Agilent 81180A
Arbitrary Waveform Generator

Data Sheet
1.0

Set up complex real-world signals with up to 4.2-GSa/s arbitrary waveforms and 12-bit vertical resolution

Agilent Technologies

81180A at a glance

- 10-MS/s to 4.2-GSa/s sample clock control, 2 GHz IQ modulation bandwidth and 12 bit vertical resolution
- 1 or 2 channel, coupled or uncoupled
- Two 2-channel systems can be synchronized to form a 4-channel system
- Interchannel skew control from -3 ns to +3 ns with 10-ps resolution
- Three software-selectable amplifiers optimized for
    - I/Q applications with 1 GHz, differential DC-coupled output
    - Maximum bandwidth and flatness for direct RF applications with AC output bandwidth to > 1.5 GHz
    - Time domain applications with low overshoot and jitter
- 16 M points or 64 M points per channel
- 8-bit external input for dynamic control of segments and sequences
- Advanced sequencing scenarios define stepping, looping and conditional jumps of waveforms or waveform sequences for best memory usage
- Smart trigger allows trigger hold-off and programmable pulse width
- Trigger input is programmed to wait for waveform end or abort waveform and restart
- Two markers for each channel have controlled marker positions, widths and levels
- Markers do not reduce DAC bits
- Internal flash memory stores settings and waveforms
- Remote control through LAN, USB and GPIB
- Waveforms and instrument settings can be uploaded from disk-on-key
- Integration in
    - MATLAB®
    - NI LabVIEW
    - Agilent Signal Studio[1]
    - Agilent BenchLink Waveform Builder Pro[2]

1. Integration in Signal Studio pulse builder and multitone is planned.
2. Available by end of 2010

The 81180A arbitrary waveform generator offers convenient features that make your test easier

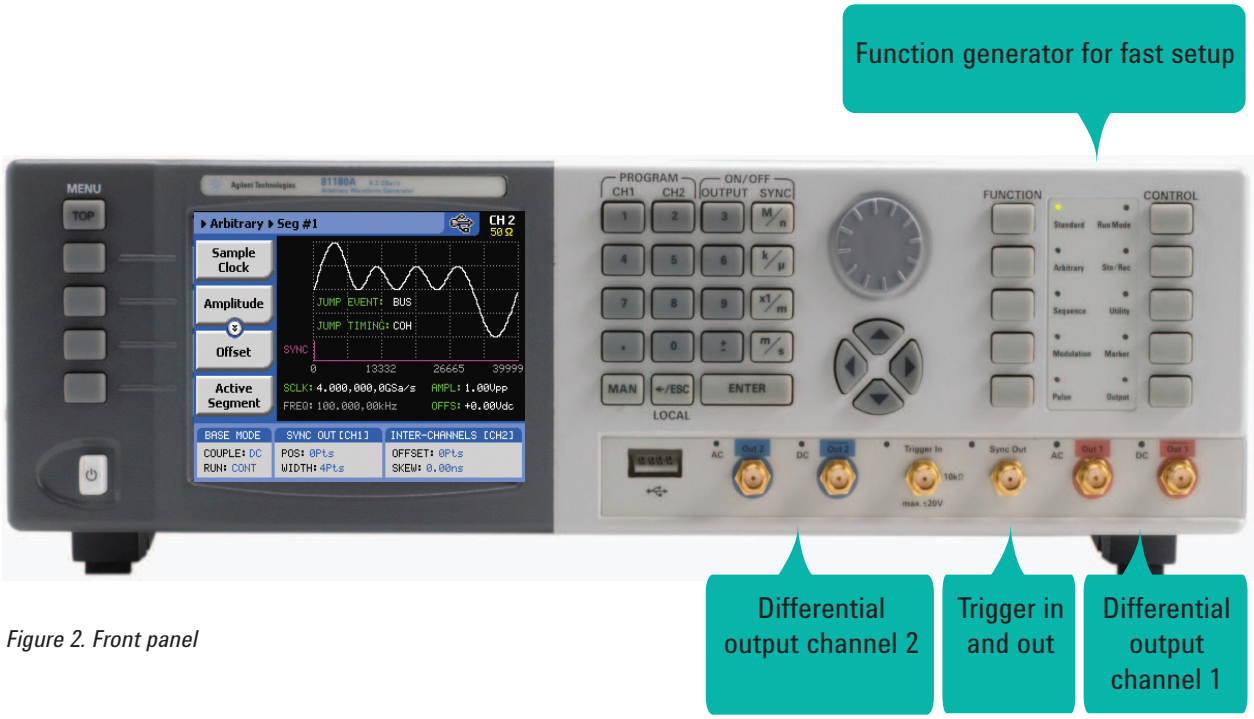

Figure 2. Front panel

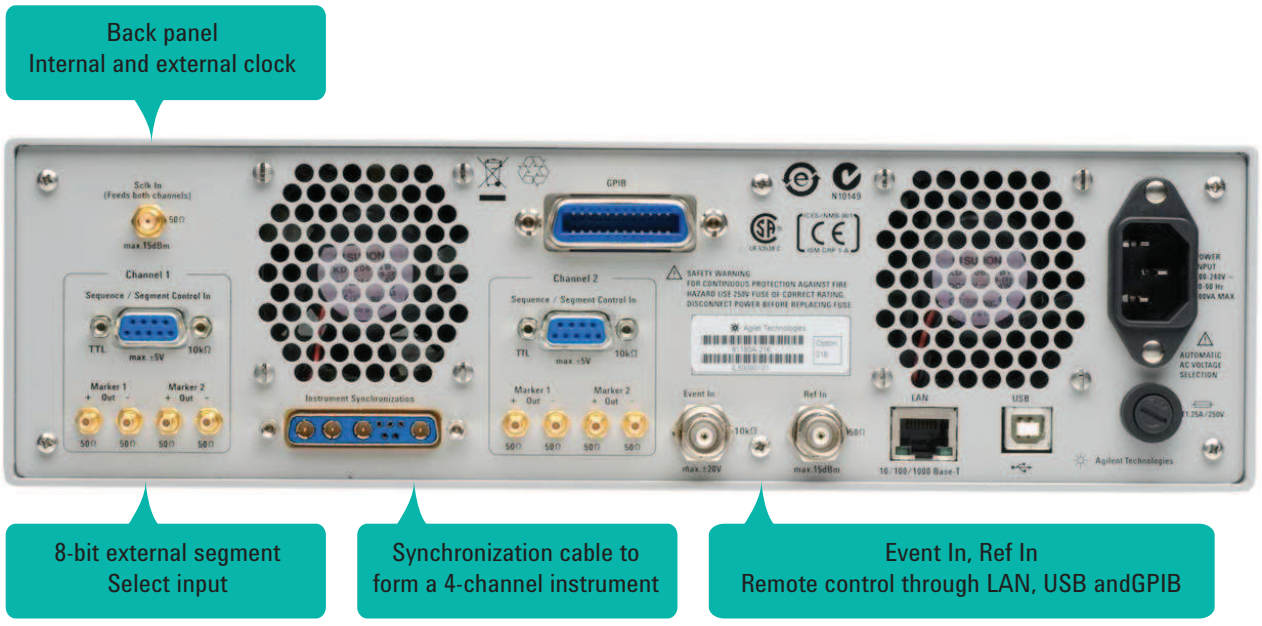

Figure 3. Back panel

Overcome your test challenges with the 81180A arbitrary waveform generator

Electronic devices continue to grow increasingly complex, and the demand for higher performance never ends. In addition, you are under pressure to reduce test times and tighten specifications.

The complexity of modern wireless systems skyrockets when you use techniques like digital modulation that compress wireless data to use bandwidth more efficiently. Test accuracy and repeatability are critical. In radar applications, a higher range helps you detect targets further out, and increased accuracy helps you better track targets. Range is proportional to the length of a pulse, so parameters like pulse length and pulse repetition frequency influence the radar range and range resolution. You need to be able to verify the performance of your radar system.

Commercial off-the-shelf waveform packages are seldom available for devices under test used in aerospace and defense applications, so testing system performance is challenging. To test your DUTs to their limits, you need flexible stimulus generating capability for any signal you can imagine.

To meet these challenges, you need new test tools.

New high-bandwidth, high-resolution arbitrary waveform generator helps you test with confidence

The Agilent 81180A arbitrary waveform generator provides 4.2 GSa/s, 2 GHz IQ modulation bandwidth and 12-bit vertical resolution for applications where waveform resolution is an issue.

Data-centric warfare requires real-time data and video communication. Satellite designers are pushed to use bandwidth greater than 1 GHz bandwidth.

In addition, these bandwidths need to be available at higher carrier frequencies up to 44 GHz. New emerging standards like wireless HD or WiGig call for up conversion up to 60 GHz.

These setups require a reliable and precise modulation source. Any signal distortion gets multiplied by each of the test instruments, making it difficult to pinpoint a DUT failure. When the foundation for your signals is more precise, your test results are more meaningful. You want to test your DUT, not the source.

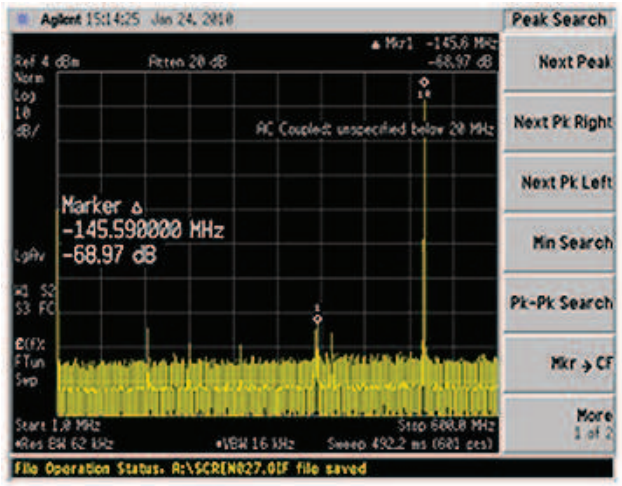

Figure 4. Spurious performance of 81180A

Use models of 81180A

In this setup, the 81180A is used as a 2-GHz IQ modulation source. The Agilent E8267D performance signal generator Option 016 is needed for the 2 GHz IQ modulation input. You can use markers in conjunction with the pulse modulation to suppress the signal in the pulse pauses. The markers don't reduce the number of bits, so using markers improves waveform resolution instead of reducing it.

You can use the 81180A for generating direct RF signals up to 1.5 GHz with a good signal waveform resolution.

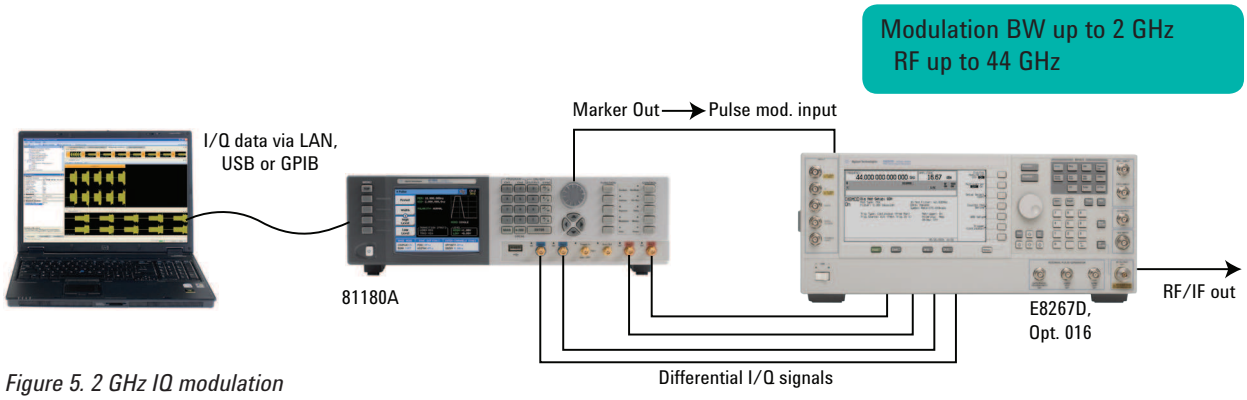

Figure 5. 2 GHz IQ modulation

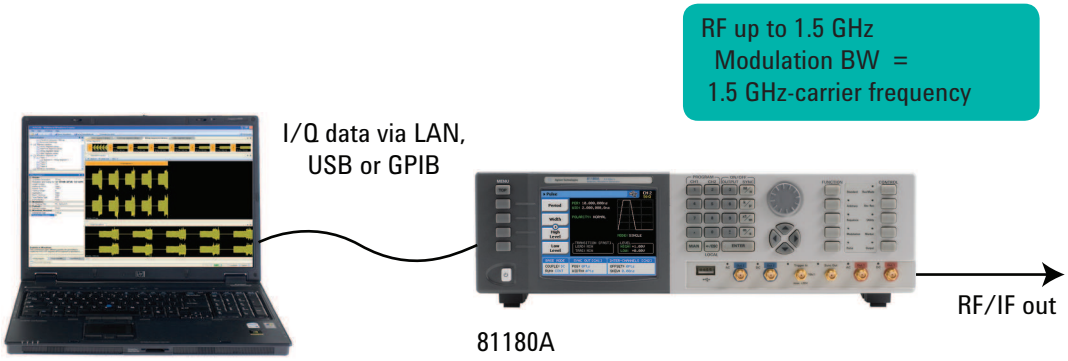

Figure 6. 1.5 GHz direct RF carrier frequency

Generate versatile waveforms

An arbitrary waveform generator is ideal for generating multiple waveform formats, so you can achieve interoperability between terrestrial and space-based communication devices.

In addition to the flexibility of an arbitrary waveform generator, the 81180A gives you unprecedented flexibility with respect to channels. The instrument is available in 1- or 2-channel versions. The 2-channel version can run either in uncoupled mode so both channels work independently or in coupled mode, either phase coherent or with a defined delay between them. You can couple two 2-channel instruments to form a 4-channel instrument to simulate multiple emitter or receivers, such as multiple aircraft, where each could be designated as a target. By synchronizing the channels, you simplify your test setup and align the frequency and phase of the signals.

Choose the best amplifier to optimize your signal characteristics

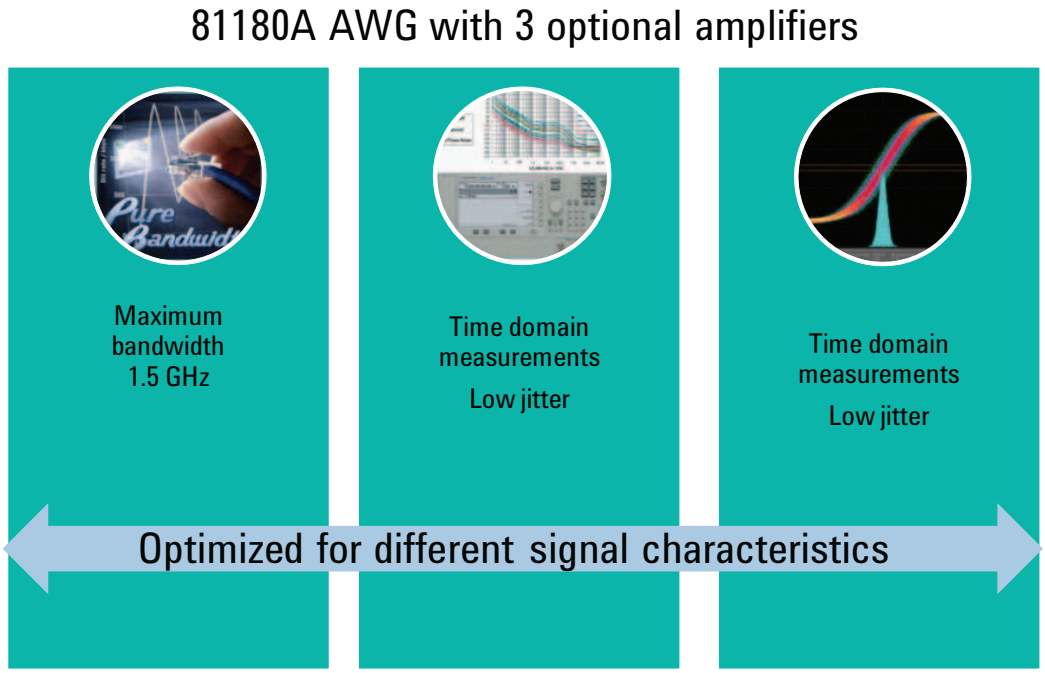

Figure 7.

Different applications call for different signal characteristics. You can choose from three different amplifiers with different characteristics. You can switch between the amplifiers using your software application, the programming interface or the instrument's front panel.

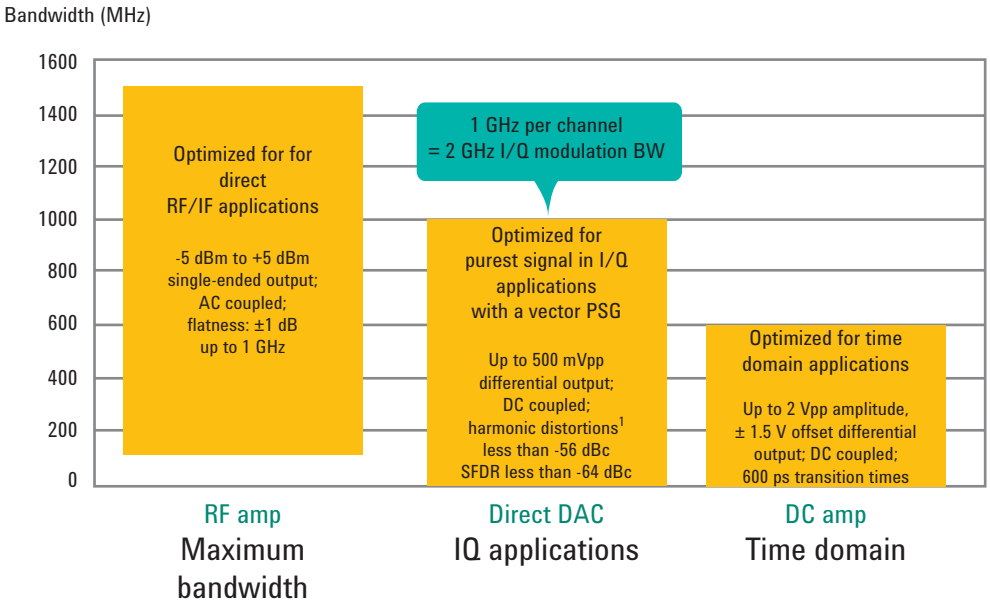

Figure 8.

Increase your signal play time with advanced sequencing

The closer your test signals are to the real-world situation, the better your test results will be. A key requirement is long signal play time, which means you need a big memory. The 81180A offers the choice between two memory sizes: 16 MSa and 64 MSa. For the best memory usage, a sequencer helps you create versatile, unique signals.

Agilent 81180A sequence example:

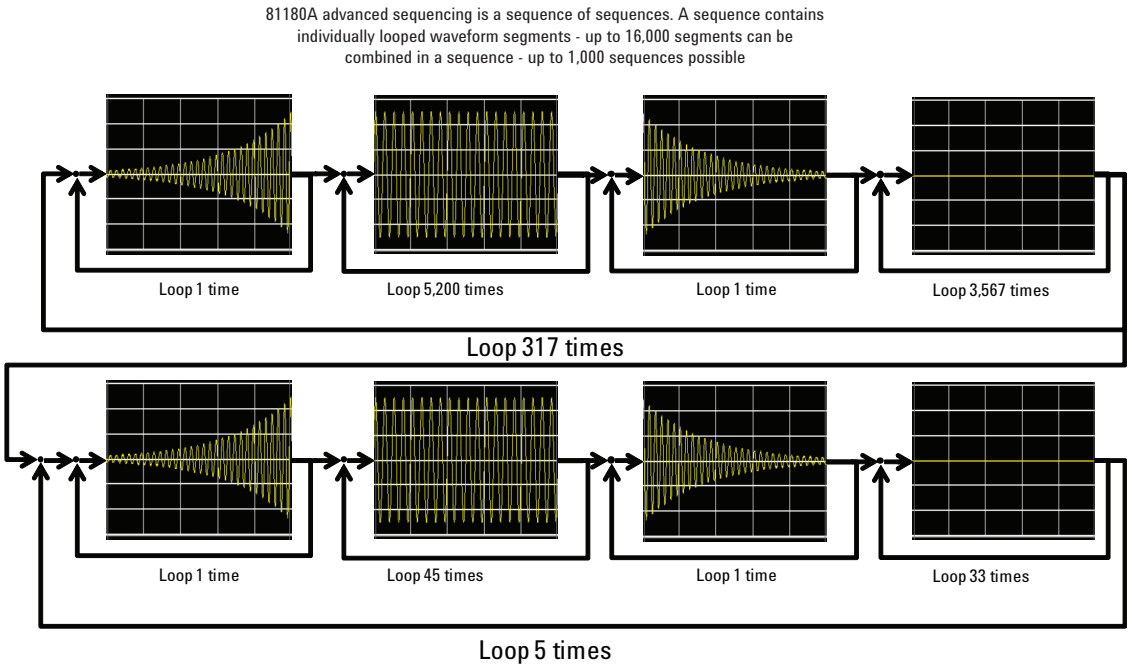

Figure 9. Agilent 81180A sequence example

Figure 10. Agilent 81180A sequence/segment control Input

In advanced sequencing scenarios you can define steps, loops and conditional jumps of waveforms or waveform sequences. You can set up to 1 advanced sequences per channel. Each sequence contains up to 16,000 different segments. Up to 1,000 sequences are possible.

With this powerful sequencer, you can easily set up communication between ground stations and airborne devices. After an initiation sequence, the signal can contain separate transmission sequences followed by different messages.

In some applications it is important to change quickly between different waveforms to minimize reconfiguration time. The sequencer allows you to download different test setups into memory. It is possible to directly access the memory via a 8-bit and 9-pin external input, which accepts TTL signals. You can select up to 256 segments or sequences via this dynamic segment/sequence control input. **It can act as a dynamic switch between the sequences and segments as well.**

Create complex signals in a variety of software environments

You can easily set up simple waveforms like sine waves, pulses, or ramps from the front panel of the 81180A. Complex modulation or arbitrary waveforms require waveform creation tools to create realistic signals.

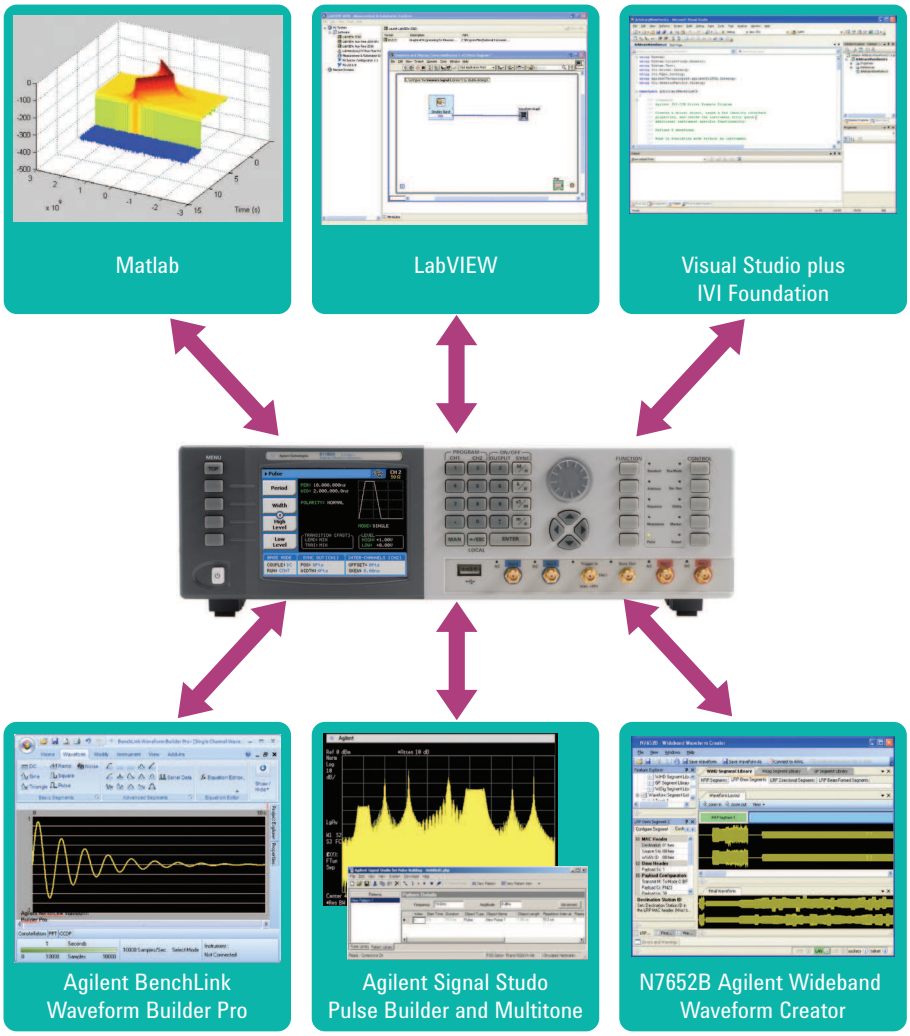

Figure 11.

You can choose between tools like MATLAB software, NI LabVIEW and Visual Studio with IVI or Agilent waveform creation tools like Agilent BenchLink Waveform Builder Pro, Signal Studio (planned) and Agilent wideband waveform creator.

With the optional BenchLink Waveform Builder Pro you can simply create custom, user-defined waveforms and import other waveforms from MATLAB and oscilloscopes measurements.

MATLAB scipt examples are available on www.agilent.com/find/81180_demo and will give you a jumpstart to generate multi-tone signals, pulsed radar signals and multi-carrier modulated waveforms using the 81180 – standalone or in conjunction with a Vector PSG.

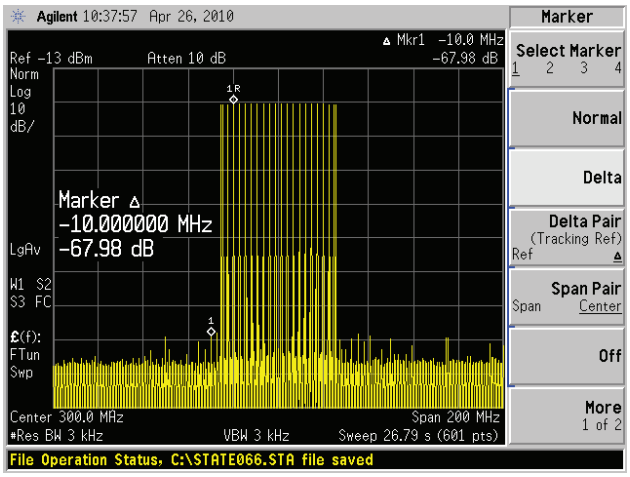

Figure 12. Multi-tone signal on spectrum analyzer. 20 tones spanning ± 25 MHz around 300 MHz, Fs = 4.2 GS/s, IMD: -68 dB

Analysis of radar pulse on scope with VSA software

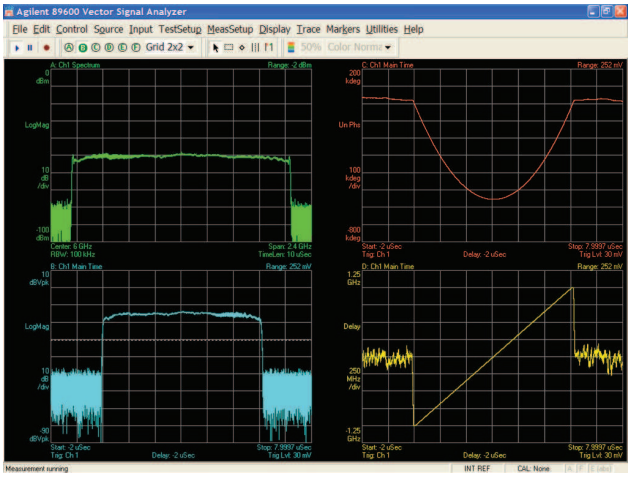

Figure 13. Radar pulse with 2 GHz bandwidth. Radar pulse with 2 GHz bandwidth

Electrical Specifications

Instrument configuration

Characteristics	Description
81180A	4.2-GSa/s arbitrary waveform generator with three output paths, DC-coupled direct DAC output with 1 GHz bandwidth, DC-coupled 2-V amplifier with > 600 MHz analog bandwidth or, AC-coupled 5 dBm amplifier with 1.5 GHz analog bandwidth
81180A-116	Single-channel instrument with 16,000,000 waveform points
81180A-216	Dual-channel instrument with 16,000,000 waveform points
81180A-264	Dual-channel instrument with 64,000,000 waveform points
81180A-F4G	Reconstruction filter
81180A-1CN	Rack mounting kit assembly
81180A-SYN	Synchronization cable to synchronize two dual-channel 81180As to form a four-channel 4.2-GSa/s arbitrary waveform generator system

Interchannel offset control (Course tuning – dual-channel versions only)

Characteristics	Description
Initial skew	< 200 ps from 1 GSa/s to 4.2 GSa/s; < 1 ns from 100 MSa/s to 1 GSa/s; < 10 ns below 100 MSa/s
Control	
Range	0 to n – 128 points; 0 to 80 points with external segment control (n = segment length)
Resolution	8 points
Accuracy	Same as sample clock accuracy

Interchannel skew control (Fine tuning – dual-channel versions only)

Characteristics	Description
Initial skew	< 200 ps from 1 GSa/s to 4.2 GSa/s; < 1 ns from 100 MSa/s to 1 GSa/s; < 10 ns below 100 MSa/s
Control	
Range	-3 ns to +3 ns
Resolution	10 ps
Accuracy	± (10% of setting + 20 ps)

Waveform type

Characteristics	Description
Standard	A waveform is selected from a built-in library. The standard waveform parameters are programmable.
Arbitrary	Arbitrary waveform coordinates are downloaded and stored in memory segments. The arbitrary waveform parameters are programmable.
Sequenced	Arbitrary waveforms are downloaded and stored in memory segments. The segments are arranged in a sequence table that step, loop, jump and nest on segments in a user-defined configuration. Conditional jump and nest pending an event signal.
Advanced sequences	Same functionality as described for sequenced waveforms except sequences are arranged in the sequence table.
Modulated	A modulated waveform is calculated from a built-in library of modulation schemes.
Pulse	A pulse waveform is calculated and downloaded to the arbitrary waveform memory.

Run mode

Characteristics	Description
Continuous	
Self armed	A selected output function shape is output continuously. No start commands are required to generate waveforms.
Armed	No start commands are required to generate waveforms.
Triggered	A trigger signal activates a single-shot or counted burst of output waveforms and then the instrument waits for the next trigger signal.
Normal mode	The first trigger signal activates the output; consecutive triggers are ignored for the duration of the output waveform.
Override mode	The first trigger signal activates the output; consecutive triggers restart the output waveform whether the current waveform has been completed or not.
Gated	A waveform is output when a gate signal is asserted. The waveform is repeated until the gate signal is de-asserted. Last period is always completed.

Standard waveforms

Characteristics	Description
General	Waveforms are computed and generated every time a standard waveform is selected.
Standard waveform library	Built-in, auto computed waveforms: sine, triangle, square, ramp, pulse, sink, exponential rise, exponential decay, Gaussian, noise and DC.
Standard waveform control	The standard waveform parameters can be adjusted to specific requirements. The waveform is recomputed with each parameter change.

Standard waveforms frequency control

Characteristics	Description
Range	10 kHz to 250 MHz
Resolution	8 digits
Accuracy	
Internal reference	≤ 1 ppm from 19 °C to 29 °C; 1 ppm/°C below 19 °C or above 29 °C; ≤ 1 ppm/year aging rate
External reference	Same as accuracy and stability of the external reference. Reference is applied to the reference input.

Arbitrary waveforms

Characteristics	Description
General	Arbitrary waveforms are created on a remote computer and downloaded to the arbitrary waveform memory through one of the available remote interfaces. The frequency of the waveform is calculated from its programmed sample clock value and the number of waveform points that were used for creating the waveform.
Waveform length	320 to 16,000,000 points (320 to 64,000,000 with Option (264), in multiples of 32 points
Number of waveforms	1 to 16,000
Dynamic waveform control	Software command or rear-panel segment control input (D-sub, 8-bit lines)
Waveform jump timing	Coherent or asynchronous, selectable
DAC resolution	12 bits

Sequenced waveforms

Characteristics	Description
General	Segments are grouped in a sequence table that links, loops and jumps to next in user-defined scenarios. Sequence steps are advanced on trigger events or remote commands. Each channel has its own sequence scenario.
Sequence scenario	1 to 1,000 unique scenarios, programmed in sequence tables
Sequence table length	1 to 16k steps
Step advance control	Auto, once (x “N”) and stepped
Loop counter	
Segment loops	1 to 1,000,000 cycles, each segment
Sequence loops	1 to 1,000,000 (applies to “Once” sequence advance mode only)
Accuracy	10 ps

Advanced sequencing

Characteristics	Description
General	Enables the grouping of sequences into scenarios in a way that is similar to how segments are grouped in a sequence table. Each channel has its own advance sequencing generator.
ASequence scenario	1 scenario, programmed in advanced sequence table
Dynamic advance sequence control	Software command or rear panel sequence control input (D-sub, 8-bit lines)
ASequence table length	1 to 1k steps
Step advance control	Auto, once and stepped
Once loop counter	1 to 1,000,000 cycles, each sequence

Arbitrary/sequenced waveforms sample clock control

Characteristics	Description
Range	10 MSa/s to 4.2 GSa/s, common or separate for each channel
Resolution	8 digits
Accuracy	
Internal reference	≤ 1 ppm from 19 °C to 29 °C; 1 ppm/°C below 19 °C or above 29 °C; 1 ppm/year aging rate
External reference	Same as accuracy and stability of the external reference. Reference is applied to the reference input or sample clock input.

Analog outputs

Characteristics	Description
General	DC-coupled amplified or direct DAC or AC-coupled amplified output, selectable
Connector type	SMA
On/off control	Output is turned on or off for each channel independently

DC-analog outputs

	Description	
Characteristics	Amplified output	Direct DAC output
Type of output	Single-ended [1] or differential	Single-ended [1] or differential
Impedance	50 Ω, typical	50 Ω, typical
Amplitude control	Specified into 50 Ω, levels double into high impedance	Specified into 50 Ω, levels double into high impedance
Range, single-ended	50 mVp-p to 2 Vp-p	50 mVp-p to 500 mVp-p
Range, differential	100 mVp-p to 4 Vp-p	100 mVp-p to 1Vp-p
Resolution	3 digits	3 digits
Accuracy, offset = 0 V	± (3% +5 mV)	± (3% +5 mV)
Offset control	Common mode, specified into 50 Ω, levels double into high impedance	Common mode, specified into 50 Ω, levels double into high impedance
Range	-1.5 V to + 1.5 V	-1.5 V to + 1.5 V
Resolution	3 digits	3 digits
Accuracy	± (5% +5 mV)	± (5% +5 mV)
Rise/fall time (10% to 90%)	600 ps, typical	350 ps, typical
Bandwidth	600 MHz, typical (calculated	1 GHz, typical (calculated)
Overshoot	5%, typical	15%, typical
Harmonic distortion [2]	-49 dBc, 1 Vp-p	-56 dBc, 0.5 Vp-p
Non harmonic distortion [2]	-69 dBC, 1 Vpp, DC to 600 MHz	-64 dBc, 0.5 Vp-p, DC to 1 GHz
SCLK/2 spur [3]	1 Vp-p	0.5 Vp-p amplitude
200 MHz	-42 dBc	-63 dBc [4]
500 MHz	-40 dBc	-63 dBc [4]
800 MHz	-36 dBc	-63 dBc [4]
SCLK/2-fout spur [3]	1 Vp-p	0.5 Vp-p [4]
200 MHz	-45 dBc	-67 dBc [4]
500 MHz	-42 dBc	-67 dBc [4]
800 MHz	-37 dBc	-55 dBc [4]
Phase Noise [2]	-90 dBc/Hz, 1 Vp-p, 10 kHz offset	-90 dBc/Hz, 1 Vp-p, 10 kHz offset

1. The unused output must be terminated with 50 Ω to ground
2. Offset = 0 V, SCLK = 4.2 GSa/s, 32 points sine waveform (131.25 MHz output frequency), typical values
3. Offset = 0 V, SCLK = 4.2GSa/s, arbitrary sine waveforms, typical values
4. Measured with low pass filter option 81180A-F4G

RF, AC-coupled analog output	
Characteristics	Description
Type of output	Single-ended [1]
Impedance	50 Ω [1], typical
Amplitude control	Specified into 50 Ω, levels double into high impedance
Range	-5 dBm to 5 dBm
Resolution	3 digits
Accuracy	±(3% +0.5 dBm)
Bandwidth	1.5 GHz, typical
Flatness	±1 dB 4 MHz to 1 GHz, ±2 dB to 1.5 GHz, typical
Harmonic distortion [2]	-50 dBc
Nonharmonic distortion [2]	-58 dBc, DC to 1.5 GHz
SCLK/2 spur [3]	
200 MHz	-68 dBc [4]
500 MHz	-68 dBc [4]
800 MHz	-68 dBc [4]
SCLK/2-fout spur [3]	
200 MHz	-68 dBc [4]
500 MHz	-68 dBc [4]
800 MHz	-60 dBc [4]
Phase noise [2]	-90 dBc/Hz, 10 kHz offset

1. *The unused output can be left open*
2. *SCLK = 4.2 GSa/s, 32 points sine waveform (131.25 MHz output frequency), typical values*
3. *SCLK = 4.2GSa/s, arbitrary sine waveforms, typical values*
4. *Measured with low pass filter option 81180A-F4G*

Marker outputs

Characteristics	Description
Connector type	SMB
Number of markers	Two markers per channel
Type of output	Differential (+) and (-) outputs
Impedance	50 Ω, typical
Level control	Specified into 50 Ω, levels double into high impedance
Voltage window	0 V to 1.25 V, single-ended; 0 V to 2.5 V, differential
Low level	0 V to 0.8 V, single-ended; 0 V to 1.6 V, differential
High level	0.5 V to 1.25 V, single-ended; 1 V to 2.5 V, differential
Resolution	10 mV
Accuracy	10% of setting
Width control	0 SCLK periods to segment length
Position control	0 to segment length in 4 point increments
Marker resolution	4 SCLK periods (programmed as part of the output waveform)
Initial delay 1)	3.5 ns, +1 sample clock period, typical
Initial skew between marker 1 and marker 2	< 100 ps, typical
Variable delay control	Separate for each marker
Range	0 to 3 ns
Resolution	10 ps
Accuracy	± (10% of setting +20 ps)
Rise/fall time	1.0 ns, typical

[1] *Analog output to marker output*

SYNC output

Characteristics	Description
Connector type	SMA
Type of output	Single ended
Source	Channel 1 or channel 2
Waveform	Pulse (32 points width), WCOM (waveform duration pulse)
Impedance	50 Ω, typical
Amplitude	1.2 V, typical; doubles into high impedance
Variable position control	
Range	0 to segment length
Resolution	32 points
Rise/fall time	2 ns, typical
Variable width control	
Range	32 points to segment length
Resolution	32 points

Trigger input

Characteristics	Description
Connector type	SMA
Drive	Channel 1, channel 2, or both
Input impedance	10 kΩ, typical
Polarity	Positive, negative, or both, selectable
Damage level	± 20 Vdc
Frequency range	0 to 15 MHz
Trigger level control	
Range	-5 V to 5 V
Resolution	12 bit (2.5 mV)
Accuracy	± (5% of setting + 2.5 mV)
Sensitivity	200 mVp-p
Pulse width, minimum	10 ns
System delay [4]	200 sample clock periods + 50 ns, typical
Trigger delay	Separate for each channel
Range	0 to 8,000,000 sample clock periods
Resolution	8 points
Accuracy	Same as sample clock accuracy
Smart trigger	Detects a unique pulse width range
Conditioned trigger	< pulse width, > pulse width, <> pulse width
Pulse width range	50 ns to 2 s
Resolution	2 ns
Accuracy	± (5% of setting +20 ns)
Trigger holdoff	Ignores triggers for a holdoff duration
Holdoff range	100 ns to 2 s
Resolution	2 ns
Accuracy	± (5% of setting +20 ns)
Trigger jitter	8 sampling periods

4. Trigger input to analog output

Internal trigger generator

Characteristics	Description
Source	Common or separate for each channel
Mode	Timer (waveform start to waveform start); delayed (waveform stop to waveform start)
Timer	
Range	100 ns to 2 s
Resolution	3 digits
Accuracy	100 ppm
Delayed	
Range	152 to 8,000,000 sample clock periods
Resolution	Integer numbers, divisible by 8

Event input

Characteristics	Description
General	Used for branching in or out from a sequence loop. Also used for enabling or disabling the output in armed mode.
Connector type	Rear panel BNC
Input impedance	10 kΩ, typical
Polarity	Positive, negative or either, selectable
Damage level	± 20 Vdc
Frequency range	0 to 15 MHz
Trigger level control	
Range	-5 V to 5 V
Resolution	12 bit (2.5 mV)
Accuracy	± (5% of setting + 2.5 mV)
Sensitivity	200 mVp-p
Pulse width, minimum	10 ns

Sequence/segment control input

Characteristics	Description
Connector type	D-sub, 8-bit lines
Number of input connectors	1-ch instrument: 8-bit bus + valid line 2-ch instrument: (8-bit bus + valid line) per channel
Switching rate	20 ns + waveform duration minimum
Input impedance	10 kΩ, typical
Input level	TTL

External reference clock input

Characteristics	Description
Connector type	Rear panel BNC
Input frequency	10 MHz to 100 MHz, programmable
Input impedance	50 Ω, typical
Input voltage swing	-5 dBm to 5 dBm
Damage level	10 dBm

External sample clock input	
Characteristics	Description
General	External signal is fed to a frequency splitter. Same frequency is applied to both channels.
Connector type	Rear-panel SMA
Input impedance	50 Ω, typical
Input voltage swing	0 dBm to 10 dBm
Input frequency range	2.0 GHz to 4.2 GHz
Clock divider	1/1, ½, ¼, ... 1/256, separate for each channel
Damage level	15 dBm

Two-instrument synchronization	
Characteristics	Description
General	Two instruments are synchronized via dedicated synchronization cable. Master instrument controls waveform generation of slave instrument.
Initial skew between instruments	20 ns + 0 to 16 SCLK periods
Offset control	8 SCLK periods increments
Clock source	Master sample clock generator
Trigger source	Master trigger input

Mechanical, Environmental and Maintenance Specifications

Display	
Characteristics	Description
Type	TFT LCD, back-lit
Size	4 “
Resolution	320 x 240 pixels

Peripheral devices	
Characteristics	Description
USB port	1 x front, USB host, standard A; 1 x rear, USB device, standard B
LAN port	1000/100/10 BASE-T
GPIB port	IEEE 488.2 standard interface, 24 pin
Segment control port	2 x D-sub, 9 pin

Power supply

Characteristics	Description
Source voltage and frequency	
Rating range	100 VAC to 240 VAC
Frequency range	50 Hz to 60 Hz
Power consumption	100 VA

Mechanical

Characteristics	Description
Dimensions	
With feet	315 x 102 x 395 mm (W x H x D)
Without feet	315 x 88 x 395 mm (W x H x D)
Weight	
Without package	4.5 kg
Shipping weight	6 kg

Environmental

Characteristics	Description
Operating temperature	0 °C to 40 °C
Storage temperature	-40 °C to 70 °C
Humidity	85% RH, non condensing

Certifications and compliances

Characteristics	Description
Safety	IEC61010-1
EMC	IEC 61326-1:2006

Maintenance

Characteristics	Description
General	Periodic recalibration is required to maintain accuracy of output characteristics
Recalibration period	2 years

Related literature / Pub. No.
Best memory usage for real-world signals – Understanding Sequence Run and Sequence Advance Modes 5990-5965EN

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