

# 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 <sup>3,5</sup> 0.1Hz-10Hz	Typical Noise (peak-peak) /RMS <sup>3,4,5</sup> 10Hz-(BW)	Output Response Bandwidth (BW) into Short	Settling Time <sup>1,2</sup> (1% of final value)	
							Output Resp. Fast (Typical <sup>5</sup> )	Output Resp. Slow (Max)
2nA	0.4% + 2pA	100fA	0.02% + 200fA	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:**  $<10\text{pF}$ ,  $<100\text{pF}$  Filter ON. (2nA/20nA range)

**LOAD IMPEDANCE:** Stable into  $10\mu\text{H}$  typical,  $100\mu\text{H}$  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:**  $\pm 1\text{mV}$  for output currents  $<2\text{mA}$  (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  $50\Omega$  load).
5. Typical values are non-warranted, apply at 23°C, represent the 50<sup>th</sup> 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 ACCURACY<sup>4</sup>:**  $\pm 100$  ppm (1 Year)

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

**AMPLITUDE ACCURACY (<10kHz):<sup>2</sup>**

**Magnitude:** 1% rdg + 0.2% mg

**Offset:** 0.2% rdg + 0.2% mg

**SINE WAVE CHARACTERISTICS:**

**Frequency Range:** 1mHz to 100kHz.<sup>2</sup>

**Amplitude Flatness:** Less than 1dB up to 100kHz.<sup>4</sup>

**SQUARE WAVE CHARACTERISTICS:**

**Frequency Range:** 1mHz to 100kHz.<sup>2</sup>

**Overshoot:**  $<2.5\%$ <sup>4</sup>

**Variable Duty Cycle:**<sup>1,3</sup> Settable to 1 $\mu$ s min. pulse duration, 0.01% programming resolution.

**Jitter (RMS):** 100ns + 0.1% of period.<sup>4</sup>

**RAMP WAVE CHARACTERISTICS:**

**Frequency Range:** 1mHz to 100kHz.<sup>2</sup>

**Linearity:**  $<0.1\%$  of peak output up to 10kHz.<sup>4</sup>

**ARBITRARY WAVE CHARACTERISTICS:**

**Frequency Range:** 1mHz to 100kHz.<sup>2</sup>

**Waveform Length:** 2 to 64K points.

**Amplitude Resolution:** 16 bits (including sign).<sup>5</sup>

**Sample Rate:** 10 MSPS.<sup>5</sup>

**Jitter (RMS):** 100ns + 0.1% of period.<sup>4</sup>

**Maximum User Waveforms:** 4.

**PROGRAMMING TIME (Typical):<sup>6</sup>**

**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 $\Omega$  (1 nSiemen).

(100M $\Omega$  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 $\mu$ 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 $\mu$ A ranges (Fast Mode) into a maximum resistive load of  $2V/1_{fullscale\ of\ range}$ . 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 $\Omega$  load.
5. These characteristics for informational purposes only.
6. Typical values are non-warranted, apply at 23°C, represent the 50<sup>th</sup> percentile, and are provided solely as useful information.

## GENERAL SPECIFICATIONS

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

**COMMON MODE ISOLATION:**  $>10^9\Omega$ ,  $<2nF$ .

**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 $\Omega$  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°-50°C, 70%R.H. up to 35°C. Derate 3% R.H./°C, 35°-50°C.

**Storage:** -25°C to 65°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.