DATA SHEET

Keysight N5166B CXG RF Vector Signal Generator

9 kHz to 3 or 6 GHz

KEYSIGHT TECHNOLOGIES

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Definition and Terms

Specifications represent warranted performance of a calibrated instrument that has been stored for a minimum of 2 hours within the operating temperature range of 0 to 55°C, unless otherwise stated, and after a 45-minute warm-up period.

Typical values (typ.) describe additional product performance information that is not covered by the product warranty. It is performance beyond specifications that 80 percent of the units exhibit with a 90 percent confidence level over the temperature range 20 to 30°C. Typical performance does not include measurement uncertainty.

Nominal values (nom.) indicate expected mean or average performance or an attribute whose performance is by design, such as the 50-ohm connector. This data is not warranted and is measured at room temperature (approximately 25°C).

Measured value (meas.) describes an attribute measured during the design phase for purposes of communicating expected performance, such as amplitude drift vs. time. This data is not warranted and is measured at room temperature (approximately 25°C).

Master the essentials

IoT and general-purpose R&D and design validation engineers need to keep up with today's expanding consumer electronic market. Engineers, like yourself, need an economic and versatile test and measurement system that can handle the diverse consumer electronics devices and give the performance required to make receiver tests across several different wireless standards.

Keysight has developed the N5166B CXG X-Series RF vector signal generator, that is a low-cost, multi-functional signal generation tool, used in general-purpose, and educational applications.

Explore the N5166B CXG data sheet now, and see how well it fits for your testing needs.

Frequency Specifications

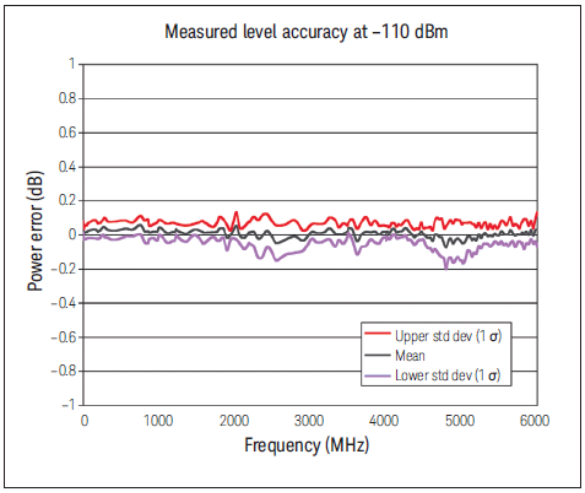
Frequency range			
Frequency range	Option 503	9 kHz (5 MHz IQ mode) to 3 GHz	
	Option 506	9 kHz (5 MHz IQ mode) to 6 GHz	
Resolution	0.001 Hz		
Phase offset	Adjustable in nominal 0.1° increments		
Frequency bands[1]	Band	Frequency range	N
	1	9 kHz to < 5 MHz	1 (Digital synthesis)
	1	5 to < 250 MHz	1
	2	250 to < 375 MHz	0.25
	3	375 to < 750 MHz	0.5
	4	750 to < 1500 MHz	1
	5	1500 to < 3000.001 MHz	2
	6	3000.001 to 6000 MHz	4
Frequency switching speed[2,3]			
SCPI, or List/Step sweep mode	≤ 5 ms, typical	For both CW and digital modulation modes	
Frequency reference			
Accuracy		± (time since last adjustment × aging rate) ± temperature effects ± line voltage effects ± calibration accuracy	
Internal time base reference oscillator aging rate		≤ ±5 ppm/10 years, < ±1 ppm/year	
Initial achievable calibration accuracy		± 4 × 10^{-8}	
Adjustment resolution		< 1 × 10^{-10}	
Temperature effects		±1 ppm (0-55°C), nominal	
Line voltage effects		±0.1 ppm, nominal; 5%-10%, nominal	
Reference output		10 MHz, > +4 dBm, nominal into 50 Ω load	
External reference input			
Input frequency	10 MHz standard; 1 to 50 MHz with option 1ER, in multiples of 0.1 Hz		
Stability	Follows the stability of external reference signal		
Lock range	±1 ppm		
Amplitude	> –3.0 to 20 dBm, nominal		
Impedance	50 Ω, nominal		
Waveform	Sine or Square		
Sweep modes (frequency and amplitude)			
Operating modes	Step sweep (equally spaced frequency and amplitude steps)		
	List sweep (arbitrary list of frequency and amplitude steps)		
	Simultaneously sweep waveforms; see Baseband generator section for more detail		
Sweep range	Within instrument frequency and amplitude range		
Dwell time	100 µs to 100 s		
Number of points	2 to 65535 (Step sweep)		
	1 to 3201 (List sweep)		
Step change	Linear or logarithmic		
Triggering	Free run, trigger key, external, timer, bus (GPIB, LAN, USB)		

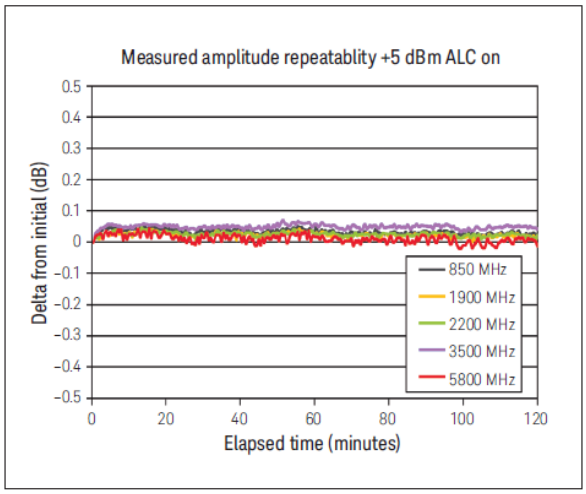
1. N is a factor used to help define certain specifications within the document
2. Time from receipt of SCPI command or trigger signal to within 0.1 ppm of final frequency or within 100 Hz, whichever is greater, and amplitude settled to within 0.2 dB from 20 to 30°C. When switching into or out of band 6, amplitude settling time is within 0.3dB. Implies simultaneous freq and ampl switching.
3. With internal channel corrections on, the frequency switching speed is < 1.3 ms, measured for list mode and SCPI mode cached frequency points. For the initial frequency point in SCPI mode, the time is < 3.3 ms, measured. The instrument will automatically cache the most recently used 1024 frequencies. There is no speed degradation for amplitude-only changes

Amplitude Specifications

Output parameters		
Settable range	+19 to -144 dBm	
Resolution	0.01 dB	
Step attenuator	0 to 130 dB in 5 dB steps, electronic type	
Connector	Type N, 50 Ω nominal	
Maximum output level[1]		
9 kHz to 10 MHz	+13 dBm	
>10 MHz to 3 GHz	+18 dBm	
3 to 6 GHz	+16 dBm	
Absolute level accuracy in CW mode[2] **(ALC on)**		
Range	Max. power to -60 dBm	< -60 to -110 dBm
9 to 100 kHz	±0.6 dB typical	±0.9 dB typical
100 kHz to 5 MHz	±0.8 dB, ±0.3 dB typical	±0.9 dB, ±0.3 dB typical
> 5 MHz to 3 GHz	±0.6 dB, ±0.3 dB typical	±0.8 dB, ±0.3 dB typical
3 to 6 GHz	±0.6 dB, ±0.3 dB typical	±1.1 dB, ±0.3 dB typical
Absolute level accuracy in CW mode (ALC off, power search run, relative to ALC on)		
9 kHz to 6 GHz	±0.15 dB typical	
Absolute level accuracy in digital IQ mode (ALC on, relative to CW, W-CDMA 1 DPCH configuration < +10 dBm)		
5 MHz to 6 GHz	±0.25 dB, ±0.05 dB typical	

1. Quoted specifications between 20-30°C. For temperature outside this range, absolute level accuracy degrades by 0.01 dB/°C.
2. Quoted specifications between 20-30°C. For temperature outside this range, absolute level accuracy degrades by 0.01 dB/°C. Output power may drift up to 0.10 dB < 3 GHz and 0.15 dB > 3 GHz per g/kg change in absolute humidity (nom.)

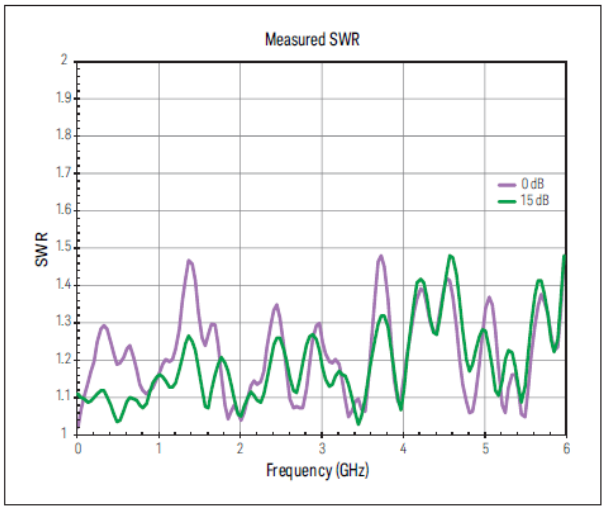


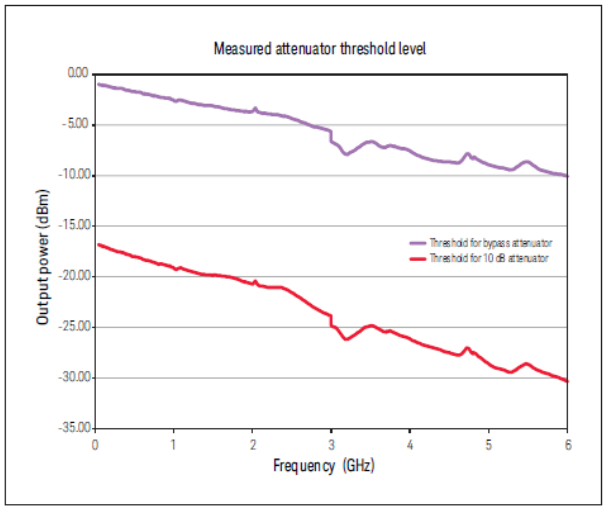


Repeatability measures the ability of the instrument to return to a given power setting after a random excursion to any other frequency and power setting. It should not be confused with absolute level accuracy

SWR (measured CW mode) [1]			
Frequency	Attenuator state		
	Bypass	0 to 10 dB	15 dB or more
≤ 1.0 GHz	< 1.3: 1	< 1.35: 1	< 1.2: 1
> 1.0 to 2 GHz	< 1.55: 1	< 1.5: 1	< 1.3: 1
> 2 to 3 GHz	< 1.8: 1	< 1.5: 1	< 1.45: 1
> 3 to 4 GHz	< 1.5: 1	< 1.6: 1	< 1.7: 1
> 4 to 6 GHz	< 1.9: 1	< 1.6: 1	< 1.6: 1

1. SWR < 1.60: 1 below 30 kHz





Maximum reverse power, nominal		
< 1 GHz	50 W	
> 1 to 2 GHz	25 W	
> 2 to 6 GHz	20 W	
Max. DC voltage	50 VDC	
Trip level	2 W	
Amplitude switching speed	CW mode	Digital modulation mode
SCPI mode	≤ 5 ms, typical	≤ 5 ms, typical
Power search SCPI mode	< 12 ms, measured	< 12 ms, measured
List /Step sweep mode	≤ 5 ms, typical	≤ 5 ms, typical
Alternate power level control		
Switching time (via waveform marker)	20 µs within ± 1 dB, measured	
Functional power range	-15 dBm to -144 dBm, measured	
User flatness correction		
Number of points	3201	
Number of tables	Dependent on available free memory in instrument; 10,000 maximum	
Entry modes	USB/LAN direct power meter control, LAN or USB to GPIB, remote bus, and manual USB/GPIB power meter control	
Sweep mode		
	See Frequency Specifications section for more detail	

Spectral Purity Specifications

Absolute SSB phase noise	CW at 20 kHz offset
5 to 250 MHz	-116 dBc/Hz, typical
250 MHz	-130 dBc/Hz, typical
500 MHz	-125 dBc/Hz, typical
1 GHz	-119 dBc/Hz, typical
2 GHz	-112 dBc/Hz, typical
3 GHz	-107 dBc/Hz, typical
4 GHz	-106 dBc/Hz, typical
5 GHz	-105 dBc/Hz, typical
6 GHz	-103 dBc/Hz, typical

Residual FM (CW mode, 300 Hz to 3 kHz BW, CCITT, rms	
5 MHz to 6 GHz	< N × 2 Hz (measured); See N value in frequency band table
Residual AM (CW mode, 0.3 to 3 kHz BW, rms, +5 dBm	
100 kHz to 3 GHz	< 0.01% (measured)
Harmonics (CW mode)	Input power < +4 dBm
9 kHz to 3 GHz	< -35 dBc
> 3 to 4 GHz	< -35 dBc, typical
> 4 to 6 GHz	< -53 dBc, typical
Non-harmonics (CW mode)	> 10 kHz offset
9 kHz to < 5 MHz	-65 dBc, nominal
5 to 250 MHz	-75 dBc
250 to < 750 MHz	-75 dBc
750 MHz to < 1.5 GHz	-72 dBc
1.5 to <3.0 GHz	-66 dBc
3 to 6 GHz	-60 dBc
Sub-harmonics (CW mode)	
9 kHz to 1.5 GHz	None
> 1.5 to 3 GHz	-77 dBc
> 3 to 6 GHz	-74 dBc

Jitter[1]

Carrier frequency	SONET/SDH data rate	rms jitter BW	µUI rms	Seconds
155 MHz	155 MB/s	100 Hz –1.5 MHz	140 (meas.)	0.9 ps typical
622 MHz	622 MS/s	1 kHz – 5 MHz	67	0.11 ps
2.488 GHz	2488 MB/s	5 kHz – 20 MHz	271	0.11 ps

1. Calculated from phase noise performance in CW mode at +10 dBm.

Analog Modulation Specifications

Frequency modulation (Option UNT)	(See N value in Frequency Specification section)	
Max. deviation	N × 10 MHz, nominal	
Resolution	0.025% of deviation or 1 Hz, whichever is greater, nominal	
Deviation accuracy	< ±2% + 20 Hz (1 kHz rate, deviation is N × 50 kHz)	
Modulation frequency response @100 kHz rate	1 dB bandwidth	DC/5 Hz to 3 MHz, nominal
	3 dB bandwidth	DC/1 Hz to 7 MHz, nominal
Carrier frequency accuracy	< ±0.2% of set deviation + (N × 1 Hz) [1]	
Relative to CW in DCFM	< ±0.06% of set deviation + (N × 1 Hz)[2], typical	
Distortion	< 0.4% [1 kHz rate, deviation is N × 50 kHz]	
FM using external input 1 or 2	Sensitivity	+1V peak for indicated deviation, nominal
	Input impedance	50Ω/600Ω/1MΩ, nominal
	Paths	FM path 1and 2 are summed internally for composite modulation
Phase modulation (Option UNT)	(See N value in Frequency Specification section)	
Maximum deviation[3]	Normal bandwidth	N × 5 radians, nominal
	High-bandwidth mode	N × 0.5 radians, nominal
Frequency response	Normal bandwidth (3 dB)	DC to 1 MHz, nominal
	High-bandwidth mode (3 dB)	DC to 4 MHz, nominal
Resolution	0.1% of deviation	
Deviation accuracy	< +0.5%+0.01 rad, typical [1 kHz rate, normal bandwidth mode]	
Distortion	< 0.2% typical [1 kHz rate, normal bandwidth mode]	
ΦM using external input 1 or 2	Sensitivity	+1V peak for indicated deviation, nominal
	Input impedance	50Ω/600Ω/1MΩ, nominal
	Paths	ΦM path 1and 2 are summed internally for composite modulation

1. Specification valid for temperature changes of less than ±5°C, since last DCFM calibration
2. Typical performance immediately after a DCFM calibration
3. Digital synthesis band FM deviation is 5 MHz

Amplitude modulation (Option UNT)			
AM depth type	Linear or exponential		
Maximum depth	100%		
Depth resolution	0.1% of depth, nominal		
AM depth error @ 1kHz rate and < 80% depth	F < 5 MHz	<1.5% of setting + 1% (typ. 0.5% of setting + 1%)	
	5 MHz ≤ F ≤ 2 GHz	<3% of setting + 1 %	
	2 < F ≤ 3 GHz	<5% of setting + 1% (typ. 3% of setting + 1%)	
	3 < F ≤ 6 GHz	(typical 4% of setting + 1%)	
Total harmonic distortion @ 1 kHz rate		**at 30% depth**	**at 80% depth**
	F < 5 MHz	<0.25%, typical	< 0.5%, typical
	5 MHz ≤ F < 2 GHz	< 2%	< 2%
	2 ≤ F < 3 GHz	< 2%, typical	< 2%, typical
Frequency response	30% depth, 3 dB BW	DC/10 Hz to 50 kHz	
Frequency response wideband AM	Rates ALC Off/On	DC/800 Hz to 80 MHz, nominal	
AM inputs using external inputs 1 or 2	Sensitivity	1 V_{peak} for indicated depth (Over-range can be 200% or 2.2 $V_{peak)}$	
	Input impedance	50 Ω or 600 Ω or 1 MΩ; Damage level: ±5 V_{max}	
	Path	AM path 1 and path 2 are summed internally for composite modulation	
Wideband AM inputs	Sensitivity	1 $V_{peak\text{-}to\text{-}peak}$ sine wave signal with 0.5V DC offset required input for 100% AM	
	Input impedance	50 Ω, nominal, Input via I only	

Simultaneous and composite modulation

Simultaneous modulation:

All modulation types (I/Q, AM, FM, ΦM and pulse modulation) may be simultaneously enabled, except: FM and ΦM cannot be combined and two modulation types cannot be simultaneously generated using the same modulation source. For example, the baseband I/Q generator, AM and FM can run co-currently and all will modulate the output RF (this is useful for simulating signal impairments)

Composite modulation:

AM, FM, and ΦM each consist of two modulation paths which are summed internally for composite modulation; modulation can be any combination of internal or external sources

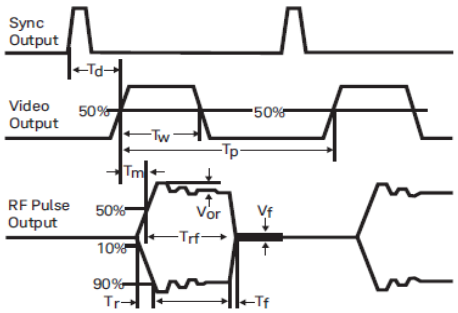
	AM	FM	ΦM	Pulse	Internal I/Q	External I/Q
AM	+	+	+	+	+	+
FM	+	+	-	+	+	+
ΦM	+	-	+	+	+	+
Pulse	+	+	+	-	+	+
Internal I/Q	+	+	+	+	-	+
External I/Q	+	+	+	+	+	-
"+" = compatible, "-" = incompatible						

External modulation inputs (Option UNT required for AM, FM, ΦM modulation input; Option UNW required for pulse modulation inputs)	
EXT 1	AM, FM, ΦM
EXT 2	AM, FM, ΦM
PULSE	Pulse (50 Ω only)
I	Wideband AM (50 Ω only)
Input impedance	50 Ω, 1 MΩ, 600 Ω, DC and AC coupled
Standard internal analog modulation source (Single sine wave generator for use with AM, FM, ΦM; Requires Option UNT or 303)	
Waveform	Sine, Square, Triangle, Positive ramp, Negative ramp
Rate range	0.1 Hz to 2 MHz (tunable to 3 MHz)
Resolution	0.1 Hz
Frequency accuracy	Same as RF reference source, nominal
LF audio output	0 to 5 V_{peak} into 50 Ω, -5V to 5V offset, nominal
Multifunction generator (Option 303)	
The multifunction generator option (Option 303) consists of seven waveform generators that can be set independently with up to five simultaneously using the composite modulation features in AM, FM/PM, and LF out	
Waveform	
Function generator 1	Sine, Triangle, Square, Positive ramp, Negative ramp, Pulse
Function generator 2	Sine, Triangle, Square, Positive ramp, Negative ramp, Pulse
Dual function generator	Sine, Triangle, Square, Positive ramp, Negative ramp, Phase offset and amplitude ratio for Tone 2 relative to Tone 1
Swept function generator	Sine, Triangle, Square, Positive ramp, Negative ramp Trigger: free run, trigger key, bus, external, internal, timer trigger
Noise generator 1 and 2	Uniform, Gaussian
DC	Only for LF output -5V to +5V, nominal
Frequency parameters	
Sine wave	0.1 Hz to 10 MHz, nominal
Triangle, Square, Ramp, Pulse	0.1 Hz to 1 MHz, nominal
Noise bandwidth	10 MHz, nominal
Resolution	0.1 Hz
Frequency accuracy	Same as RF reference source, nominal
Narrow pulse modulation (Option UNW) [1]	
On/Off ratio	> 80 dB, typical
Rise/Fall times (Tr, Tf)	< 10 ns, 7 ns typical
Minimum pulse width ALC on/off	≥ 2µs / ≥ 20ns
Repetition frequency ALC on/off	10 Hz to 500 kHz / DC to 10 MHz
Level accuracy relative to CW ALC on/off [2]	< ± 1.0 dB, ± 0.5 dB typical / < ± 0.5 dB typical
Width compression (RF width relative to video out)	< 5 ns, typical

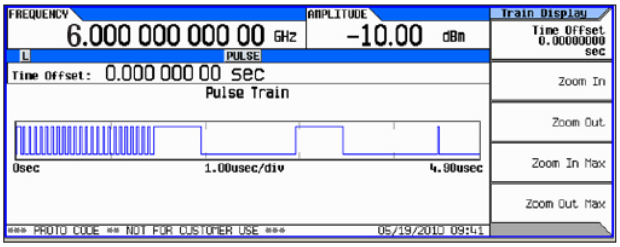
1. Pulse specifications apply to frequencies > 100 MHz and power set to > -3 dBm. Operable down to 9 kHz
2. With power search on

Narrow pulse modulation (continued)		
Video feed-through[1], ≤ 3 GHz / > 3 GHz	< 50 mV typical / < 5 mV typical	
External video delay (ext. input to video)	30 ns, nominal	
RF delay (video to RF output)	20 ns, nominal	
Pulse overshoot	<15%, typical	
Input level	+1 V_{peak} = RF on into 50 Ω, nominal	

Td video delay (variable)
Tw video pulse width (variable)
Tp pulse period (variable)
Tm RF delay
Trf RF pulse width
Tf RF pulse fall time
Tr RF pulse rise time
Vor pulse overshoot
Vf Video feedthrough



Internal pulse train generator (included in option UNW)		
Mode	Free-run, Square, Triggered, Adjustable doublet, Trigger doublet, Gated, External Pulse	
Square wave rate	0.1 Hz to 10 MHz, 0.1 Hz resolution, nominal	
Pulse period	30 ns to 42 seconds, nominal	
Pulse width	20 ns to pulse period –10 ns, nominal	
Resolution	10 ns	
Adjustable trigger delay	(-pulse period + 10 ns) to (pulse width – 10 ns)	
Settable delay	Free run	-3.99 to 3.97 µs
	Triggered	0 to 40 s
Resolution (delay, width, period)	10 ns nominal	
Pulse doublets	1st pulse delay	(relative to sync out) 0-42s – pulse width – 10 ns
	1st pulse width	500 ns to 42 s – delay – 10 ns
	2nd pulse delay	0 to 42 s – (Delay 1 + width 2) – 10 ns
	2nd pulse width	20 ns to 42 s – (Delay 1+ Delay 2) – 10 ns
Pulse train generator (N5180320B)		
Number of pulse patterns	2047	
On/Off time range	20 ns to 42 sec	

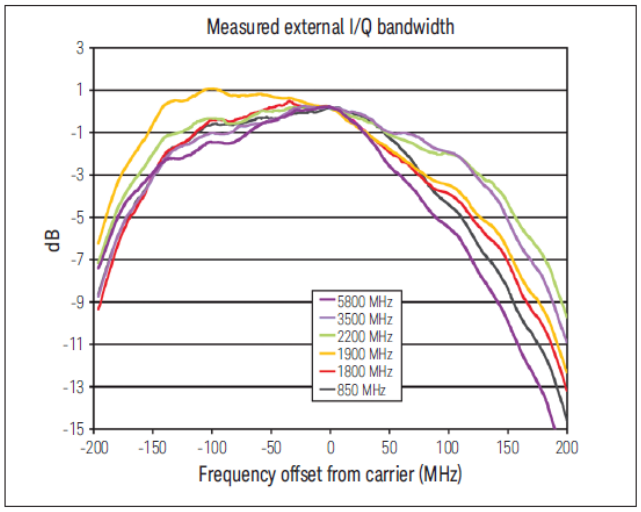


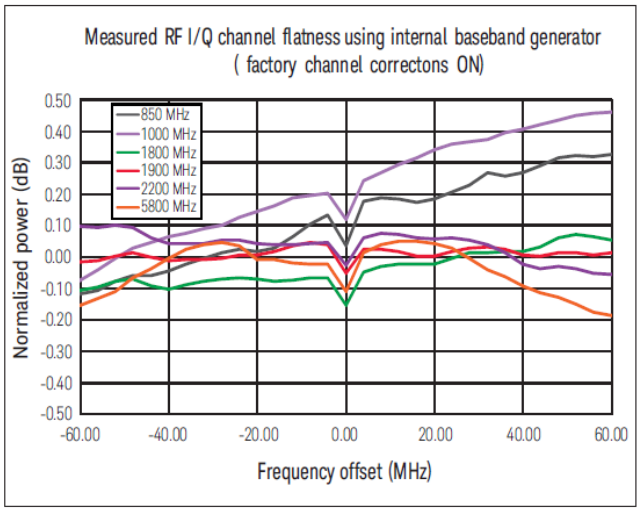
1. Video feedthrough applies to power levels < +10 dBm

Vector Modulation Specifications

IQ modulator external inputs [1]		
Bandwidth	Baseband (I or Q)	Up to 100 MHz, nominal
	RF (I + Q)	Up to 200 MHz, nominal
I or Q offset	±100 mV	(200 µV resolution)
I/Q gain balance	± 4 dB	(0.001 dB resolution)
I/Q attenuation	0 – 50 dB	(0.01 dB resolution)
Quadrature angle adjustment	± 200 units	
Full scale input drive (I + Q)	0.5V into 50Ω, nominal	
Internal I/Q baseband generator adjustment (option 653 and 655)		
I/Q offset	± 20%	(0.025% dB resolution)
I/Q gain	± 1 dB	(0.001 dB resolution)
Quadrature angle adjustment	± 10°	(0.01 degrees resolution)
I/Q phase	± 360.0°	(0.01 degrees resolution)
I/Q skew	± 500 ns	(1 ps resolution)
I/Q delay	± 250 ns	(1 ps resolution)
Internal IQ outputs [1]		
Impedance	50 Ω, nominal per output	
Type	Single-ended	
Maximum voltage per output	1V $_{peak\text{-}to\text{-}peak}$, or 0.5V$_{peak}$	Into 50 Ω (200µV resolution)
Bandwidth (I, Q)	Baseband (I or Q)	60 MHz, nominal (opt.653, 655)
	RF (I+Q)	120 MHz, nominal (opt. 653, 655)
Amplitude flatness	± 0.2dB, measured with channel corrections optimized for I/Q output	
Phase flatness	± 2.5 degrees measured with channel corrections optimized for I/Q output	
Common mode I/Q offset	±1.5V into 50Ω	(200 µV resolution)

1. I/Q adjustments represent user interface nominal parameter ranges and not specifications
2. Intern I/Q adjustments apply to RF out and I/Q outputs simultaneously





Internal real time complex digital I/Q filters (included with option 653)		
Factory channel correction (256 taps)		
Corrects the linear phase and amplitude response of the baseband I/Q and RF outputs of the signal generator, using factory calibration arrays (default mode is off).		
RF amplitude flatness (120 MHz)	±0.2 dB measured	
RF phase flatness (120 MHz)	±2 degrees measured	
User channel correction (256 taps)		
Automated routine uses USB power sensor to correct for linear phase and amplitude response of DUT. See User's Guide for more detail.		
Max. RF amplitude flatness correction	±15 dB	
Max. RF phase flatness correction	± 20 degrees	
Equalization filter (256 taps)		
User can download and apply inverse or custom phase and amplitude response coefficients from tools such as MATLAB, 89601B VSA, or SystemVue to correct for linear errors of DUT/system. See User's Guide for more detail		
Baseband generator (Option 653, 655)		
Channels	2 (I and Q)	
Resolution	12 bits	
Sample rate	Option 653	100 Sa/s to 75 MSa/s
	Option 653 and 655	100 Sa/s to 150 MSa/s
RF bandwidth (I+Q)	Option 653	60 MHz, nominal
	Option 653 and 655	120 MHz, nominal
Interpolated DAC rate	800 MHz (waveforms only need OSR= 1.25)	
Frequency offset range	±80 MHz	
Digital sweep modes	In list sweep mode, each point in the list can have independent waveforms along with user definable frequencies and amplitudes; See Frequency Specifications section for more detail	
Waveform switching speed[1]	≤ 5 ms, measured, in both SCPI mode and List/Step sweep mode	
Waveform transfer rates (Measured, no markers, unencrypted)	FTP LAN to internal SSD	10.7 MB/sec or 2.67 MSa/sec
	Internal SSD to FTP LAN	7.7 MB/sec 1.92 MSa/sec
	FTP LAN to BBG	8.2 MB/sec or 2.05 MSa/sec
	FTP LAN to BBG encrypted	4 MB/sec or 1 MSa/sec
	USB to BBG	19 MB/sec or 4.75 MSa/sec
	BBG to USB	1.2 MB/sec or 300 kSa/sec
	Internal SSD to BBG	48 MB/sec or 12 MSa/sec
	BBG to internal SSD	1.2 MB/sec or 300 kSa/sec
Arbitrary waveform memory	Max. playback capacity	32 MSa standard, 512 MSa with Opt. 022
	Max. storage capacity incl. markers	3 GB/800 MSa, 30GB/7.5GSa with opt.009
Waveform segments	Segment length	60 samples to 32 MSa, standard
		60 samples to 512 MSa, requires opt.022
	Min. memory allocation per segment	256 samples
	Max. number of segments	8192
Waveform sequences	Max. number of sequences	> 2000 depending on non-volatile memory usage
	Max. number of segments/sequence	32,000 (standard), 4 million (opt. 022)
	Max. number of repetitions	65,535

1. SCPI mode switching speed applies when waveforms are pre-loaded in list sweep and sample rate ≥ 10 MSa/s.

Triggers	Types		Continuous, single, gated, segment advance
	Source		Trigger key, external, bus (GPIB, LAN, USB)
	Modes	Continuous	Free run, trigger and run, reset and run
		Single	No retrigger, buffered trigger, restart on trigger
		Gated	Negative polarity or positive polarity
		Segment advance	Single or continuous
	External coarse delay time		5 ns to 40 s
	External coarse delay resolution		5 ns
	Trigger latency (single trigger only)		356 ns + 1 sample clock period, nominal
	Trigger accuracy (single trigger only)		± 2.5 ns, nominal
	Single trigger – restart on trigger mode will initiate a FIFO clear.		

Multi-baseband generator synchronization mode (multiple sources)	Fan out	1 master and up to 15 slaves
	Trigger repeatability	< 1 ns, nominal
	Trigger accuracy	Same as normal mode
	Trigger latency	Same as normal mode
	Fine trigger delay range	See Internal I/Q Baseband section
	Fine trigger delay resolution	See Internal I/Q Baseband section
	I/Q phase adjustment range	See Internal I/Q Baseband section
Markers	Markers are defined in a segment during the waveform generation process, or from the front panel; a marker can also be routed to the RF blanking, ALC hold functions, and alternate amplitude; see Users Guide for more information	
	Marker polarity	Negative, positive
	Number of markers	4
	RF blanking/Burst On/Off ratio	> 80 dB
	Alternate amplitude control switching speed	
Real-time modulation FIR filters	Nyquist, root-Nyquist, WCDMA, EDGE, Gaussian, rectangular, APCO 25 C4FM, IS-95, User FIR	Applies real-time FIR filtering when playing waveforms with OSR=1. Helps to reduce waveform size for long simulation times. Option 660 not required

AWGN (N5180403B)		
Type	Real-time, continuously calculated, and played using DSP	
Modes of operation	Standalone, or digitally added to signal played by arbitrary waveform	
Bandwidth	With option 653	1 Hz to 60 MHz
	With option 653 and 655	1 Hz to 120 MHz
Crest factor	15 dB	
Randomness	90 bit pseudo-random generation, repetition period 313 × 10^9 years	
Carrier-to-noise ratio	± 100 dB when added to signal	
Carrier-to-noise formats	C/N, Eb/No	
Carrier-to-noise ratio error	Magnitude error ≤ 0.2 dB at baseband I/Q input	
Custom modulation ARB mode (N5180431B)		
Modulation	PSK	BPSK, QPSK, OQPSK, π/4DQPSK, gray coded and unbalanced QPSK, 8PSK, 16PSK, D8PSK
	QAM	4, 16, 32, 64, 128, 256, 1024 (and 89601B VSA mappings)
	FSK	Selectable: 2, 4, 8, 16, C4FM
	MSK	0 to 100°
	ASK	0 to 100%
Multicarrier	Number of carriers	Up to 100 (limited by a max BW of 120 MHz depending on symbol rate and modulation type)
	Frequency offset (per carrier)	Up to -60 to +60 MHz
	Power offset (per carrier)	0 to -40 dB
Symbol rate	50 sps to 100 Msps	
Filter types	Nyquist, root-Nyquist, Gaussian, rectangular, APCO 25 C4FM, user	
Quick setup modes	APCO 25w/C4FM, APCO25 w/CQPSK, Bluetooth®, CDPD, DECT, EDGE, GSM, NADC, PDC, PHS, PWT, TETRA	
Data	Random only	
Custom modulation real-time mode (N5180431B) (Does not require option 660)		
Modulation	PSK	BPSK, QPSK, OQPSK, π/4DQPSK, gray coded and unbalanced QPSK, 8PSK, 16PSK, D8PSK
	QAM	4, 16, 32, 64, 128, 256, 1024 (and 89601B VSA mappings)
	FSK	Selectable: 2, 4, 8, 16, C4FM Custom map of up to 16 deviation levels Max. deviation 20 MHz
	MSK	0 to 100°
	ASK	0 to 100%
	DVB-S2 APSK	16APSK 2/3, 16APSK 3/4, 16APSK 4/5, 16APSK 5/6, 16APSK 8/9, 16APSK 9/10, 32APSK 3/4, 32APSK 4/5, 32APSK 5/6, 32APSK 8/9, 32APSK 9/10
	Custom I/Q	Custom map of 1024 unique values
Frequency offset	Up to -60 to +60 MHz	
Symbol rate	Internal generated data	1 sps to 100 Msps of max. of 10 bits per symbol (option 653+655)
	External serial data	1 sps to [(50 Mbits/sec) / (# bits/symbol)]
Filter types	Selectable	Nyquist, root-Nyquist, Gaussian, rectangular, APCO 25 (phase 1 and 2 UL and DL), IS-95, WCDMA, EDGE (wide and HSR) IS-95 w/EQ, IS-95 Mod, IS-95 Mod w/EQ, HDQPSK, APCO25 HCPM, SOQPSK-TG

Custom modulation real-time mode (continued)			
Filter type	Custom FIR	16-bit resolution, up to 64 symbols long, automatically resampled to 1024 coefficients (max) > 32 to 64 symbol filter: symbol rate ≤ 12.5 MHz > 16 to 32 symbol filter: symbol rate ≤ 25 MHz Internal filters switch to 16 tap when symbol rate is between 25 and 100 MHz	
Quick setup modes	APCO 25 with (C4FM, CQPSK, HCPM, HDQPSK), TETRA , Bluetooth, CDPD, DECT, EDGE, GSM, NADC, PDC, PHS, PWT, WorldSpace, Iridium, ICO, CT2, TFTS 16APSK 2/3, 16APSK 3/4, 16APSK 4/5, 16APSK 5/6, 16APSK 8/9, 16APSK 9/10, 32APSK 3/4, 32APSK 4/5, 32APSK 5/6, 32APSK 8/9, 32APSK 9/10, SOQPSK		
Trigger delay	Range	0 to 1,048,575 bits	
	Resolution	1 bit	
Data type	Internal generated	Pseudo-random patterns	PN9, PN11, PN15, PN20, PN23
		Repeating sequence	Any 4-bit sequence
	Direct-pattern RAM max. size (Used for custom TDMA or non-standard framing)		32 Mb (standard) 1024 Mb (option 022)
	User filer		32 Mb (standard) 1024 Mb (option 022)
	Externally streamed data (via AUX I/O)	Type	Serial data
		Inputs/Outputs [1]	Data, symbol sync, bit clock
Internal burst shape (varies with bit rate)	Rise/Fall time range	Up to 30 bits	
	Rise/Fall delay range	-15 to +15 bits	
Multitone and two-tone (requires N5180430B)			
Number of tones	2 to 512, with selectable on/off state per tone		
Frequency spacing	100 Hz to 120 MHz (with option 653, 655)		
Phase (per tone)	Fixed or random		

3GPP W-CDMA distortion performance [2, 3]			
Offset	Configuration	Frequency	Power level ≤ 2 dBm[3]
Adjacent (5 MHz)	1 DPCH, 1 carrier	1800 to 2200 MHz	-69 dBc, -73 dBc typical
Alternate (10 MHz)			-70 dBc, -75 dBc typical
Adjacent (5 MHz)	Test model 1 with 64 DPCH, 1 carrier	1800 to 2200 MHz	-68 dBc, -70 dBc typical
Alternate (10 MHz)			-68 dBc, -73 dBc typical
Adjacent (5 MHz)	Test model 1 with 64 DPCH, 4 carrier	1800 to 2200 MHz	-63 dBc, -65 dBc typical
Alternate (10 MHz)			-64 dBc, -66 dBc typical

1. Bit clock and symbol sync inputs will be available in future firmware release.
2. ACPR specifications apply when the instrument is maintained within ± 20 to 30 °C.
3. This is rms power. Convert from rms to peak envelope power (PEP) with the following equation: PEP = rms power + crest factor (for example, 3GPP test model 1 with 64 DPCH has a crest factor 11.5 dB, therefore at +5 dBm rms, the PEP = 5 dBm + 11.5 dB = +16.5 dBm PEP).

3GPP LTE-FDD distortion performance[1]			
Offset	Configuration	Frequency	Power level ≤ 2 dBm [2]
Adjacent (10 MHz) [3]	10 MHz E-TM 1.1 QPSK	1800 to 2200 MHz	-64 dBc, -66 dBc typical
Alternate (20 MHz) [3]			-66 dBc, -68 dBc typical

GSM/EDGE output RF spectrum (ORPS)			GSM	EDGE
Offset	Configuration	Frequency	Power level < +7 dBm	Power level < +7 dBm
200 kHz	1 normal timeslot, bursted	800 to 900 MHz 1800 to 1900 MHz	-34 dBc	-37 dBc
400 kHz			-69 dBc	-69 dBc
600 kHz			-81 dBc	-80 dBc
800 kHz			-82 dBc	-82 dBc
1200 kHz			-84 dBc	-83 dBc
3GPP2 cdma2000 distortion performance				
Offset	Configuration	Frequency	Power level ≤ +2 dBm [2]	
885 kHz to 1.98 MHz	9 channel forward link	800 to 900 MHz	-78 dBc	
> 1.98 to 4.0 MHz			-86 dBc	
> 4.0 to 10 MHz			-91 dBc	

1. ACPR specifications apply when the instrument is maintained within ± 20 to 30 °C.
2. This is rms power. Convert from rms to peak envelope power with the following equation: PEP = rms power + crest factor (for example, 3GPP test model 1 with 64 DPCH has a crest factor 11.5 dB, therefore at +5 dBm rms, the PEP = 5 dBm + 11.5 dB = +16.5 dBm PEP).
3. ACPR measurement configuration: reference channel integration BW: 9.015 MHz, offset channel integration bandwidth: 9.015 MHz.

EVM performance [1, 2]					
Format	GSM	EDGE	cdma2000/IS95	W-CDMA	LTE-FDD[3]
Modulation type	GMSK (bursted)	3pi/8 8PSK (bursted)	QPSK	QPSK	64 QAM
Modulation rate	270.833 ksps	70.833 ksps	1.2288 Mcps	3.84 Mcps	10 MHz BW
Channel config.	1 timeslot	1 timeslot	Pilot channel	1 DPCH	E-TM 3.1
Frequency [4]	800 to 900 MHz 1800 to 1900 MHz	800 to 900 MHz 1800 to 1900 MHz	800 to 900 MHz 1800 to 1900 MHz	1800 to 2200 MHz	1800 to 2200 MHz
EVM power level	≤ 7 dBm	≤ 7 dBm	≤ 7 dBm	≤ 7 dBm	≤ 7 dBm
EVM/global phase error	0.2° typical	0.75° typical	0.8° typical	0.8° typical	0.2° typical

EVM performance						
Format	802.11a/g	802.11ac [5]	QPSK		16 QAM	
Modulation type	64 QAM	256 QAM	QPSK		QPSK	
Modulation rate	54 Mbps	80 MHz BW	4 Msps (root-Nyquist filter ą = 0.25)			
Frequency [4]	2400 to 2484 MHz		≤ 3 GHz	≤ 6 GHz	≤ 3 GHz	≤ 6 GHz
	5150 to 5825 MHz	5775 MHz				
EVM power level	≤ -5 dBm	≤ -5 dBm	≤ 4 dBm	≤ 4 dBm	≤ 4 dBm	≤ 4 dBm
EVM	0.3% measured	0.4% measured	0.8% typical	1.1% typical	0.65% typical	0.9% typical

1. EVM specifications apply for the default ARB file setup conditions with the default ARB files supplied with the instrument.
2. EVM specifications apply after execution of I/Q calibration when the instrument is maintained within ± 5 °C of the calibration temperature.
3. LTE FDD E-TM 3.1,10 MHz, 64 QAM PDSCH, full resource block. Measured EVM after DC calibration.
4. Performance evaluated at bottom, middle, and top of bands shown.
5. WLAN 802.11ac 80 MHz, 256 QAM, MCS 8, 7 symbols, no filtering. Channel corrections enabled. Rx equalizer training: preamble only.

General Specifications

Temperature range		
Operating	0 to 55 °C	
Storage	-40 to 70 °C	
Operating and storage altitude		
Up to 15,000 feet		
Humidity		
Maximum Relative Humidity (non-condensing): 95%RH up to 40°C, decreases linearly to 45%RH at 55°C. [1]		
EMC		
Complies with European EMC Directive 2004/108/EC: – IEC/EN 61326-2-1 – CISPR 11, Group 1, Class A – AS/NZS CISPR 11 – ICES/NMB-001 This ISM device complies with Canadian ICES-001 Cet appareil ISM est conforme à la norme NMB-001 du Canada		
Safety		
Complies with European Low Voltage Directive 2006/95/EC — IEC/EN 61010-1 — Canada: CSA C22.2 No. 61010-01 — USA: UL 61010-1, 2nd edition		
Acoustic noise emission	Geraeuschemission	
LpA < 70 dB Operator position Normal position Per ISO 7779	LpA < 70 dB Am Arbeitsplatz Normaler Betrieb Nach DIN 45635 t.19	
Environmental stress		
Samples of this product have been type tested in accordance with the Keysight Environmental Test Manual and verified to be robust against the environmental stresses of Storage, Transportation and End-use; those stresses include but are not limited to temperature, humidity, shock, vibration, altitude and power line conditions. Test Methods are aligned with IEC 60068-2 and levels are similar to MIL-PRF-28800F Class 3.		
Power requirements		
Voltage and frequency (nominal)	100/120 V, 50/60/400 Hz 220/240 V, 50/60 Hz	The instruments can operate with mains supply voltage fluctuations up to ± 10% of the nominal voltage
Power consumption	300 W maximum	

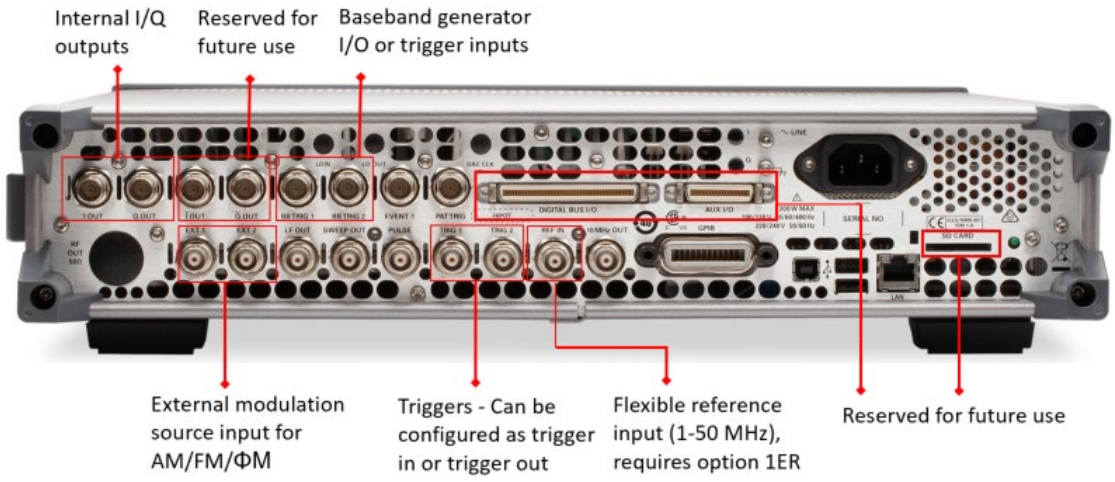
1. From 40°C to 55°C, the maximum % Relative Humidity follows the line of constant dew point

Self-test	
Internal diagnostic routines test most modules in a preset condition; for each module, if its node voltages are within acceptable limits, the module passes the test	
Remote programming	
Interfaces	GPIB IEEE-488.2, 1987 with listen and talk LAN 1000BaseT LAN interface, LXI Class C compliant USB Version 2.0
Control languages	SCPI Version 1997.0
Compatibility languages	Keysight Technologies: N5181A\61A, N 5182A\62A, N5183A, E4438C, E4428C, E442xB, E443xB, E8241A, E8244A, E8251A, E8254A, E8247C, E8257C/D, E8267C/D, 8648 Series, 8656B, E8663B, 8657A/B, 8662A, 8663A
	Aeroflex Inc.: 3410 Series
	Rohde & Schwarz: SMB100A, SMBV100A, SMU200A, SMJ100A, SMATE200A, SMIQ, SML, SMV
Data storage	
Internal	3 GB (30 GB with option 009)
External	Supports USB 2.0 compatible memory devices
Weight (without options)	
Net	15.9 kg (35 lbs.) (nominal)
Shipping	30.8 kg (68 lbs.) (nominal)
Dimensions	
Height	88 mm (3.5 in)
Width	426 mm (16.8 in)
Length	489 mm (19.2 in)
Calibration cycle	
The recommended calibration cycle is 3 year; calibration services are available through Keysight service centers	

Inputs and Outputs

Front panel connectors	
RF output	Outputs the RF signal via a precision N type female connector; see output section for reverse power protection information
I and Q inputs	BNC input accepts "in-phase" and "quadrature" input signals for I/Q modulation; nominal input impedance is 50 Ω, damage levels are 1 Vrms and 5 Vpeak
USB 2.0	Used with a memory stick for transferring instrument states, licenses and other files into or out of the instrument; also used with U2000, U848X, and U202X Series USB power sensors
Rear panel connectors	
Rear panel inputs and outputs are 3.3 V CMOS, unless indicated otherwise; CMOS inputs will accept 5 V CMOS, 3 V CMOS, or TTL voltage levels	
I and Q outputs	BNC outputs the analog I/Q modulation signals from the internal baseband generator; nominal output impedance 50 Ω, DC coupled; damage levels ± 2 V
Event 1	This connector outputs the programmable timing signal generated by marker 1 The marker signal can also be routed internally to control the RF blanking and ALC hold functions; this signal is also available on the AUX I/O connector
Pattern trigger	Accepts signal to trigger internal pattern generator to start single pattern output, for use with the internal baseband generators Accepts CMOS signal with minimum pulse width of 10 ns Female BNC Damage levels are > +8 V and < –4 V
BBTRIG 1	For arbitrary and real-time baseband generators I/O such as Markers or trigger inputs
BBTRIG 2	For arbitrary and real-time baseband generators I/O such as Markers or trigger inputs
Sweep out	Generates output voltage, 0 to +10 V when the signal generator is sweeping; this output can also be programmed to indicate when the source is settled or output pulse video and is TTL and CMOS compatible in this mode; output impedance < 1 Ω, can drive 2 kΩ; damage levels are ± 15 V
EXT 1	External AM/FM/PM #1 input; nominal input impedance is 50 Ω/600 Ω/1M Ω, nominal; damage levels are ± 5 V
EXT 2	External AM/FM/PM #1 input; nominal input impedance is 50 Ω/600 Ω/1M Ω, nominal; damage levels are ± 5 V
LF out	0 to 5 V peak into 50 Ω, –5 V to 5 V offset, nominal
Pulse	External pulse modulation input; this input is TTL and CMOS compatible; low logic levels are 0 V and high logic levels are +1 V; nominal input impedance is 50 Ω; input damage levels are ≤ –0.3 V and ≥ +5.3 V
Trigger in	Accepts TTL and CMOS level signals for triggering point-to-point in sweep mode; damage levels are ≤ –0.3 V and ≥ +5.3 V
Trigger out	Outputs a TTL and CMOS compatible level signal for use with sweep mode The signal is high at start of dwell, or when waiting for point trigger in manual sweep mode, and low when dwell is over or point trigger is received This output can also be programmed to indicate when the source is settled, pulse synchronization, or pulse video Nominal output impedance 50 Ω Input damage levels are ≤ –0.3 V and ≥ +5.3 V

Rear panel (continued)	
Reference input	Accepts a 10 MHz reference signal used to frequency lock the internal timebase; Option 1ER adds the capability to lock to a frequency from 1 MHz to 50 MHz; nominal input level –3 to +20 dBm, impedance 50 Ω, sine or square waveform
10 MHz reference out	Outputs the 10 MHz reference signal used by internal timebase; level nominally +3.9 dBm; nominal output impedance 50 Ω; input damage level is +16 dBm
Digital bus I/O Aux I/O Differential I/Q output	Reserved for future use
USB 2.0	The USB connector provides remote programming functions via SCPI
GPIB interface	The GPIB connector provides remote programming functionality via SCPI
LAN TCP/IP interface	The LAN connector provides the same SCPI remote programming functionality as the GPIB connector and is also used to access the internal Web server and FTP server Supports DHCP, sockets SCPI, VXI-11 SCPI, connection monitoring, dynamic hostname services, TCP keep alive LXI class C compliant Trigger response time for the immediate LAN trigger is 0.5 ms (minimum), 4 ms (maximum), 2 ms, typical; delayed/ alarm trigger is unknown Trigger output response time is 0.5 ms (minimum), 4 ms (maximum), 2 ms, typical



Related Literature

Publication title	Publication number
N5166B CXG signal generator Configuration Guide	*5992-4077EN*
N9000B CXA signal analyzer data sheet	*5992-1274EN*
X-Series Signal Sources Technical Overview	*5990-9957EN*

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