KEITHLEY

Model 2920

Vector Signal Generator Specifications

Keithley Instruments, Inc.
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Basic Modes of Operation

CW Signal Generator mode – CW signal generator. Default mode.

Vector Signal Generator Personalities – modulation quality source for GSM, GPRS, EDGE, GPS, cdma2000, and WCDMA mobile phone transmitter signals.

Note: All items are Specifications unless otherwise noted.

FREQUENCY

Frequency Parameters		**Specification**
Frequency range	Configuration	
	2920-004	10 MHz to 4.0 GHz
	2920-006	10 MHz to 6.0 GHz[1]
Frequency Input Units		Hz, kHz, MHz, GHz
Frequency setting resolution		0.1 Hz
Frequency accuracy		Same as frequency reference + synthesizer resolution term[2]
Frequency Switching Time[3]		≤ 1.6 ms (modulation off) ≤ 1.8 ms (modulation on)
		≤ 3.0 ms (Characteristic)[4]

INTERNAL FREQUENCY REFERENCE

Internal Frequency Reference Parameters	**Specification**
Aging rate	≤ 1ppm/year
Temperature stability	≤ 0.2ppm[5]

FREQUENCY REFERENCE OUTPUT

Frequency Reference Parameters	**Specification**
Impedance	50 Ohm (Characteristic), AC coupled
Ref output signal	10 MHz, +7 dBm ± 3 dB (Characteristic)

[1] Over range operation provided: 10 MHz to 6.9 GHz. Performance above 6.0 GHz is not specified.
[2] Synthesizer resolution term: ≤ 5 uHz.
[3] To within 0.1ppm of final value. List mode or swept mode. Free run or hardware trigger. ALC on or off. Modulation on or off.
[4] To within 0.1ppm of final value. Via remote command after receipt of end-of-operation indicator (EOI). ALC no or off. Modulation on or off.
[5] Total variation relative to 0ºC to 50ºC ambient temperature range.

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EXTERNAL FREQUENCY REFERENCE INPUT

External Frequency Reference Parameters		**Specification**
Frequency Lock Range	Hardware Lock Mode[6]	10 MHz ±10 Hz (1ppm) input frequency lock range.
	Variable Input Frequency Mode	1 to 20 MHz[7]
Amplitude		Lock range: -3 to +15 dBm[8]
Impedance		50 Ohm (Characteristic)

SPECTRAL PURITY

Spectral Purity Parameter			
SSB Phase Noise; 20kHz Offset	Carrier Frequency; GHz	Specification	Characteristic
	1	≤ -117 dBc/Hz	≤ -124 dBc/Hz
	2	≤ -111 dBc/Hz	≤ -118 dBc/Hz
	3	≤ -108 dBc/Hz	≤ -116 dBc/Hz
	4	≤ -105 dBc/Hz	≤ -113 dBc/Hz
	6	≤ -101 dBc/Hz	≤ -110 dBc/Hz
Harmonics and sub-harmonics[9]	Fundamental Frequency; Ff	Harmonics Specification (Typical)	Sub- Harmonics (Typical)
	10 MHz ≤ Ff < 20 MHz[10]	≤ -25 dBc	Not Applicable
	20 MHz ≤ Ff < 4.0 GHz	≤ -30 dBc	≤ -40 dBc
	4.0 GHz ≤ Ff ≤ 6.0 GHz	≤ -40 dBc	≤ -40 dBc
Non-Harmonic Spurious[11]	Fundamental Frequency; Ff	Specification	Characteristic
	10 MHz ≤ Ff < 1.0 GHz	≤ -55 dBc	≤ -64 dBc
	1.0 GHz ≤ Ff < 3.0 GHz	≤ -55 dBc	≤ -60 dBc
	3.0 GHz ≤ Ff < 4.0 GHz	≤ -55 dBc	≤ -58 dBc
	4.0 GHz ≤ Ff ≤ 6.0 GHz	≤ -50 dBc	≤ -55 dBc

[6] Factory preset setting
[7] On 10Hz boundaries Freq = 1 MHz + n * 10 Hz. Reference accuracy: ≤ ± 1 ppm. Sine or square wave inputs acceptable. Lock time may be up to 30 seconds.
[8] For optimum phase noise performance use hardware lock mode. Reference input power 0 to +10 dBm.
[9] Pout ≤ +4 dBm, specifications apply to harmonic and sub-harmonic responses within the specified operating range of the instrument.
[10] Pout <= 0.0 dBm.
[11] Valid for responses offset from carrier >10 kHz, Pout = 0 dBm and Modulation off, specifications apply to responses within the specified operating range of the instrument.

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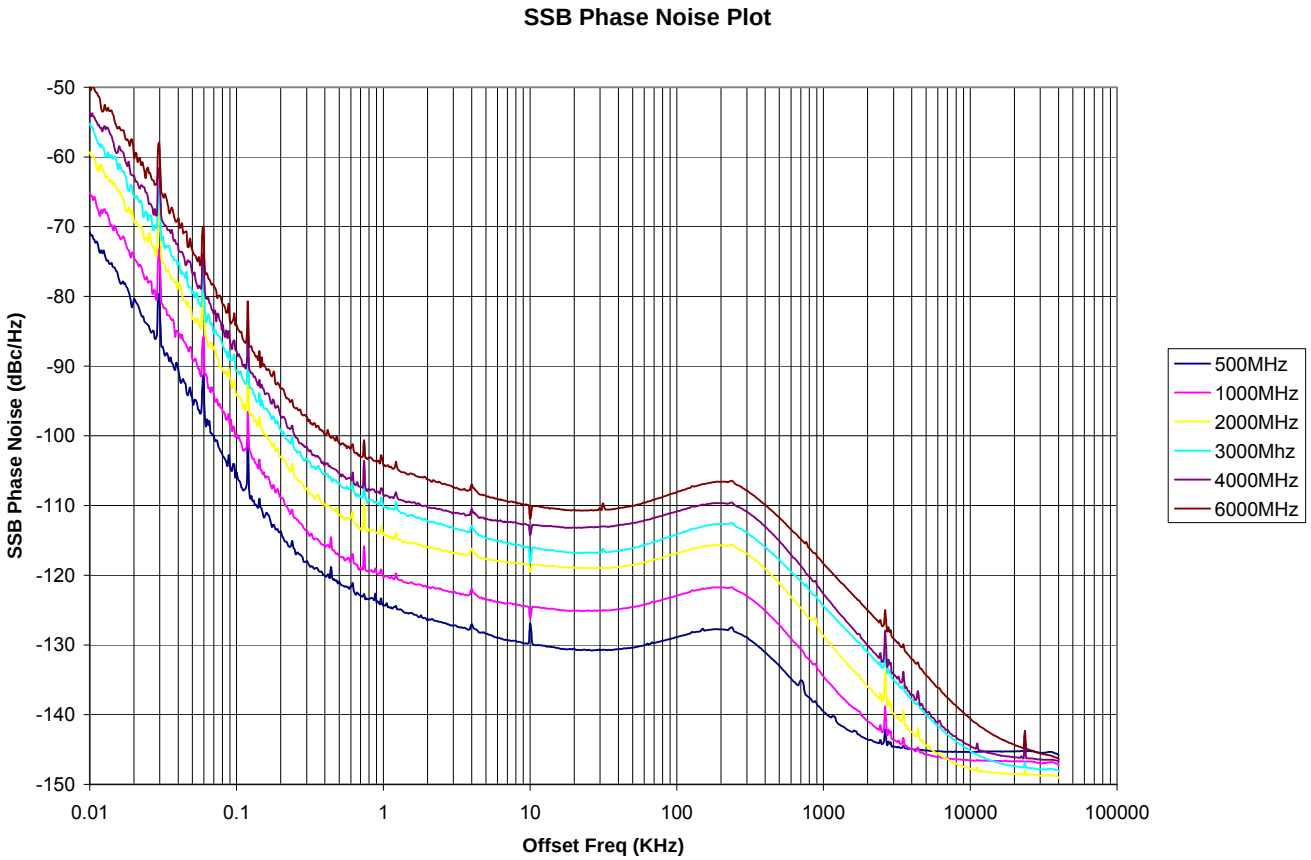
2920-LPN LOW PHASE NOISE OPTION

Low Phase Noise Parameter					
	Carrier Frequency; GHz	**Specification (Characteristic) at Offset frequency; dBc/Hz**			
		20 kHz	**100 kHz**	**1 MHz**	**10 MHz**
SSB Phase Noise; dBc/Hz[12]	0.5	≤ -127 (-130)	≤ -125 (-128)	≤ -135 (-139)	≤ -142 (-145)
	1.0	≤ -121 (-125)	≤ -119 (-122)	≤ -129 (-134)	≤ -143 (-146)
	2.0	≤ -115 (-118)	≤ -113 (-116)	≤ -123 (-128)	≤ -144 (-147)
	3.0	≤ -112 (-116)	≤ -110 (-114)	≤ -121 (-124)	≤ -142 (-145)
	4.0	≤ -109 (-113)	≤ -107 (-110)	≤ -117 (-122)	≤ -139 (-144)
	6.0	≤ -106 (-110)	≤ -104 (-108)	≤ -115 (-118)	≤ -136 (-140)

Option 2920-LPN: Characteristic Single Side Band Phase Noise Carrier Frequencies



[12] RF output power set to 0dBm

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AMPLITUDE[13]

Amplitude Parameters					
Amplitude level range (CW)	**Specification**				
	Carrier Frequency	**Standard**	**2920-LAR**		
	10 MHz to < 330 MHz	-110 to +10 dBm	-130 to +10 dBm		
	330 MHz to ≤ 3.0 GHz	-110 to +13 dBm	-130 to +13 dBm		
	3.0 GHz to ≤ 6.0 GHz	-110 to +10 dBm	-130 to +10 dBm		
Amplitude level range (GSM)		-110 to +6dBm	-130 to +6dBm		
Amplitude level range (EDGE)		-110 to +6dBm	-130 to +6dBm		
Amplitude level range (cdma2000)[14]		-110 to +3dBm	-130 to +3dBm		
Amplitude level range (WCDMA)[15]		-110 to +4dBm	-130 to +4dBm		
Amplitude setting resolution			0.01dB		
Amplitude Input Units			dBm		
Absolute Amplitude level accuracy (CW); dB	**Amplitude Level Setting**	**Frequency (Typical)**			
		10 MHz to < 330 MHz	**330 MHz to < 3.0 GHz**	**3.0 GHz to < 4.0 GHz**	**4.0 GHz to 6.0 GHz**
	Max to > +9 dBm	≤ ± 0.6 (0.3)	≤ ± 0.6 (0.3)	≤ ± 0.7 (0.4)	≤ ± 0.5 (Characteristic)
	+9 to > -75 dBm	≤ ± 0.6 (0.3)	≤ ± 0.6 (0.3)	≤ ± 0.7 (0.4)	≤ ± 0.7 (0.4)
	-75 to > -110 dBm	≤ ± 0.6 (0.3)	≤ ± 0.6 (0.3)	≤ ± 0.8 (0.4)	≤ ± 0.8 (0.4)
	2920-LAR:				
	-110 to > -120dBm	≤ ± 0.6 (0.3)	≤ ± 1.0 (0.6)	≤ ± 1.5 (0.7)	≤ ± 1.5 (0.7)
	-120 to > -125dBm	≤ ± (0.6)	≤ ± (0.6)	≤ (0.7)	≤ ± (0.7)
User Flatness Correction Max number of points = 10 (Points are Amplitude Correction & Frequency pairs)					
Power change over temperature 0 to 50°C (Characteristic)			0.02 dB/°C		
Relative Amplitude accuracy - linearity[16] (Characteristic)			≤ ± 0.05 dB		
Amplitude Repeatability[17] (Characteristic)			< ± 0.05 dB		
Amplitude switching time[18]		Specification			
	List or sweep mode	≤1.6 ms (Modulation Off) ≤1.8 ms (Modulation On)			
	Via remote command – after receipt of end-of-operation indicator (EOI)	≤ 3.0 ms (Characteristic)			
Output match -	Carrier Frequency; Fc		Specification		Typical

[13] Specifications apply when in autocoupled mode unless otherwise stated.
[14] +3 dBm max for Pilot only. +0.5 dBm max for Forward 9 channel.
[15] +4 dBm max for CPICH only. -1.0 dBm max for Test Model 1 with 16 DPCH.
[16] -110 dBm < Pout < +2 dBm, modulation off
[17] -110 dBm < Pout < +2 dBm, ALC mode = fast, modulation off – change note to match measurement.
[18] To within ±0.05 dB of final value <3.4 GHz, ±0.25 dB of final value =>3.4 GHz

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Amplitude Parameters			
VSWR	10MHz ≤ Fc ≤ 3.0GHz	< 1.45:1	< 1.3:1
	3.0GHz < Fc ≤ 6.0GHz	< 1.60:1	< 1.4:1
Reverse power protection[19]		+35 dBm OR 10 Vdc	

LIST AND STEP SWEEP MODES

Parameter	**Specification**
Frequency Step/Sweep	Start, Stop, Number of Points, Dwell Time
Amplitude Step/Sweep	Start, Stop, Number of Points, Dwell Time
Dwell time min/max	0 to 999.9999 sec
Dwell time resolution	0.1 msec
Arbitrary List	List of Frequency / Amplitude/ Dwell Time sets
	Maximum number of sets = 1000

2920-ALG - ANALOG MODULATION PERSONALITY[20]

Frequency Modulation Parameter	**Specification**
FM modulation frequency range	1 Hz to 100 kHz
FM modulation frequency setting resolution	1 Hz
FM deviation internal sine wave only	0 Hz to 1 MHz
FM distortion	< 1.5% (Characteristic)
Internal modulation waveform types	Sine, ramp up, ramp down and triangle waves
Amplitude Modulation Parameter	**Specification**
AM modulation frequency range	1 Hz to 100 kHz
AM modulation frequency setting resolution	1 Hz
AM modulation depth	0 to 100%
AM distortion	< 1.0% (Characteristic)
Internal modulation waveform types	Sine, ramp up, ramp down and triangle waves
Phase Modulation Parameter	**Specification**
ΦM modulation frequency range	1 Hz to 100 kHz
ΦM modulation frequency setting resolution	1Hz
ΦM deviation	0 to 100 radians
ΦM distortion	< 1.5% (Characteristic)
Internal modulation waveform type	Sine wave only
Pulse Modulation Parameter	**Specification**
PM pulse repetition rate	1 Hz to 100 kHz
PM pulse repetition rate setting resolution	1 Hz
PM minimum pulse width[21]	1.2 us

[19] UP to 50VDC with optional external DC block Keithley part number, 2910-DCBLOCK.
[20] Frequency ranges and resolution can be multiplied by up to 40 times with 2920-ARB-XX license. For example, FM deviation can be extended to 40MHz.

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PM On-Off ratio[22]	Pulse Width	Characteristic
	< 5 us	> 50 dB
	≥ 5 us	> 100 dB
PM Rise / Fall time (10% to 90%)		Characteristic
		< 600 ns
Two-Tone Parameters		**Specification**
Two-Tone CW Frequency Separation Settings		2 Hz to 2 MHz
Two-Tone CW 3rd Order Intermodulation[23]		> 54 dBc (Characteristic)
Two-Tone CW Carrier Feed through		> 65 dBc (Characteristic)
Noise modulation bandwidth[24]		1 kHz to 2.5 MHz

2920-BBIQ-A BASEBAND ANALOG I-Q INPUTS AND OUTPUTS OPTION

Baseband Analog Inputs	**Specification (Characteristic)**
External IQ Input 3dB Bandwidth[25]	I channel: (DC-200 MHz) Q channel: (DC-200 MHz)
Input Impedance (single ended only)	50 ohm (Characteristic) , DC coupled, SMB (m) connector
Maximum input V (DC + AC peak)[26]	±3V peak damage level
Baseband Analog Outputs	**Specification (Characteristic)**
0.2dB Bandwidth[27]	I channel: (DC-40 MHz) Q channel: (DC-40 MHz)
Output Impedance (single ended only)	50 ohm (Characteristic), DC coupled, SMB (m) connector
Full Scale Output V (DC +AC peak)	±1.0 V peak
Maximum Reverse Input Voltage (damage level)	±1.0 V
IQ offset (DC & Quadrature Adjustment)	±12.5% of Full Scale ±10°
IQ gain	0 to Full Scale

[21] Can be decreased by up to 40 times with 2920-ARB-XX license.
[22] Only valid when Pulse Modulation is only active modulation type.
[23] Relative to power of desired tones. Pout=0 dBm.
[24] 6 dB double sided.
[25] 3 dB BW. With inputs applied directly to I/Q modulator. User needs to provide correction for I/Q AC and DC amplitude and phase skew and offsets.
[26] Maximum voltage includes Offsets and Signal for nominal input of 50 ohms. Optimal drive voltage ± 0.8 V.
[27] Into 50 ohm impedance.

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2900-ARB-xx - ARBITRARY WAVEFORM GENERATOR

Parameter		**Specification**
Maximum modulation bandwidth for internal modulation generation	2900-ARB-20	20 MHz (25 MSa/sec)
	2900-ARB-40	40 MHz (50 MSa/sec)
	2900-ARB-80	80 MHz (100 MSa/sec)
Waveform memory		100 Megasamples
Minimum Segment Length		1000 samples
Maximum Segment Length		100 Megasamples
Max number of segments in a sequence		400
Non-volatile memory		2 GBytes

2900-WCDMA – W-CDMA FDD DOWNLINK SIGNAL GENERATION PERSONALITY

W-CDMA Parameter			
Frequency range		1800-2200MHz	
		Typical	Characteristic
EVM[28]		< 0.85% RMS	
ACLR[29]	Adjacent	> 66 dBc	> 68 dBc
	Alternate	> 72 dBc	> 73 dBc

2900-CDMA-F – CDMAONE-CDMA2000 FORWARD LINK SIGNAL GENERATION PERSONALITY

CDMA2000 and CDMAOne Parameter			
Frequency range		800-900MHz, 1800-1900MHz	
		Typical	**Characteristic**
RHO[30]		> 0.9995	> 0.9999
ACPR[31]	Adjacent at 750 kHz	> 69 dBc	> 71 dBc
	Adjacent at 885 kHz	> 73 dBc	> 76 dBc
	Alternate at 1980 kHz	> 75 dBc	> 84 dBc

[28] Pout ≤ -10 dBm.
[29] CPICH only, Pout ≤ -1 dBm, Adjacent spacing 5 MHz offset. Alternate spacing 10 MHz offset.
[30] Pilot only.
[31] Pilot only. Pout ≤ -4 dBm.

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2900-GSM - MODULATION PERSONALITY

EDGE/GSM Parameter			
Frequency Range		800-900MHz, 1800-1900MHz	
		Typical	Characteristic
EVM for EDGE[32]		< 0.60% RMS	< 0.35% RMS
Phase Error for GSM[33]		< 0.25° RMS	< 0.15° RMS
ORFS for EDGE (Characteristic)		Carrier Frequency; Fc	
	Frequency Offset; kHz	1 GHz Pout=0dBm	400MHz to 2.5GHz -10 ≤ Pout ≤ +6 dBm
	200	> 36 dBc	> 37 dBc
	400	> 69 dBc	> 63 dBc
	600	> 76 dBc	> 69 dBc
ORFS for GSM (Characteristic)		Carrier Frequency; Fc	
	Frequency Offset; kHz	1 GHz Pout=0 dBm	400 MHz to 2.5 GHz -10 ≤ Pout ≤ +6 dBm
	200	> 36 dBc	> 35 dBc
	400	> 69 dBc	> 65 dBc
	600	> 76 dBc	> 69 dBc

2900-GPS – SIGNAL GENERATION PERSONALITY

GPS Parameter	**Specification**
Carrier Frequency	200 MHz to 2.5 GHz Button provided to set carrier frequency to L1 (1575.42 MHz)
C/A code ID Range	1 through 37, Default value = 1
Data Pattern	Selectable: PN9 (default), PN15, all ones, all zeros, square 1-bit [0 1] and square 2-bit [0011] User Defined: Pattern from a file, length range of 1 to 37,504 bits Default Pattern = PN9
Doppler shift Range	-10 kHz to +10 kHz, default value = 0 Hz
EVM	3.5% (Characteristic)

[32] Measured at Pout = 0 dBm.
[33] Measured at Pout = +4 dBm.

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2900-DIG – GENERAL PURPOSE DIGITAL MODULATION GENERATION PERSONALITY

Common Parameters		**Specification**
Symbol Rate	Symbol Rate Resolution	1 Sps (Symbols per second)
	Minimum Symbol Rate	500 Sps
	Maximum Symbol Rate	▪ 2 MSps for NRZ, Gaussian and Wideband ▪ 25 MSps for RC and RRC
Filters	Filter Types	▪ NRZ, RC, RRC, Gaussian and Wideband
Filter Factor	RC, RRC Gaussian	▪ 0.2 to 1.0 ▪ 0.1 to 3.0
Symbol Format	Differential Encoding	On/Off
Sequence Format	Output Inversion	On/Off
Data Pattern	PRBS Count Alternating 0,1	PN5, PN9, PN11, PN15 Radix 1-16

Modulation Format	Modulation Type	**Parameter**	**Specification**
ASK	OOK (ASK2) ASK4 SASK2 SASK4	See Common Parameters	See Common Specifications
FSK	FSK2	Frequency Separation Resolution	1 Hz
		Frequency Separation Range	0 to 2 x symbol rate in Sps
PSK	BPSK QPSK QPSK-π/4 QPSK-3π/4 OQPSK 8PSK	See Common Parameters	See Common Specifications
QAM	QAM 16 QAM 32 QAM 64 QAM 128 QAM 256	See Common Parameters	See Common Specifications

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EVM Characteristics for 2900-DIG[34]		
Format	Filter Conditions	RMS EVM; %
QPSK	RRC, α=default (0.35)	≤1.5%
16QAM	RRC, α=default (0.35)	≤1.5%
FSK	Gaussian BT = 0.7	≤1.5%

SUPPLEMENTARY CHARACTERISITICS

Parameter	**Signal Type**	**Characteristic**
EVM	802.11n WLAN, 20 & 40 MHz BW, 64 QAM	2.4 & 3.5 GHz <-41dB 5.8 GHz <-37dB

2900-TDSCDMA-PC SIGNALMEISTER™ LICENSE FOR TD-SCDMA

TD-SCDMA Parameter		**Specification**
Channels	Physical	DwPCH, UpPCH, P-CPCH, S-CCPCH, FPACH, PICH, PRACH, PUSCH, PDSCH, DPCH, DPCHO
	Transport	
		Characteristic
Modulation Accuracy	EVM	< 0.3%
	ACP	< -62 dBc

[34] Characterized at 2.5 and 6.0 GHz. Symbol rates from minimum to maximum. For best results at low symbol rates, use the 2920 external reference hardware lock mode.

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TRIGGER AND SYNCHRONIZATION INPUTS AND OUTPUTS

Trigger and Synchronization Input and Output Parameters	**Events**
Trigger modes	• Free Run • Trigger sweeps in sweep or list mode • Trigger a sweep or list • Trigger start of arb waveform
Arb Sequence Trigger Modes	• Stepping Only • Start and Step
Trigger Sources	• SCPI or Rear Panel Trigger • Rising edge of external TTL input • Falling edge of external TTL input
External trigger Characteristics	• Minimum input pulse width required 50nsec (Characteristic) • Trigger repeatability ±10nsec
Trigger delay	0 to 1 sec
Sync output modes	Generate a sync pulse: • Never (Off) • On arb waveform wrap • At beginning of sweep, list or sequence • At end of each step in sweep, list or sequence • At end of dwell in sweep, list or sequence • At end of sweep, list or sequence
Sync output polarity select	• Sync out is on rising edge • Sync out is on falling edge
Sync output Characteristics	• 3.3 V CMOS, SMV (m) • Minimum pulse width 200nsec
Even second clock input	External even second clock 3.3V CMOS, SMB (m)
Even second clock output	External even second clock 3.3V CMOS, SMB (m)

GENERAL SPECIFICATIONS**:**

General Specifications	
Power	100VAC to 240VAC; 50/60 Hz (automatically detected); 175VA max.
CE EMC Compliance	EU Directive 89/336/EEC; EN 61326-1
CE Safety Compliance	CE; EU Directive 73/23/EEC, EN 61010-1
Calibration	Annual calibration cycle in system.

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General Specifications	
Environment (for indoor use only)	• 18°C to 23°C specified operating, unless otherwise noted • 0°C to 50°C operating survival, non-specified operation • -25°C to 65°C. non-operating (AC power off) storage • Altitude: Maximum 2000 meters above sea level • Cooling forced air top, bottom and side intakes and rear exhaust. For proper cooling in a rack, use Keithley Instruments 2910-RMK Rack Mount Kit
Digital inputs/outputs	• 4 bits, TTL-compatible
Interfaces	• IEEE-488.1 compliant. Supports IEEE-488.2 -common commands and status model topology • LAN: 10/100BT Ethernet, RJ45, LXI Class C, no auto MDIX • IVI-COM • USB: USB full speed • Supports Keithley Model 3500 in pass through mode via USB • RF out: Type N connector
Mechanical vibration and shock	• MIL-PRF-2880 CL3 random vibration, 3 axes • Sine-Sweep test for resonances, 3 axes • MIL-STD-810F 516.5 paragraph, 4.5.7 procedure VI bench drop MIL-PRF-2880 CL3 random vibration, 3 axes.
General mechanical Characteristics	• Height: 3U (133mm) (5.25”) • Width: half-rack (213mm) (8.4”) • Depth: 464mm (18.25”) • Weight: 9.3kg (20.5lb)
Warranty	3 years standard
Accessories supplied	• AC power cable • Printed quick start guide • CD-ROM containing 2920-VSG system help, utility programs, and PDF files (also available on-line at www.keithley.com). • On-board, context sensitive help system

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SPECIFICATION NOTES**:** Specifications describe the instrument's warranted performance. Typical and Characteristic values are not warranted, but provide additional information regarding performance that you should expect from the Model 2920 VSG and are provided to assist in application of the Model 2920 VSG.

Specifications: (warranted performance):

Specifications indicate performance that is warranted. All units are warranted to meet these performance Specifications under the following conditions:

Ambient operating temperature of 18 to 28°C, unless otherwise noted.

After specified warm-up time of 30 minutes and self calibration at ambient temperature.

Typical (mean + 3 standard deviations):

Typical indicates performance that units will meet under the following conditions:

Ambient operating temperature of 23°C, unless otherwise noted.

After specified warm-up time of 30 minutes and self calibration at ambient temperature.

This performance is not warranted.

Characteristic (mean or expected value):

Characteristic indicates performance that a unit would be expected to exhibit under the following conditions:

Ambient operating temperature of 23°C, unless otherwise noted.

After specified warm-up time of 30 minutes and self calibration at ambient temperature.

This performance is not warranted.