

6221 AC and DC Current Source

SOURCE SPECIFICATIONS

Range (+5% over range)	Accuracy (1 Year) 23°C±5°C ±(%rdg. + amps)	Programming Resolution	Temperature Coefficient/°C 0°-18°C & 28°- 50°C	Typical Noise (peak-peak) /RMS ^{3,5} 0.1Hz-10Hz	Typical Noise (peak-peak) /RMS ^{3,4,5} 10Hz-(BW)	Output Response Bandwidth (BW) into Short	Settling Time ^{1,2} (1% of final value)	
							Output Resp. Fast (Typical ⁵)	Output Resp. Slow (Max)
2nA	0.4% + 2pA	100fA	0.02% + 100fA	400/80fA	250/50pA	10kHz	90µs	100µs
20nA	0.3% + 10pA	1pA	0.02% + 200fA	4/0.8pA	250/50pA	10kHz	90µs	100µs
200nA	0.3% + 100pA	10pA	0.02% + 2pA	20/4pA	2.5/0.5nA	100kHz	30µs	100µs
2µA	0.1% + 1nA	100pA	0.01% + 20pA	200/40pA	25/5.0nA	1MHz	4µs	100µs
20µA	0.05% + 10nA	1nA	0.005% + 200pA	2/0.4nA	500/100nA	1MHz	2µs	100µs
200µA	0.05% + 100nA	10nA	0.005% + 2nA	20/4nA	1.0/0.2µA	1MHz	2µs	100µs
2mA	0.05% + 1µA	100nA	0.005% + 20nA	200/40nA	5.0/1µA	1MHz	2µs	100µs
20mA	0.05% + 10µA	1µA	0.005% + 200nA	2/0.4µA	20/4.0µA	1MHz	2µs	100µs
100mA	0.1% + 50µA	10µA	0.01% + 2µA	10/2µA	100/20µA	1MHz	3µs	100µs

ADDITIONAL SOURCE SPECIFICATIONS

OUTPUT RESISTANCE: $>10^{14}\Omega$. (2nA/20nA range)

OUTPUT CAPACITANCE: <10 pF, <100 pF Filter ON. (2nA/20nA range)

LOAD IMPEDANCE: Stable into 10µH typical, 100µH 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. 0.1V to 105V in 0.01V programmable steps. Accuracy for 0.1V to 20V: 0.1% +20mV, accuracy for 20V to 105V: 0.1% + 100mV

MAX. OUTPUT POWER: 11W, four quadrant source or sink operation.

GUARD OUTPUT:

Maximum Load Capacitance: 10nF.

Maximum Load Current: 1mA 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, e.g. Sweeps)

Number of Locations: 64K.

EXTERNAL TRIGGER: TTL-compatible EXTERNAL TRIGGER INPUT and OUTPUT.

Max Trigger Rate: 1000/s.

Source Notes

1. Settling times are specified into a resistive load, with a maximum resistance equal to $2V / I_{\text{fullscale}}$ of range. See manual for other load conditions.
2. Settling times to 0.1% of final value are typically $<2x$ of 1% settling times.
3. Noise current into $<100\Omega$.
4. RMS Noise 10Hz-20MHz (2nA – 20mA Range) Less than 1mVrms, 5mVp-p (into 50Ω load).
5. Typical values are non-warranted, apply at 23°C, represent the 50th percentile, and are provided solely as useful information.

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ARBITRARY FUNCTION GENERATOR

WAVEFORMS: Sine, Square, Ramp, and 4 User Defined Arbitrary Waveforms.

FREQUENCY ACCURACY⁴: ± 100 ppm (1 Year)

AMPLITUDE: 2pA to 210mA peak-peak into loads up to $10^{12}\Omega$.

AMPLITUDE ACCURACY (<10kHz):²

Magnitude: 1% rdg + 0.2% mg

Offset: 0.2% rdg + 0.2% mg

SINE WAVE CHARACTERISTICS:

Frequency Range: 1mHz to 100kHz.²

Amplitude Flatness: Less than 1dB up to 100kHz.⁴

SQUARE WAVE CHARACTERISTICS:

Frequency Range: 1mHz to 100kHz.²

Overshoot: <2.5%⁴

Variable Duty Cycle:^{1,3} Settable to 1 μ s min. pulse duration, 0.01% programming resolution.

Jitter (RMS): 100ns + 0.1% of period.⁴

RAMP WAVE CHARACTERISTICS:

Frequency Range: 1mHz to 100kHz.²

Linearity: <0.1% of peak output up to 10kHz.⁴

ARBITRARY WAVE CHARACTERISTICS:

Frequency Range: 1mHz to 100kHz.²

Waveform Length: 2 to 64K points.

Amplitude Resolution: 16 bits (including sign).⁵

Sample Rate: 10 MSPS.⁵

Jitter (RMS): 100ns + 0.1% of period.⁴

Maximum User Waveforms: 4.

PROGRAMMING TIME (Typical):⁶

Waveform/Amplitude/Frequency Change: 1ms

ARB Transfer Times:

(External transfer time over Bus)

	16K	64K
LAN	0.750s	3.000s
GPIB	1.250s	5.000s

(Internal transfer time of preloaded Arb locations 1-4)

Arb 1 0.001s 0.001s

Arb 2-4 0.500s 2.000s

6221 – 2182 MEASUREMENT FUNCTIONS

DUT RESISTANCE: Up to 1G Ω (1 nSiemen).

(100M Ω limit for pulse mode)

DELTA MODE RESISTANCE MEASUREMENTS and

DIFFERENTIAL CONDUCTANCE: Controls Keithley Model 2182A Nanovoltmeter at up to 24Hz reversal rate (2182 at up to 12Hz).

PULSE MEASUREMENTS:

Pulse widths 50 μ s to 12ms, 1pA to 100mA.

Repetition interval 83.3ms to 5s.

Waveform Notes:

1. Minimum realizable duty cycle is limited by current range response and load impedance.
2. Amplitude accuracy is applicable for 100mA through 2 μ A ranges (Fast Mode) into a maximum resistive load of $2V_{fullscale\ of\ range}$. Amplitude attenuation will occur at higher frequencies dependent upon current range and load impedance.
3. For frequencies less than 1 Hz, duty cycle not tested, guaranteed by design.
4. These Specifications are only valid for the 20mA range and a 50 Ω load.
5. These characteristics for informational purposes only.
6. Typical values are non-warranted, apply at 23 $^{\circ}$ C, represent the 50th percentile, and are provided solely as useful information.

GENERAL SPECIFICATIONS

COMMON MODE VOLTAGE: 250Vrms, DC to 60Hz.

COMMON MODE ISOLATION: >10 $^{\circ}$ Ω , <2nF.

SOURCE OUTPUT MODES: Fixed DC level, Memory List, Arbitrary Waveform Function.

REMOTE INTERFACE

Ethernet: RJ-45 connector, TCP/IP (Auto sensed 10bT or 100bTx), 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, +5V@300mA supply.

Digital I/O: 1 trigger input, 4 TTL/Relay Drive outputs (33V@500mA, diode clamped).

OUTPUT CONNECTIONS:

- Teflon insulated 3-lug triax 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

INTERLOCK: Maximum 10 Ω external circuit impedance.

POWER SUPPLY: 100V to 240V rms, 50-60Hz.

POWER CONSUMPTION: 120VA.

WARRANTY: 1 Year.

ENVIRONMENT:

For Indoor Use Only: Maximum 2000m above Sea Level.

Operating: 0 $^{\circ}$ -50 $^{\circ}$ C, 70%R.H. up to 35 $^{\circ}$ C. Derate 3% R.H./ $^{\circ}$ C, 35 $^{\circ}$ -50 $^{\circ}$ C.

Storage: -25 $^{\circ}$ C to 65 $^{\circ}$ C, guaranteed by design.

EMC: Conforms to European Union Directive 89/336/EEC, EN 61326-1.

SAFETY: Conforms to European Union Directive 73/23/EEC, EN61010-1.

VIBRATION: MIL-PRF-28800F Class 3, Random.

WARMUP: 1 hour to rated accuracies.

Passive Cooling: No fan.

DIMENSIONS:

Rack Mounting: 89mm high x 213mm wide x 370mm deep (3.5 in. x 8.375 in. x 14.563 in.).

Bench Configuration (with handle and feet): 104mm high x 238mm wide x 370mm deep (4.125 in. x 9.375 in. x 14.563 in.).

SHIPPING WEIGHT: 4.75kg (10 lbs).

ACCESSORIES SUPPLIED: Model 237-ALG-2 Triaxial Test Lead (6.6ft), Trigger Link cable, RS-232 (Null Modem) cable, Interlock terminal block, User's Manual, CD Manual, LabVIEW Drivers.