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AC and DC Current Source Instrument Specifications

SOURCE SPECIFICATIONS

Range (+5 % over range)	Accuracy (1 year) 23 °C ±5 °C ±(% reading + amps)	Pro- gramming resolu- tion	Temperature coefficient/°C 0 °C to 18 °C and 28 °C to 50 °C	Typical noise (peak-to- peak) /RMS ^{1, 2} 0.1 Hz to 10 Hz	Typical noise (peak-to- peak) /RMS ^{1, 2, 3} 10 Hz to (bandwidth)	Output response bandwidth into short	Settling time ^{4, 5} (1% of final value)	
							Output response fast (typical ⁵)	Output response slow (maximum)
2 nA	0.4 % + 2 pA	100 fA	0.02 % + 200 fA	400/80 fA	250/50 pA	10 kHz	90 μs	100 μs
20 nA	0.3 % + 10 pA	1 pA	0.02 % + 200 fA	4/0.8 pA	250/50 pA	10 kHz	90 μs	100 μs
200 nA	0.3 % + 100 pA	10 pA	0.02 % + 2 pA	20/4 pA	2.5/0.5 nA	100 kHz	30 μs	100 μs
2 μA	0.1 % + 1 nA	100 pA	0.01 % + 20 pA	200/40 pA	25/5.0 nA	1 MHz	4 μs	100 μs
20 μA	0.05 % + 10 nA	1 nA	0.005 % + 200 pA	2/0.4 nA	500/100 nA	1 MHz	2 μs	100 μs
200 μA	0.05 % + 100 nA	10 nA	0.005 % + 2 nA	20/4 nA	1.0/0.2 μA	1 MHz	2 μs	100 μs
2 mA	0.05 % + 1 μA	100 nA	0.005 % + 20 nA	200/40 nA	5.0/1 μA	1 MHz	2 μs	100 μs
20 mA	0.05 % + 10 μA	1 μA	0.005 % + 200 nA	2/0.4 μA	20/4.0 μA	1 MHz	2 μs	100 μs
100 mA	0.1 % + 50 μA	10 μA	0.01 % + 2 μA	10/2 μA	100/20 μA	1 MHz	3 μs	100 μs

ADDITIONAL SOURCE SPECIFICATIONS

Output resistance	> 10 ¹⁴ Ω. (2 nA and 20 nA range)
Output capacitance	< 10 pF, < 100 pF filter ON (2 nA and 20 nA range)
Load impedance	Stable into 10 μH typical, 100 μH with Output Response SLOW
Current regulation	
Line	< 0.01 % of range
Load	< 0.01 % of range
Voltage limit (compliance)	Bipolar voltage limit set with single value; 0.1 V to 105 V in 0.01 V programmable steps Accuracy for 0.1 V to 20 V: 0.1 % + 20 mV; accuracy for 20 V to 105 V: 0.1 % + 100 mV
Max. output power	11 W, four quadrant source or sink operation

¹ Noise current into < 100 Ω.

² Typical values are non-warranted, apply at 23 °C, represent the 50th percentile, and are provided solely as useful information.

³ RMS noise 10 Hz to 20 MHz (2 nA to 20 mA range); less than 1 mV_{rms}, 5 mV_{peak-to-peak} (into 50Ω load)

⁴ Settling times are specified into a resistive load, with a maximum resistance equal to 2 V / 1_{fullscale of range}. See manual for other load conditions.

⁵ Settling times to 0.1 % of final value are typically less than twice the settling times to 1 % of the final value.

ADDITIONAL SOURCE SPECIFICATIONS (CONTINUED)

Guard output	
Maximum load capacitance	10 nF
Maximum load current	1 mA for rated accuracy
Accuracy	±1 mV for output currents < 2 mA (excluding output lead voltage drop)
Program memory	(offers point-by-point control and triggering, for example, Sweeps)
Number of locations	64 K
External trigger	TTL-compatible EXTERNAL TRIGGER INPUT and OUTPUT
Maximum trigger rate	1000/s

ARBITRARY FUNCTION GENERATOR

Waveforms	Sine, square, ramp, and 4 user-defined arbitrary waveforms.
Frequency accuracy⁷	±100 ppm (1 Year)
Amplitude	4 pA to 210 mA peak-to-peak into loads up to 10 ¹² Ω.
Amplitude accuracy (<10 khz)⁶	
Magnitude	1 % reading + 0.2 % range
Offset	0.2 % reading + 0.2 % range
Sine wave characteristics	
Frequency range	1 mHz to 100 kHz ⁶
Amplitude flatness	Less than 1 dB up to 100 kHz ⁷
Square wave characteristics	
Frequency range	1 mHz to 100 kHz ⁶
Overshoot	<2.5 % ⁷
Variable duty cycle	Settable to 1 μs minimum pulse duration, 0.01 % programming resolution. ^{8,9}
Jitter (RMS)	100 ns + 0.1% of period. ⁷
Ramp wave characteristics	
Frequency range	1 mHz to 100 kHz ⁶
Linearity	<0.1 % of peak output up to 10 kHz ⁷

⁶ Amplitude accuracy is applicable for 100 mA through 2 μA ranges (Fast Mode) into a maximum resistive load of 2 V/I_{fullscale} of range. Amplitude attenuation will occur at higher frequencies dependent upon current range and load impedance.

⁷ These specifications are only valid for the 20 mA range and a 50 Ω load.

⁸ Minimum realizable duty cycle is limited by current range response and load impedance.

⁹ For frequencies less than 1 Hz, duty cycle not tested, guaranteed by design.

ARBITRARY FUNCTION GENERATOR (CONTINUED)

Arbitrary wave characteristics			
Frequency range	1 mHz to 100 kHz ⁶		
Waveform length	2 to 64 K points		
Amplitude resolution	16 bits (including sign) ¹⁰		
Sample rate	10 MSPS ¹⁰		
Jitter (RMS)	100ns + 0.1% of period ⁷		
Maximum user waveforms	4		
Programming time(typical)²			
Waveform/amplitude/frequency change	1 ms		
ARB transfer times			
External transfer time over bus		16 K	64 K
	LAN	0.750 s	3.000s
	GPIB	1.250 s	5.000s
Internal transfer time of preloaded ARB locations 1 to 4		16 K	64 K
	ARB 1	0.001 s	0.001s
	ARB 2 to 4	0.500 s	2.000s

6221 – 2182 MEASUREMENT FUNCTIONS

DUT resistance	Up to 1 G Ω (1 nSiemen); (100 M Ω limit for pulse mode)
Delta mode resistance measurements and differential conductance	Controls Keithley Model 2182A Nanovoltmeter at up to 24 Hz reversal rate (2182 at up to 12 Hz)
Pulse measurements	Pulse widths 50 μ s to 12 ms, 1 pA to 100 mA Repetition interval 83.3 ms to 5 s

GENERAL SPECIFICATIONS

Common mode voltage	250 V _{rms} DC to 60 Hz
Common mode isolation	>10 ⁹ Ω , <2 nF
Source output modes	Fixed DC level, memory list, arbitrary waveform function
Remote interface	
Ethernet	RJ-45 connector, TCP/IP (auto-sensed 10 bT or 100 bTx), IEEE-488, and RS-232C. SCPI (Standard Commands for Programmable Instruments) DDC (command language compatible with Keithley Model 220)
IP configuration	Static or DHCP
Password protection	11 characters
Digital interface	
Handler Interface	Start of test, end of test, 3 category bits, +5 V @ 300 mA supply
Digital I/O	1 trigger input, 4 TTL/relay drive outputs (33 V @ 500 mA, diode clamped)
Output connections	<ul style="list-style-type: none"> • Teflon insulated 3-lug triaxial connector for output • Banana safety jack for GUARD, OUTPUT LO • Screw terminal for CHASSIS • DB-9 connector for EXTERNAL TRIGGER INPUT, OUTPUT, and DIGITAL I/O • Two position screw terminal for INTERLOCK

¹⁰ These characteristics are for informational purposes only.

Model 6221 AC and DC Current Source Instrument Specifications

Interlock	Maximum 10 Ω external circuit impedance.
Power supply	100 V to 240 V _{rms} 50 to 60 Hz
Power consumption	120 VA
Warranty	1 year
Environment	
For indoor use only	Maximum 2000 m above sea level
Operating	0 °C to 50 °C, 70 % relative humidity up to 35 °C; derate 3 % R.H. / °C, 35 °C to 50 °C
Storage	-25 °C to 65 °C, guaranteed by design
EMC	Conforms to European Union EMC Directive
Safety	Conforms to European Union Low Voltage Directive
Vibration	MIL-PRF-28800F Class 3, Random
Warmup	1 hour to rated accuracies
Passive cooling	No fan
Dimensions	
Rack mounting	89 mm high x 213 mm wide x 370 mm deep (3.5 in. x 8.375 in. x 14.563 in.)
Bench configuration (with handle and feet)	104 mm high x 238 mm wide x 370 mm deep (4.125 in. x 9.375 in. x 14.563 in.)
Shipping weight	4.75 kg (10 lbs)
Accessories supplied	Model 237-ALG-2 Triaxial Test Lead (6.6 ft), Trigger Link cable, RS-232 (Null Modem) cable, Interlock terminal block, User's Manual, CD Manual, LabVIEW Drivers.