



# Agilent 81180A Arbitrary Waveform Generator

Datasheet Preliminary 0.9



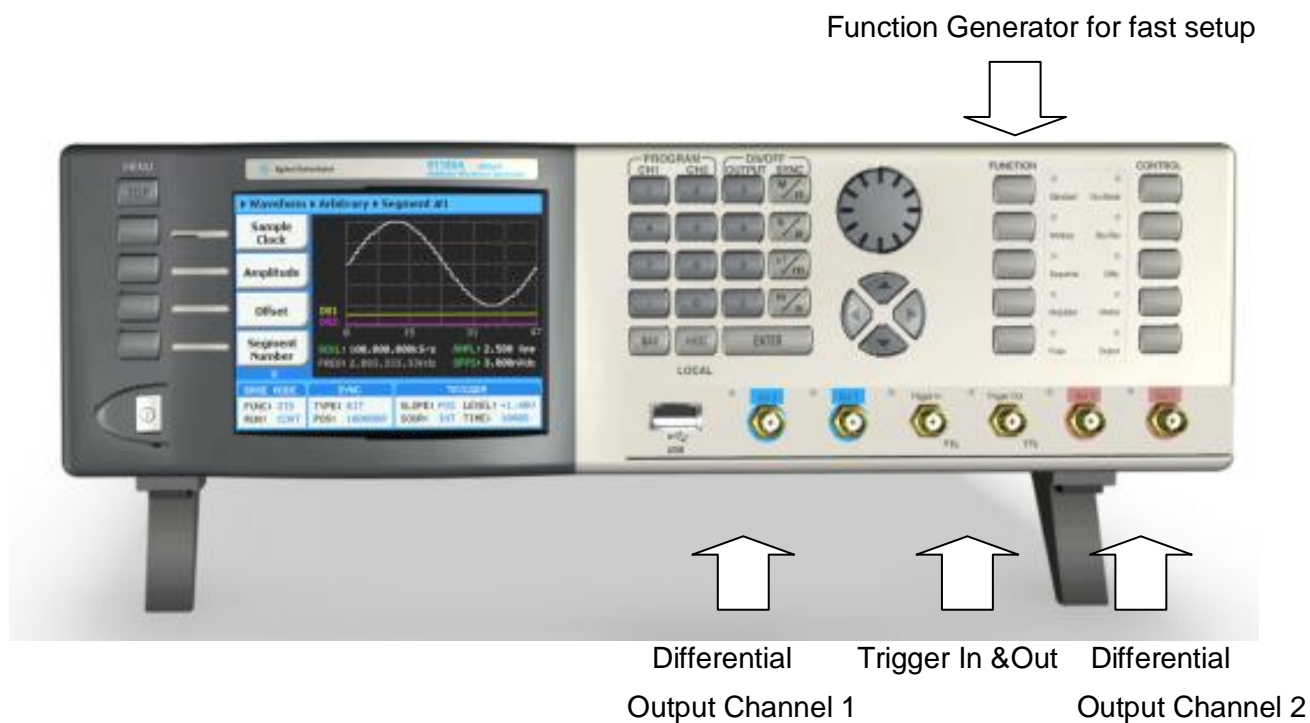
**When signal fidelity matters – test with confidence**  
4.2 GSa/s Arbitrary Waveform Generator with 12 bit vertical  
resolution



## 81180A at a glance

- 10 MS/s to 4.2 GSa/s sample clock control
- 12 bit vertical resolution
- 1 or 2 channel, coupled or uncoupled
- Two 2 channel systems can be synchronized to form a four-channel system
- Inter-channel skew control from -3 ns to +3 ns with 10 ps resolution
- Three software selectable amplifier, 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 > 1.5GHz
  - 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
- Smart trigger allows: trigger hold-off, and detect  $\Leftrightarrow$  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, width and levels
- Markers do not reduce DAC bits
- Internal flash memory stores large waveform banks
- Remote control through LAN, USB and GPIB
- Waveforms and instrument settings can be uploaded from disk-on-key
- LXI Class C compliant
- Fully controllable via Web interface
- Software
  - Integration in Matlab, LabView and Signal Studio

## Front Panel



## Back Panel

## Internal and external clock



8 bit external segment  
Select input

Synchronization  
Cable to form a  
4-channel instrument

Event In, Ref In

Remote Control  
through  
LAN, USB and GPIB



# 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 2V amplifier with >600 MHz analog bandwidth or, ac coupled 5dBm 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-SYN	Synchronization cable to synchronize two dual channel 81180A to form a four channel 4.2 GSa/s arbitrary waveform generator system
81180A-F4G	Reconstruction filterset for 4 GSa/s

## Inter-channel offset control (Course tuning – Dual-channel versions only)

Characteristics	Description
Initial skew	200 ps
Control	
Range	0 to $\pm$ waveform-length points
Resolution	8 points
Accuracy	Same as sample clock accuracy

## Inter-channel skew control (Fine Tuning – Dual-channel versions only)

Characteristics	Description
Initial skew	200 ps
Control	
Range	-3 ns to +3 ns
Resolution	10 ps
Accuracy	$\pm$ (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	A selected output function shape is output continuously
Self armed	No start commands are required to generate waveforms
Armed	The output dwells on a dc level and waits for an enable command and then the output waveform is output continuously; An abort command turns off the waveform
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 regardless if 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, sinc, exponential rise, exponential decay, gaussian, noise and dc.
Standard waveform control	The standard waveform parameters can be adjusted to specific requirements. The waveform is re-computed with each parameter change.

**Standard waveforms frequency Control**

Characteristics	Description
Range	10 kHz to 250 MHz, useable to higher frequency, depending on the waveform length
Resolution	8 digits
Accuracy	
Internal reference	$\leq 1$ ppm from 19°C to 29°C; 1ppm/°C below 19°C or above 29°C; $\leq 1$ 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	256 to 16,000,000 points (256 to 64,000,000 with option 264), in multiples of 32 points
Waveform granularity	1 point
Number of waveforms	1 to 16,000 limited by segment size $\times 16,000 \leq 16,000,000$ ( $\leq 64,000,000$ with option 1)
Dynamic waveform control	Software command or rear panel segment control port (D-sub, 8 bit lines)
Waveform jump timing	Coherent or asynchronous, selectable
DAC resolution	12 bits
Waveform creation utilities	Waveform Editor creates complex arbitrary and sequenced waveforms.

**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. 32 ns minimum step duration
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)

**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
Sequence scenario	1 scenario, programmed in advanced sequence tables
Dynamic sequence control	Software command or rear panel sequence control port (D-sub, 8 bit lines)
Sequence table length	1 to 1k steps $\left[ \sum (\# \text{ of segments within a step}) \times (\# \text{ of sequences}) \leq 32k \right]$
Step advance control	Auto, once and stepped
Loop counter	1 to 1,000,000 cycles, each segment



**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	$\leq 1$ ppm from 19°C to 29°C; 1ppm/°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-coupled analog output**

	Description	
Characteristics	Amplified output	Direct DAC output
Type of output	Single-ended <sup>1)</sup> or differential	
Impedance	50 $\Omega$	
Amplitude control	Specified into 50 $\Omega$ , levels double into high impedance	
Range, single-ended	50 mVp-p to 2 Vp-p	50 mV to 500 mV
Range, differential	100 mVp-p to 4 Vp-p	50 mV to 1 Vp-p
Resolution	3 digits	
Accuracy, offset = 0 V	$\pm(3\% + 5 \text{ mV})$	
Offset control	Common mode, specified into 50 $\Omega$ , levels double into high impedance	
Range	-1.5 V to + 1.5 V	
Resolution	3 digits	
Accuracy	$\pm(5\% + 5 \text{ mV})$	
Rise/fall time (10% to 90%)	600 ps, typical	350 ps, typical
Bandwidth	600 MHz, typical (calculated)	1 GHz, typical (calculated)
Overshoot	5%, typical	7%, typical
Harmonic distortion <sup>2)</sup>	-52 dBc, 1 Vp-p	-58 dBc, 0.5 Vp-p
Non harmonic distortion <sup>2)</sup>	-76 dBc, 1 Vp-p, DC to 600 MHz	-66 dBc, 0.5 Vp-p, DC to 1 GHz
SCLK/2 spur <sup>3)</sup>	1 Vp-p	0.5 Vp-p amplitude
200 MHz	-42 dBc	-28 dBc
500 MHz	-40 dBc	-27 dBc
800 MHz	-36 dBc	-26 dBc
SCLK/2-f <sub>out</sub> spur <sup>3)</sup>	1 Vp-p, 0 V offset, 4.2 GSa/s	0.5 Vp-p, 0 V offset, 4.2 GSa/s
200 MHz	-50 dBc	-36 dBc
500 MHz	-48 dBc	-36 dBc
800 MHz	-42 dBc	-29 dBc
Phase Noise <sup>3)</sup>	<90 dBc/Hz, 1 Vp-p, 10 kHz offset	<90 dBc/Hz, 0.5 Vp-p, 10 kHz offset

<sup>1)</sup> The unused output must be terminated with 50  $\Omega$  to ground

<sup>2)</sup> offset=0 V, SCLK=4.2 GSa/s, 32 points sine waveform (131.25 MHz output frequency), typical values

<sup>3)</sup> offset=0 V, SCLK=4.2GSa/s, arbitrary waveforms, typical values



**RF, AC-coupled analog output**

Characteristics	Description
Type of output	Single-ended <sup>1)</sup>
Impedance	50 $\Omega$
Amplitude control	Specified into 50 $\Omega$ , levels double into high impedance
Range	-5 dBm to 5 dBm
Resolution	3 digits
Accuracy	$\pm(3\% +0.5\text{dBm})$
Bandwidth	1.5 GHz, typical
Flatness	$\pm 1\text{dB}$ , typical

**RF, AC-coupled analog output (continued)**

Characteristics	Description
Harmonic distortion <sup>2)</sup>	-50 dBm
Non harmonic distortion <sup>2)</sup>	-65 dBm, DC to 1.5 GHz
SCLK/2 spur <sup>3)</sup>	0 dBm, 4.2 GSa/s
200 MHz	-46 dBc
500 MHz	-44 dBc
800 MHz	-42 dBc
SCLK/2- $f_{\text{out}}$ spur <sup>3)</sup>	0 dBm, 4.2 GSa/s
200 MHz	-49 dBc
500 MHz	-35 dBc
800 MHz	-35 dBc
Phase Noise	<90 dBc/Hz, 0 dBm, 10 kHz offset

<sup>1)</sup> The unused output can be left open

<sup>2)</sup> SCLK=4.2 GSa/s, 32 points sine waveform (131.25 MHz output frequency), 0 dBm

<sup>3)</sup> SCLK=4.2GSa/s, arbitrary waveforms, typical values



**Marker outputs**

Characteristics	Description
Connector type	SMB
Number of markers	Two markers per channel
Skew between Marker 1 and Marker 2	100 ps, typical
Type of output	Differential (+) and (-) outputs
Impedance	50 $\Omega$
Level control	Specified into 50 $\Omega$ , levels double into high impedance
Voltage window	0V to 1.25 V, single-ended; 0V 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; 0 V to 2.5 V, differential
Resolution	10 mV
Accuracy	10% of setting
Width control	4 SCLK periods to segment length
Position control	0 to segment length in 4 points increments
Initial delay <sup>3)</sup>	3.5 ns, typical
Variable delay control	Separate for each marker
Range	0 to 3 ns
Resolution	10 ps
Accuracy	$\pm(10\%$ of setting +20 ps)
Rise/fall time	1.0 ns, typical

<sup>3)</sup> Output to marker

**SYNC output**

Characteristics	Description
Connector type	SMA
Type of output	Single ended
Source	Channel 1 or channel 2

**SYNC output (continued)**

Characteristics	Description
Waveform	Pulse (32 points width), WCOM (waveform duration pulse)
Impedance	50 $\Omega$
Amplitude	1 V; doubles into high impedance, typical
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 k $\Omega$
Polarity	Positive, negative, or both, selectable
Damage level	$\pm 20$ Vdc
Frequency range	0 to 15 MHz
Trigger level control	
Range	-5 V to 5 V
Resolution	12 bit (2.5 mV)
Accuracy	$\pm$ (5% of setting + 2.5 mV)
Sensitivity	0.2 Vp-p
Pulse width, minimum	10 ns
System delay <sup>4)</sup>	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 second
Resolution	2 ns
Accuracy	$\pm$ (5% of setting +20 ns)
Trigger Holdoff	Ignores triggers for a holdoff duration
Holdoff range	100 ns to 2 second
Resolution	2 ns
Accuracy	$\pm$ (5% of setting +20 ns)
Trigger jitter	8 sampling periods

<sup>4)</sup> Trigger to 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
Delay	
Range	152 to 8,000,000 sample clock periods
Resolution	Even 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 k $\Omega$
Polarity	Positive, negative or either, selectable
Damage level	$\pm 20$ Vdc
Frequency range	0 to 15 MHz
Trigger level control	
Range	-5 V to 5 V
Resolution	12 bit (2.5 mV)
Accuracy	$\pm$ (5% of setting + 2.5 mV)
Sensitivity	0.2 Vp-p minimum
Pulse width, minimum	10 ns

**Sequence / Segment Control input**

Characteristics	Description
Connector type	D-sub, 8 bit lines
Number of input connectors	1ch instrument: One 8 bit bus + valid line 2ch instrument: Two 8 bit buses to independently control each channel + valid line
Input impedance	10 k $\Omega$
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 $\Omega$
Input voltage swing	-5dBm to 5dBm
Damage Level	10dBm

**External sample clock input**

Characteristics	Description
General	External signal is fed to a frequency splitter. Same frequency is applied to both channel
Connector type	Rear panel SMA
Input impedance	50 $\Omega$
Input voltage swing	0dBm to 10dBm
Input frequency range	2.0 GHz to 4.2 GHz
Clock divider	1/1, 1/2, 1/4, ... 1/256, separate for each channel
Damage Level	15dBm



## Two Instruments Synchronization

Characteristics	Description
General	
Initial Skew	
Offset Control	
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 2.0 port	1 x front, USB host, standard A; 1 x rear, USB device, standard B
LAN port	1000/100/10 BASE-T
GPB 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	Periodical recalibration is required to maintain accuracy of output characteristics
Recalibration Period	2 years



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