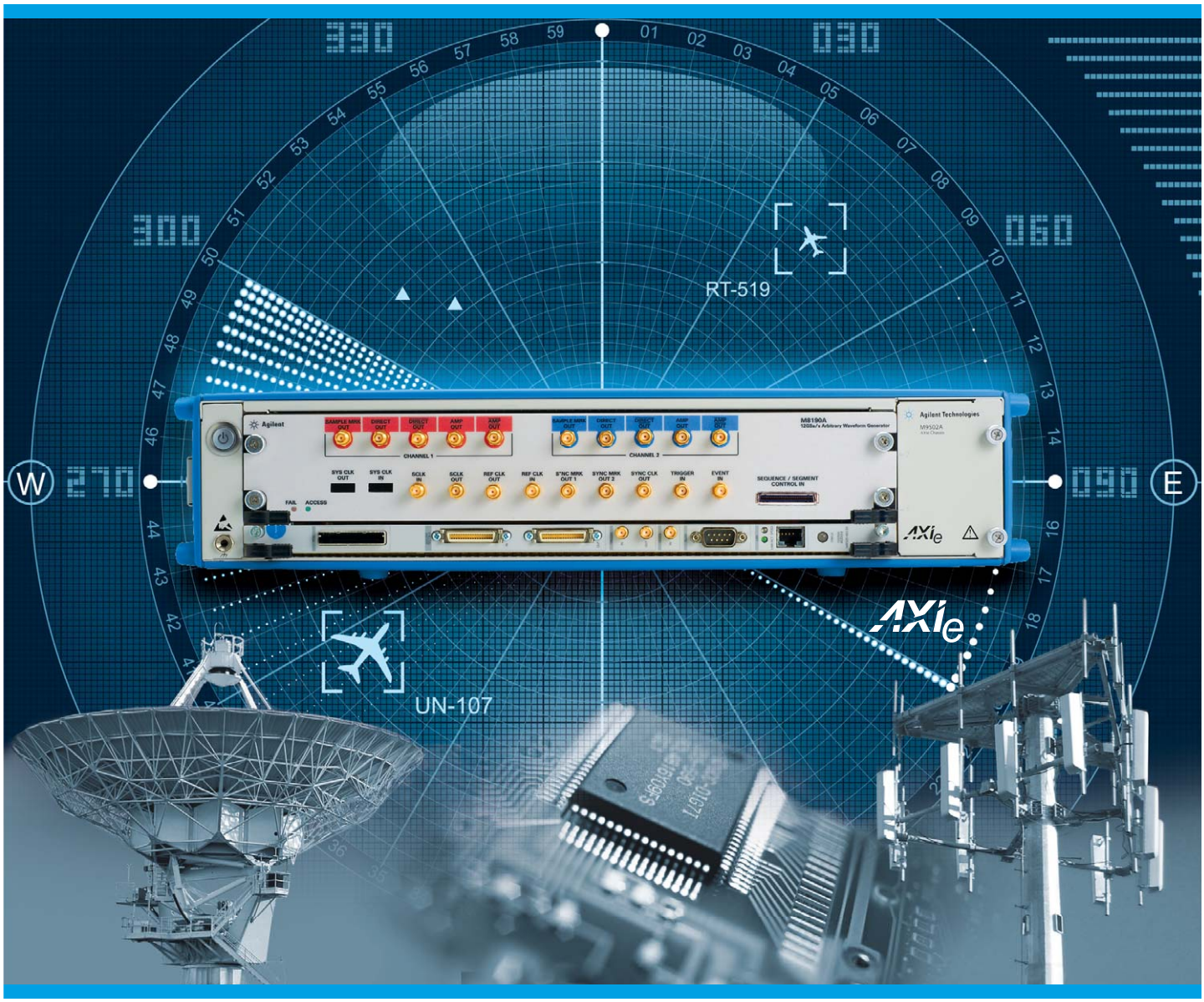
Enhance your reality

M8190 Arbitrary Waveform Generator

12 GSa/s Arbitrary Waveform Generator

Version 0.9



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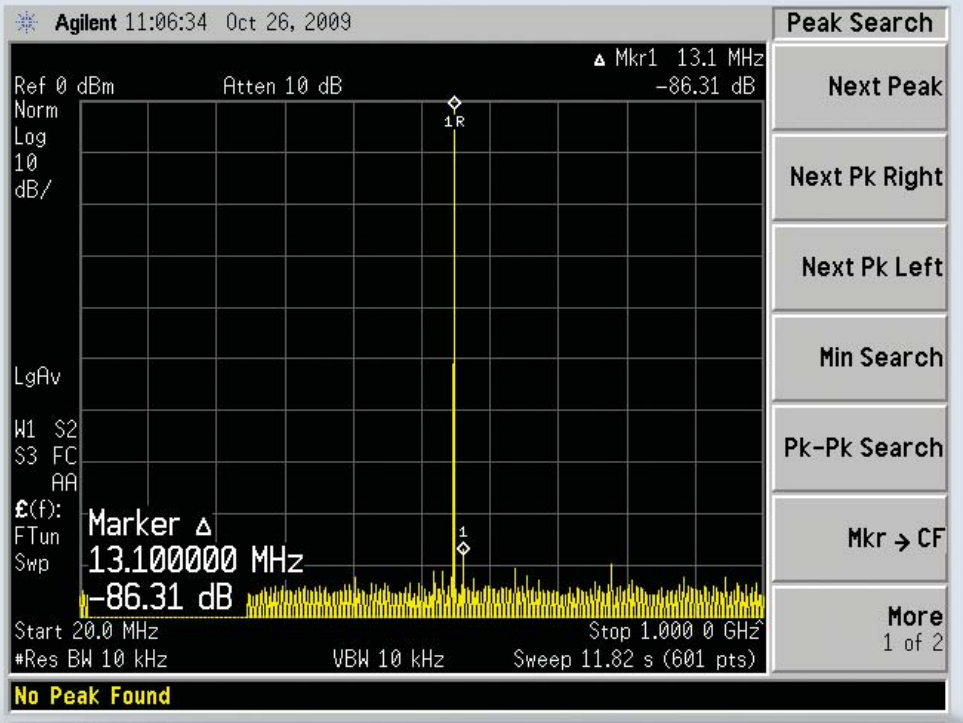


High resolution + wide bandwidth in an AWG.

M8190A 12 GSa/s
Arbitrary Waveform Generator

M8190A at a glance

- Precision AWG with two DAC settings
  - » 14-bit resolution up to 8 GSa/s
  - » 12-bit resolution up to 12 GSa/s
- Variable sample rate from 125 MSa/s to 8 / 12 GSa/s
- Spurious-free-dynamic range (SFDR) up to 80 dBc typical
- Harmonic distortion (HD) up to -72 dBc typical
- Up to 2 GSa arbitrary waveform memory per channel with advanced sequencing
- Analog bandwidth 5 GHz (direct DAC out)
- Transition times 50 ps (20/80), direct DAC out

Three amplifiers for different applications

- **Direct DAC**—optimized for I/Q signal generation with best SFDR & HD
  - ◦ DC to 5 GHz bandwidth
  - ◦ Amplitude ~350 mVpp ... 700 mVpp, fixed offset
  - ◦ Differential output
  - ◦ $t_{rise/fall,20\% - 80\%}$ ~ 50 ps
- » **DC amplifier***—optimized for serial data / time domain applications
  - ◦ DC to 5 GHz bandwidth
  - ◦ Amplitude 600 mV ...1.0 Vpp; output voltage window: -1.0 V...+3.0 V
  - ◦ $t_{rise/fall,20\% - 80\%}$ ~ 50 ps
  - ◦ Differential output
- ◦ **AC amplifier***—optimized to generate direct IF/RF signals
  - ◦ 50 MHz to 5 GHz bandwidth
  - ◦ Single ended, AC coupled output
  - ◦ Output power: -10 dBm ... +10 dBm
- Form-factor: 2 U AXIe module, controlled via external PC or AXIe system controller
- Supported software Agilent Benchlink Waveform Editor, MATLAB, LABVIEW, Agilent Signal Studio (pulse builder and multitone), Agilent SystemVue, Agilent wideband waveform creator

* AMP option

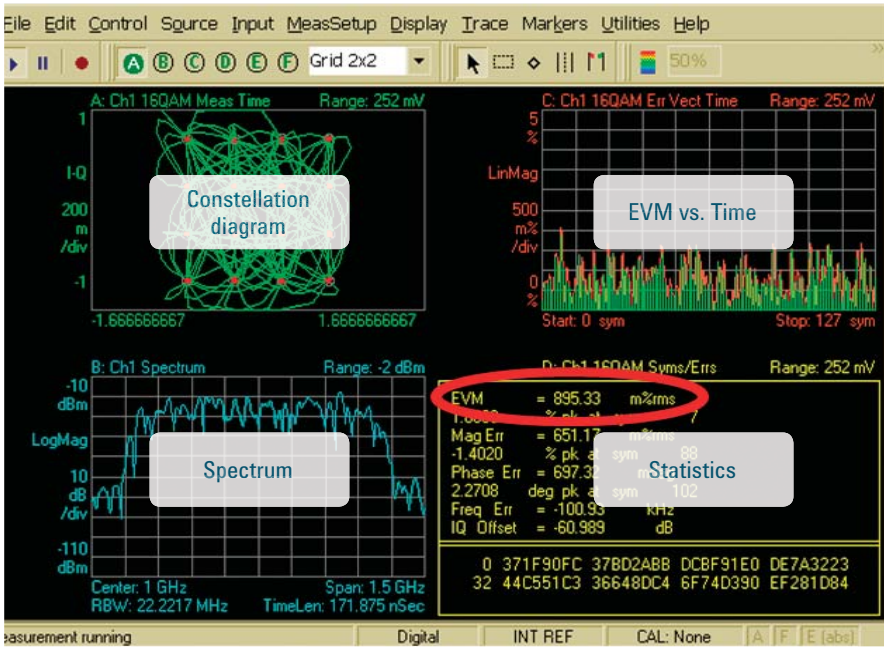
Enhance Your Reality

Get reliable, repeatable measurements from precise signal simulations

A better name for an advanced arbitrary waveform generator is a "signal scenario generator" or SSG.

This description signifies a level of versatility that enables you to set up complex real-world signals—whether you need precise signals to characterize the performance of a design or need to stress a device to its limits. From low-observable radar to high-density communications, testing is more realistic with precision arbitrary waveform generation from an SSG.

Take reality to the extreme: An Agilent AWG is the source of greater fidelity, delivering high resolution and wide bandwidth—simultaneously. This unique combination lets you create signal scenarios that push your designs to the limit and bring new insights to your analysis. Get bits and bandwidth—and enhance your reality.



High-quality signal generation is the foundation of reliable and repeatable measurements. The Agilent M8190A ensures accuracy and repeatability with 14-bit resolution, up to 8 GSa/s sampling rate and up to 80 dBc SFDR. High dynamic range and excellent vertical resolution gives you confidence that you are testing your device, not the signal source.

As an example, a test setup that exhibits a high error vector magnitude (EVM) reading might prevent you from seeing problems within your device under test (DUT). The level of reality possible with the M8190A minimizes problems like this.

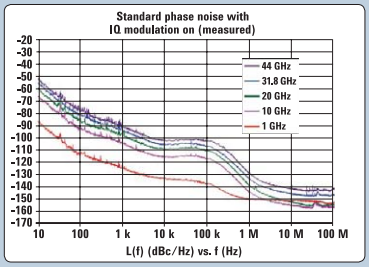
Versatile

Optimize the output to match your application

An AWG is the most versatile signal scenario generator possible. Capabilities such as easy switching between 14-bit output at 8 GSa/s and 12-bit output at 12 GSa/s help you handle multiple applications and measurement requirements.

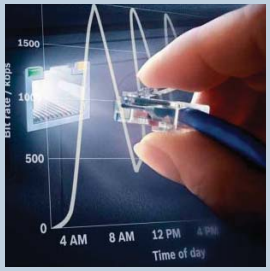
Because every application calls for different signal characteristics, the Agilent M8190A also contains three amplifiers that are optimized for I/Q signals, IF/RF output, or clean time-domain signals. You can switch between them as needed through software commands.

Optimized for different signal characteristics



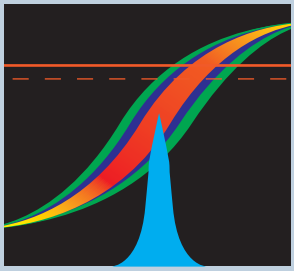
I/Q signal generation with best SFDR and HD

5 GHz Bandwidth
Differential Output
Amplitude ~350mV$_{pp}$...700mV$_{pp}$,
Fixed offset
Transition times (20/80) ~50ps
Direct Output



High Bandwidth for IF/RF Signals

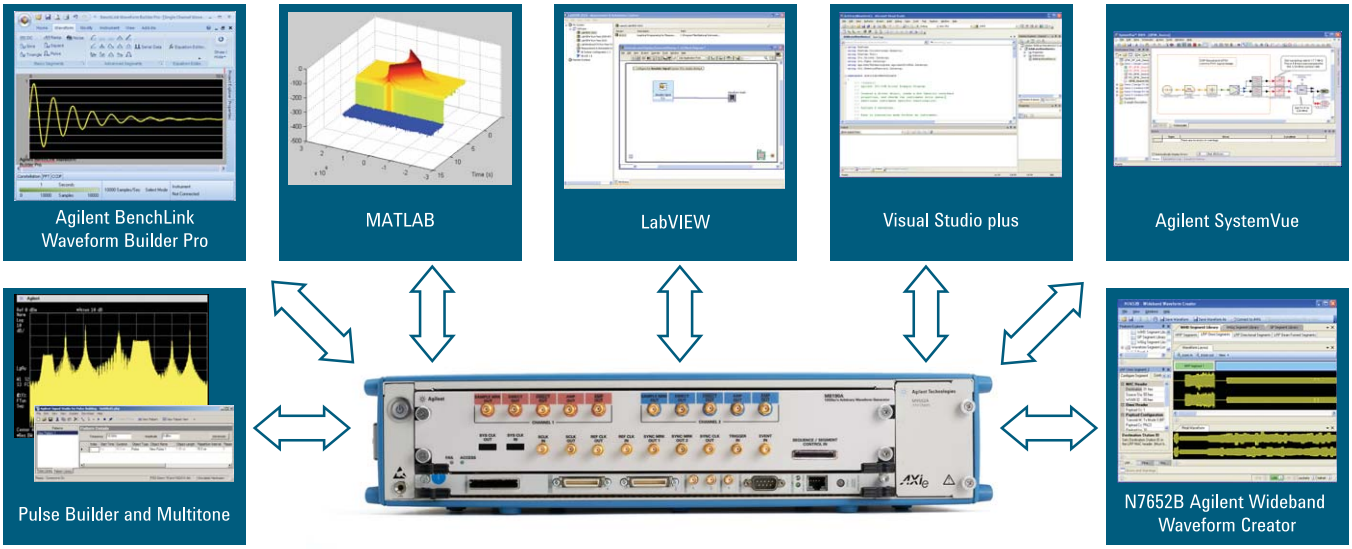
Single-ended, AC coupled output
Output Power: 10dBm...+ 10dBm
AC amplifier*



Time domain measurements Low Jitter

Differential output
Amplitude 600mV...1.0V$_{pp}$
Output voltage window—1.0V...+3.0V
Transition times (20/80) ~50ps
DC amplifier*

*AMP option



Memory

Highly realistic testing often requires long play times and long signal scenarios.

For example, 2 GSa of memory combined with advanced sequencing capabilities allow you to use the memory efficiently and effectively.

Direct access to individual memory segments is possible in real time through the dynamic sequence control input. You can create waveforms in software applications such as Signal Studio and MATLAB and download them into the M8190A.

For sensitive applications, memory storage is not persistent: Memory contents are volatile and are erased when power is turned off.

Create complex signal scenarios—efficiently

Configure

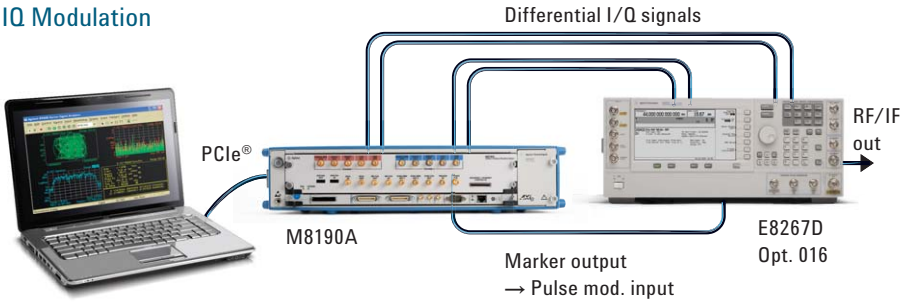
Assemble the best configuration for your application

The typical test setup shown to the right covers high RF applications up to 40 or 60 GHz. In this case the M8190A generates differential I/Q signals that are sent to an upconverter such as the Agilent PSG signal generator. The M8190A is packaged in the AXIe form factor, which reduces system size, weight and footprint.

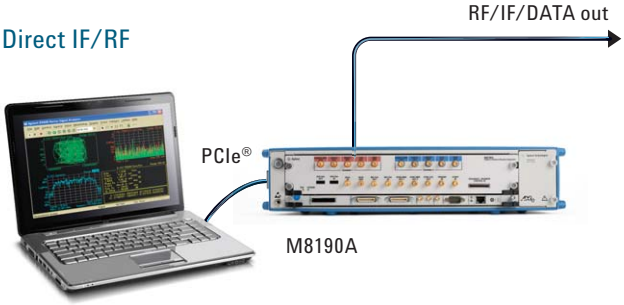
The block diagrams shown to the right illustrate configurations for I/Q modulation and direct IF/RF output. The M8190A supports direct generation of IF signals: Because this is done digitally, signal quality is outstanding. The instrument provides an analog bandwidth of 5 GHz; if higher bandwidth is needed a mixer must be added to the configuration.

Modulation BW up to **2 GHz**
RF up to **44 GHz**

IQ Modulation



Direct IF/RF



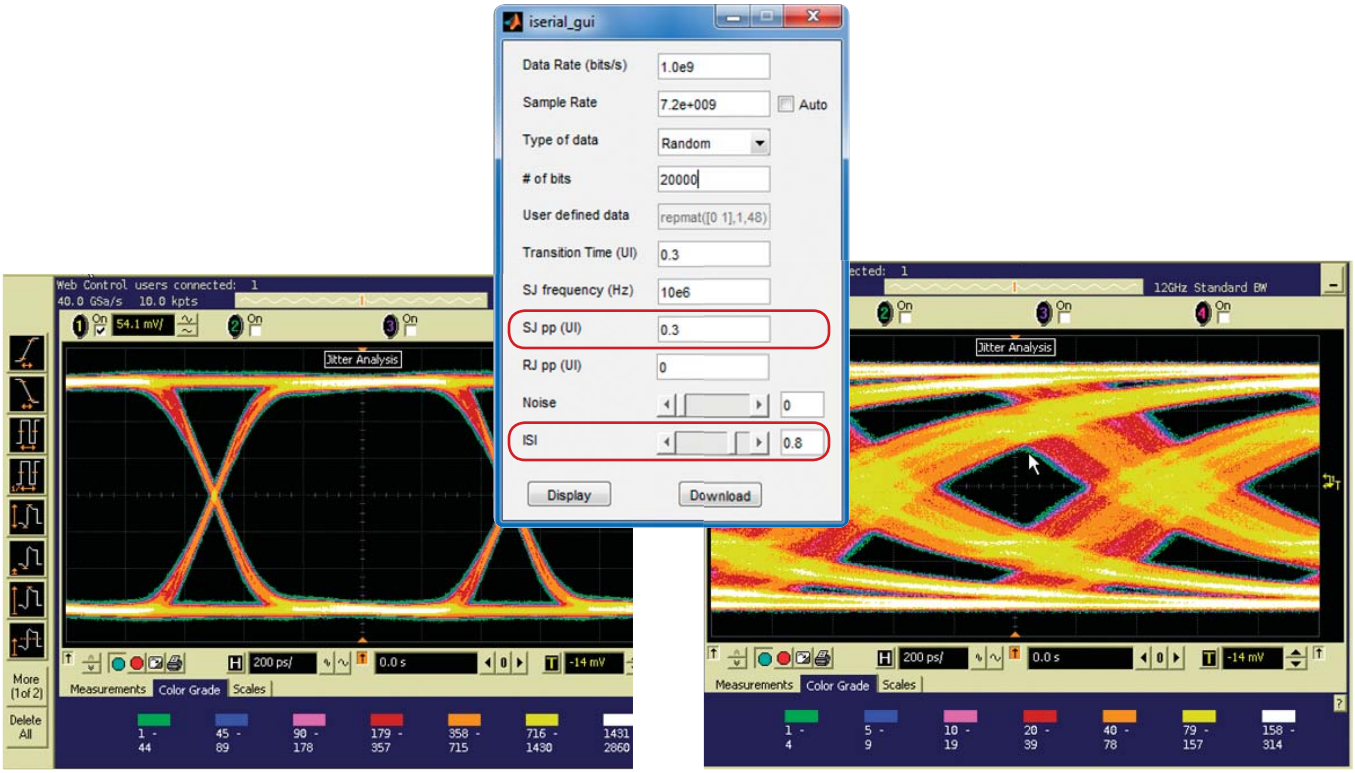
IF/RF up to **5 GHz**
Modulation BW up to 2 * (5 GHz—IF)
Data up to 3 Gb/s

Generate multi-level signals with programmable ISI and jitter up to 3 Gb/s

Multi-level signals

Jitter and noise cause misalignment of edges and levels, resulting in data errors.

The M8190A is equipped to ensure flexible modifications to fit new distortion requirements by simply adapting the waveform itself. You can easily mimic analog imperfections that occur in real-world environments by using mathematical description in tools such as MATLAB. This minimizes the need for additional hardware while preserving the ability to create realistic signal simulations.



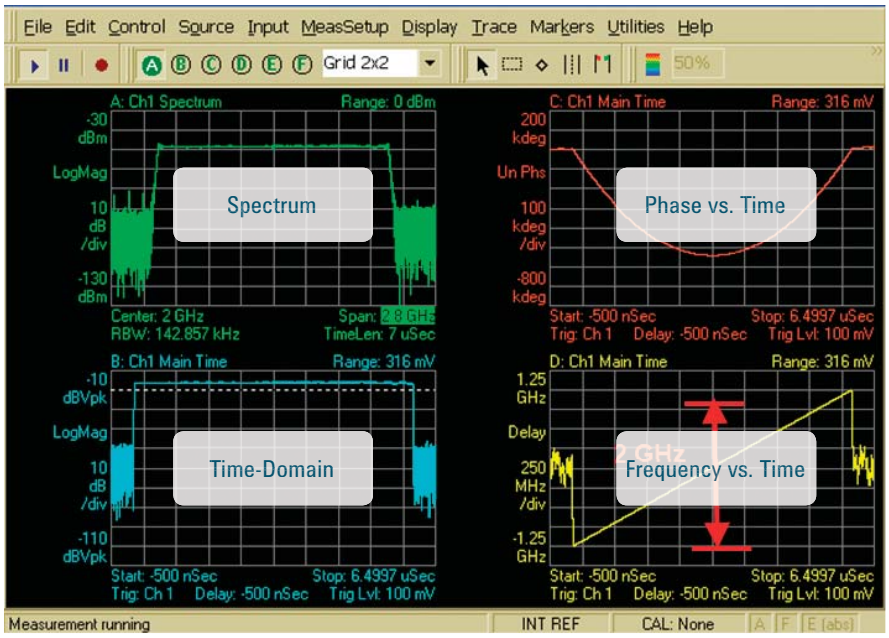
Scenarios

Push radar and EW designs farther with highly realistic signal scenarios

In aerospace and defense, technology is evolving to wider bandwidths without compromising on resolution.

The foundation is digital technology, which is becoming more prevalent because it provides advantages such as reduced size, lower power requirements, better calibration and faster volume scans.

When developing radar systems, real-life testing is very expensive. Simulations with highly realistic signals help reduce the cost of system testing. The Agilent M8190A addresses these needs with three key capabilities: wide bandwidth, high resolution and long play times.



Radar LFM chirp—spanning 2 GHz, (Fs=7.2 GHz, sin(x)/x compensated)

Build a strong foundation for highly reliable satellite communications

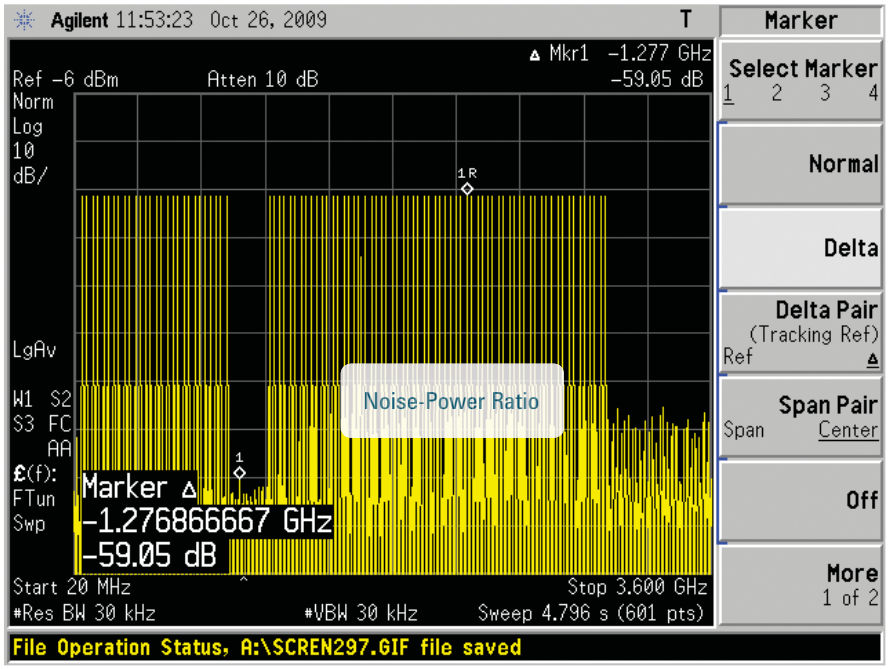
Headroom

Accurate emulation of transmissions—from ground station to airborne transceiver to distant ground station—includes interference, fading and more.

High numbered digital modulations transport more data in the same bandwidth, but tend to produce inaccurate levels and phase angles. Detailed testing becomes very important.

As a result, it is necessary to create high-quality signals with 14-bit resolution at 5 GHz analog bandwidth and an SFDR less than n – 80 dBc. This excellent SFDR ensures that tones stand out from distortion, even with hundreds of tones. The 2 GSa memory ensures that you can store more than one signal scenario and simply switch between segments via direct memory access and the dynamic sequence control input.

The M8190A gives you the versatility to define new signals—proprietary, next-generation and beyond. The 5 GHz modulation bandwidth gives you enough headroom to test and address next-generation modulation schemes.



Multi-tone signal — 100 tone from 0 to 3 GHz (Fs=7.2 GHz, sin(x)/x compensated)

Product Structure

The AWG has a modular product structure

M8190A	Option	April Shipment	October Shipment	Comment
1 channel	001		X	MUST order either 001 or 002
2 channel	002	X	X	
14 bit / 8 GSa/s	14B	X	X	MUST order either 14B or 12 G or both options
12 GSa/s / 12 bit	12G		X	
Additional DC and AC amplifier	AMP		X	
Upgrade to 2 GSa memory pro channel	02G	X	X	Optional options
Sequencer	SEQ		X	
Fast switching	FSW		X	
ISO 17025	1A7		X	
Z540	Z54		X	
April configuration requires the options 002, 14B, 02G. Ordering of additional options before October shipment requires a hardware upgrade.				

The one and two channel versions contain 128mSa of memory per channel.

Coverage of the April configuration

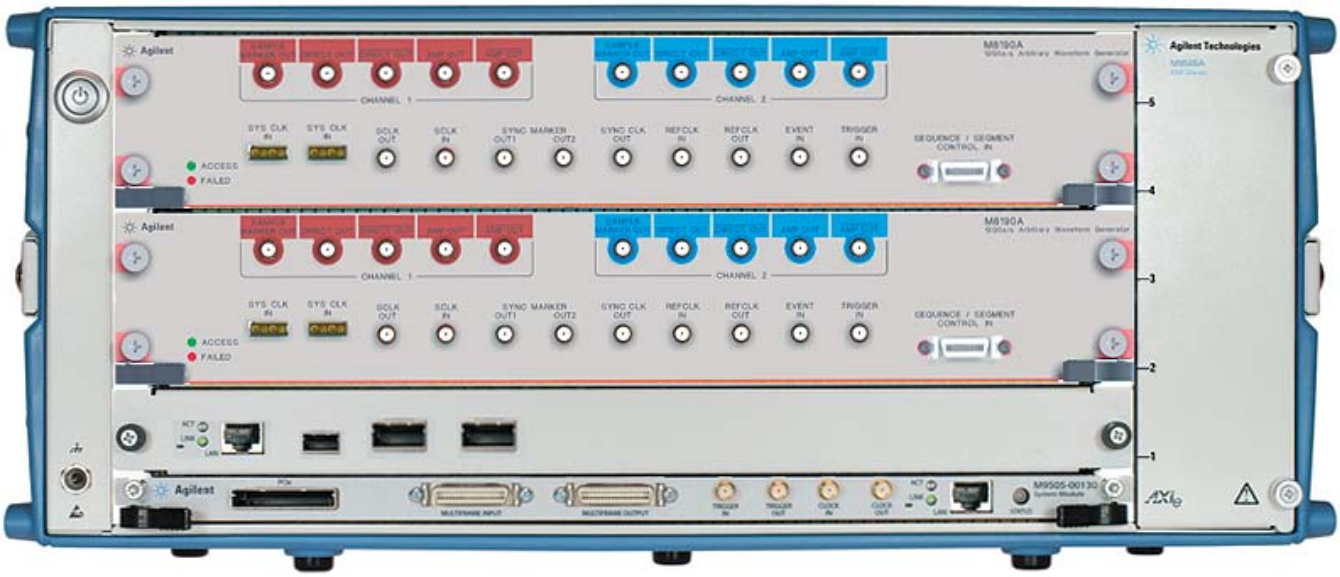
- Channels 1 and 2 always operate from the same clock source. Thus, both channels always operate synchronously.
- Markers are not supported.
- Sample rate restricted to 6.5 to 8 GHz
- Only one segment of variable size not triggered mode, no gated mode.
- Following connectors are provided:
  - » Differential DIRECT OUT CHANNEL 1
  - » Differential DIRECT OUT CHANNEL 2
  - » SCLK IN
  - » SCLK OUT

Filter option — optimized for 8 GSa/s matched.

The Instrument

DISCOVER the Alternatives...
...Agilent MODULAR products

Two slot AXIe chassis with M8190A AWG



Five slot Axle chassis with two M1890A AWG;
can contain an embedded controller

AXIe

The M8190A is a modular instrument packaged in the AXIe form factor. AXIe is a new open standard for high-performance, modular instrumentation, and incorporates the best features of other modular formats including VXIbus, LXI and PXI. Agilent offers a line of scalable chassis in this powerful format. Along with controller options, these AXIe chassis can form the basis of high-performance, AXIe-based test systems.

Two form factors are available: two-slot and five-slot chassis. These include an embedded AXIe system module that does not occupy a module slot. In addition, an AXIe controller is an entire system that can control the AWG. This controller consumes one module slot in the chassis.

The chassis can be used on the bench or in a rack, occupying only 4U of rack space. Agilent computer I/O cards are also available for AXIe systems.

- M9502A: Two-slot AXIe chassis with ESM
- M9505A: Five-slot AXIe chassis with ESM
- M9045A: PCIe laptop card adapter Gen 1 x4
- M9047A: PCIe desktop card adapter Gen 2 x8
- Y1200A: x4 – x8 PCIe cable
- Y1202A: x8 - x8 PCIe cable
- M9536A: Embedded AXIe controller

Performance Specification

Direct out1 / direct out2

Type of output	Single-ended[1] or differential, DC-coupled
Skew between normal and complement outputs	5 ps (typ)
Impedance	50 Ω (nom)
Amplitude control	Specified into 50 Ω, levels double into high impedance
Range, single-ended	350 mV_{p-p} to 700 mV_{p-p}
Resolution	3 digits
Accuracy, offset = 0 V	± (1.5% +5 mV) (spec)
Rise/fall time (20% to 80%)	50 ps (typ)
Bandwidth (3dB)	5 GHz (typ)
Delay: direct out1 to direct out2 [1]	
Fix delay accuracy	0 ns
Fix delay	± 20 ps
Variable delay	Independent for direct out 1 and direct out 2
Delay range	0 ps to 150 ps, variable
Resolution	50 fs, 4 digits
Accuracy	± 20 ps (typ)
Harmonic distortion	-72 dBc (typical), (amplitude = 700 mV_{p-p}, SCLK = 7.2 GSa/s, f_{out} = 100 MHz) -60 dBc (typical), (amplitude = 700 mV_{p-p}, SCLK = 7.2 GSa/s, f_{out} = 10 MHz ... 3000 MHz)
SFDR (excluding harmonic distortion)	-80 dBc (typical) (f_{out} = 100 MHz, measured DC to 1 GHz) -75 dBc (typical), (amplitude = 700 mV_{p-p}, SCLK = 7.2 GSa/s, f_{out} = 100 MHz) -68 dBc (typical), (amplitude = mV_{p-p}, SCLK = 7.2 GSa/s, f_{out} = 10 MHz ... 3000 MHz)

1 Unused output must be terminated with 50 Ω to GND

Amp out1 / amp out2

This functionality is available with option -AMP

	Description	
Characteristics	**Amplified output**	**RF output**
Type of output	Single-ended[1] or differential, DC-coupled	Single-ended
Impedance	50 Ω (nom)	
Amplitude control	Specified into 50 Ω, levels double into high impedance	
Range, single-ended	600 mV_{p-p} to 1.0 V_{p-p}	-10 dBm to +10 dBm[2]
Resolution	3 digits	0.5 dB
Accuracy, offset = 0 V	± (1.5% +5 mV)	0.3 dB
Offset control, common mode	Specified into 50 Ω, levels double into high impedance	
Voltage window	-1.0 V to + 3.0 V [3]	N/A
Resolution	3 digits	N/A
Accuracy	± (1,5% +5 mV) (spec)	N/A
Rise/fall time (20% to 80%)	50 ps (typical)	55 ps (typical)
Bandwidth (3dB)	DC to 5 GHz (typical)	50 MHz to 5 GHz (typical)
Delay: amp out1 to amp out2 [4]		
Fix delay	0 ns	
Fix delay accuracy	±20 ps	
Variable delay	Independent for main out 1 and main out 2	
Delay range	0 ps to 150 ps, variable	
Resolution	50 fs, 4 digits	
Accuracy	±20 ps (typical)	

1. Unused output must be terminated with 50 Ω to GND

2. Sine wave

3. Termination voltage window : low level – 500 mV to high level +500 mV

4. Synchronous operation between channel 1 and channel 2

Marker outputs

Characteristics	Description
Connector type	SMA
Number of marker	Two markers per channel: “Sample Marker” with 1 sample clock timing resolution “Sync Marker” with N sample clock timing resolution (N = 64 in 12 bit mode; N = 48 in 14 bit mode)
Output type	Sample marker: single-ended Sync marker: single ended
Output impedance	50 Ω (nom)
Level control	Specified into 50 Ω, levels double into high impedance
Voltage window	-1.0 V to 2.0 V, single-ended
Amplitude	100 mV_{p-p} to 3.0 V_{p-p}
Resolution	10 mV
Accuracy	± (10% of setting + 75 mV)
Width	Sample marker: 49 sample clocks in 12 bit mode; 40 sample clocks in 14 bit mode Sync marker: user-defined in multiples of N sample clock cycles (N = 64 in 12 bit mode; N = 48 in 14-bit mode)

Trigger / gate input

A common trigger/gate input for both channels is provided on the front panel.

Characteristics	Description
Input range	-5 V to +5 V
Threshold	
Range	-5 V to +5 V
Resolution	100 mV
Sensitivity	200 mV
Polarity	Selectable, positive or negative
Drive	Selectable channel 1, channel 2 or both
Input Impedance	1 kΩ or 50 Ω nom, DC coupled
Max toggle frequency	
12 bit mode	187.5 MHz
14 bit mode	166.6 MHz
Connector	SMA

Event input

A common event input for both channels is provided on the front panel. It is used for branching in or out from a sequence loop. It is also used for enabling or disabling the output in armed mode.

Input range	
Input range	-5V to +5V
Threshold	
Range	-5 V to 5 V
Resolution	100 mV
Sensitivity	200 mV
Polarity	Selectable, positive or negative
Drive	Selectable channel 1, channel 2 or both
Input impedance	Selectable 1 kΩ or 50 Ω nominal, DC coupled
Max toggle frequency	
12 bit mode	187.5 MHz
14 bit mode	166.6 MHz
Connector	SMA

Dynamic sequence and segment control input

Bus width	tbd
Number of addressable segments or sequences	tbd
Data rate	tbd
Input range	
Low level	0 V to +0.7 V
High level	+1.6 V to +3.6 V
Impedance	Internal 10 kΩ pull-down resistor to GND

Clock reference

Reference clock output	
Source: internal backplane 100 MHz	
Frequency	100 MHz
Stability	± 2 ppm, 0 to 55 °C
Aging	± 1 ppm per year
Source: internal oscillator	
Frequency	100 MHz
Accuracy	± 2 ppm
Source: external REF CLK In	
Frequency	Same as reference in
Output level	1 V nominal into 50 Ω
Source impedance	50 Ω nominal, AC coupled
Connector	SMA

Reference clock input	
Input frequencies	Selectable 1 MHz to 200 MHz
Lock range	± 50 ppm
Impedance	50 Ω nominal, AC coupled
Connector	SMA

Sync clock output

Sync clock output	
Frequency	
14 bit mode	Sample clock divided by 48
12 bit mode	Sample clock divided by 64
Output level	1 V nominal into 50 Ω
Impedance	50 Ω nominal, AC coupled
Connector	SMA

Sample clock

There are two selectable sources for the sample clock:

1. Internal synthesizer
2. Sample clock input
3. The two channel instrument (Option 002) offers the flexibility to independently select the sample clock sources for channel one and channel two. If different clock sources are selected for the channels, both channels operate entirely independently with respect to sample rate and sequencing. When the same sample clock source is selected for the channels, the instrument operates synchronously.

Internal synthesizer clock characteristics

Internal synthesizer clock characteristics	
Frequency	125 MHz to 12 GHz

Sample clock input

A sample clock input is provided on the front panel.

Sample clock input	
Frequency range	125 MHz to 12 GHz
Input voltage range	+0 dBm to +11 dBm (200 mV_{RMS} to 800 mV_{RMS})
Damage level	+15 dBm
Input impedance	50 Ω typical, AC coupled
Transition time	1 ns
Connector	SMA

Sample clock output

The source for the sample clock output can be either the internal synthesizer or the sample clock input. The source for the sample clock output can be independently selected from the sample clock. For example, it is possible to operate the sample clock output from the internal synthesizer at f_1 to clock the DUT; as an example, f_1 may be divided by two by the DUT. In this case, $f_1/2$ can be connected to the sample clock Input as to be used as the sample clock of the 81180A.

Sample clock output	
Source	Selectable, internal synthesizer or sample clock input
Frequency range	125 MHz to 12 GHz
Output power	+3 dBm, fix
Phase noise	85 dBc/Hz (typical) at 10 kHz offset, f_{out} = 375 MHz
Input impedance	50 Ω (nom), AC coupled
Connector	SMA

General

Operating altitude	Up to 2000 m
Storage temperature	-40 °C to 70 °C
Stored states	User configurations and factory default
Power on state	Default or last
Safety designed to	IEC61010-1, UL61010, CSA22.2 61010.1 certified
EMC tested to	IEC61326
Warm-up time	30 min
Calibration interval	1 year recommended
Warranty	1 year standard

Cooling requirements

When operating the M8190A choose a location that provides at least 80 mm of clearance at rear, and at least 30 mm of clearance at each side.

Definitions

Specification (spec)	The warranted performance of a calibrated instrument that has been stored for a minimum of 2 hours within the operating temperature range of 0 °C to – 50 °C and after a 45-minute warm up period. Within ±10 °C after autocal. All specifications include measurement uncertainty and were created in compliance with ISO-17025 methods. Data published in this document are specifications (spec) only where specifically indicated.
Typical (typ)	The characteristic performance, which 80% or more of manufactured instruments will meet. This data is not warranted, does not include measurement uncertainty, and is valid only at room temperature (approximately 23 °C).
Nominal (nom)	The mean or average characteristic performance, or the value of an attribute that is determined by design such as a connector type, physical dimension, or operating speed. This data is not warranted and is measured at room temperature (approximately 23 °C).
Measured (meas)	An attribute measured during development for purposes of communicating the expected performance. This data is not warranted and is measured at room temperature (approximately 23 °C).
Accuracy	Represents the traceable accuracy of a specified parameter. Includes measurement error and timebase error, and calibration source uncertainty.

Sequencer

The standard configuration of the M8190A offers continuous, self armed mode with one segment.

Sample memory size	128 MSa per channel, standard 2048 MSa per channel with Option 02G

Option SEQ offers the enhanced sequencing functionality described below.

Minimum segment length	320 samples in 12 bit mode; 240 samples in 14 bit mode.
Waveform granularity	64 samples in 12 bit mode; 48 samples in 14 bit mode
Segments	1 to 256k unique segments The maximum length of a segment can be up to 2048 MSa. A single segment can consist of multiple sections that are downloaded individually to the instrument and are linked inside the M81190A to form a segment.
Segment loops	A total of 4 billion (2^{32}) loops can be defined for each segment.
Sequences	Up to 256k total unique waveform sequences can be defined. A sequence is a continuous series of segments.
Sequence table entries	Up to 256k segment table entries can be defined as the sum of entries for all sequence tables.
Scenarios	Up to 64 scenarios can be defined. A scenario is a continuous series of sequences. Each sequence in a scenario can be looped up to 1M times.
Dynamic scenario control	A parallel input bus is used to externally switch between scenarios. Jumps between scenarios can be immediate (current scenario is interrupted) or synchronous (current scenario is completed before jumping to the next scenario).

Software

Operating systems	Supported Operating System is Windows® 7 64-bit.
Soft front panel	A graphical user interface (GUI or soft front panel) will be offered to control all functionality of the instrument. The GUI will be part of the soft front panel.
SCPI language	Remote control via SCPI.
IVI-driver	An IVI-COM driver as well as IVI-C driver will be provided.

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