

SOURCE SPECIFICATIONS¹

Voltage Programming Accuracy (4-wire sense)²

Range	Programming Resolution	Accuracy (1 Year) 23 °C ± 5 °C ± (% rdg + volts)	Typical Noise (peak-peak) 0.1 Hz – 10 Hz
200 mV	5 µV	0.02 % + 600 µV	5 µV
2 V	50 µV	0.02 % + 600 µV	50 µV
20 V	500 µV	0.02 % + 2.4 mV	500 µV
200 V	5 mV	0.02 % + 24 mV	5 mV

TEMPERATURE COEFFICIENT (0 °C–18 °C and 28 °C–40 °C):
±(0.15 × accuracy specification) / °C.

MAX. OUTPUT POWER: 2.2 W (four quadrant source or sink operation).
SOURCE/SINK LIMITS: ±21 V @ ±105 mA, ±210 V @ ±10.5 mA.

VOLTAGE REGULATION: Line: 0.01 % of range.
Load: 0.01 % of range + 100 µV.

NOISE 10 Hz–1 MHz (p-p): 10 mV (typical).

OVER VOLTAGE PROTECTION: User selectable values, 5 % tolerance.
Factory default = None.

CURRENT LIMIT: Bipolar current limit (compliance) set with single value.
Min. 0.1 % of range.

Current Programming Accuracy (with remote preamp)

Range	Programming Resolution	Accuracy (1 Year) ¹ 23 °C ± 5 °C ± (%rdg + amps)	Typical Noise (peak-peak) 0.1 Hz – 10 Hz
1 pA	50 aA	1.0 % + 10 fA	7 fA
10 pA	500 aA	0.50 % + 30 fA	10 fA
100 pA	5 fA	0.15 % + 40 fA	20 fA
1 nA	50 fA	0.050 % + 200 fA	80 fA
10 nA	500 fA	0.050 % + 2 pA	500 fA
100 nA	5 pA	0.050 % + 20 pA	3 pA
1 µA	50 pA	0.050 % + 300 pA	20 pA
10 µA	500 pA	0.050 % + 2 nA	200 pA
100 µA	5 nA	0.031 % + 20 nA	500 pA
1 mA	50 nA	0.034 % + 200 nA	5 nA
10 mA	500 nA	0.045 % + 2 µA	50 nA
100 mA	5 µA	0.066 % + 20 µA	500 nA

Current Programming Accuracy (without remote preamp)

Range	Programming Resolution	Accuracy (1 Year) ¹ 23 °C ± 5 °C ± (%rdg + amps)	Typical Noise (peak-peak) 0.1 Hz – 10 Hz
1 µA	50 pA	0.035 % + 600 pA	20 pA
10 µA	500 pA	0.033 % + 2 nA	200 pA
100 µA	5 nA	0.031 % + 20 nA	500 pA
1 mA	50 nA	0.034 % + 200 nA	5 nA
10 mA	500 nA	0.045 % + 2 µA	50 nA
100 mA	5 µA	0.066 % + 20 µA	50 nA

TEMPERATURE COEFFICIENT (0 °C–18 °C and 28 °C–40 °C):
±(0.15 × accuracy specification) / °C.

MAX. OUTPUT POWER: 2.2 W (four quadrant source or sink operation).
SOURCE/SINK LIMITS: ±10.5 mA @ 210 V, ±105 mA @ 21 V.

CURRENT REGULATION: Line: 0.01 % of range.
Load: 0.01 % of range + 1 fA.

VOLTAGE LIMIT: Bipolar voltage limit (compliance) set with single value.
Min. 0.1 % of range.

¹ For sink mode, 1 pA to 100 mA range, accuracy is ±(0.15 % +
² offset+4). Voltage source accuracies are not affected by the remote
preamp.

ADDITIONAL SOURCE SPECIFICATIONS

COMMAND PROCESSING TIME: Maximum time required for the output to begin to change following the receipt of :SOURce:VOLTage|CURRent <nrf> command.

Autorange On: 10 ms. **Autorange Off:** 7 ms.

OUTPUT SETTling TIME (typical to 10 % of final value): <2s, 1 pA and 10 pA ranges;
<50 ms, 100 pA through 10 nA ranges; <5 ms, 100 nA through 100 mA ranges.

OUTPUT SLEW RATE: 30 V/ms, any V range, 10 mA compliance.

COMMON MODE VOLTAGE: ±42 VDC maximum.

4-WIRE SENSE: Up to 1 V drop per load lead, 10 Ω maximum per sense lead, 100 µA range and up. For details on using 4-wire sense with the 10 µA range and below, refer to the User's Manual.

OVER TEMPERATURE PROTECTION: Internally sensed temperature overload puts unit in standby mode.

RANGE CHANGE OVERSHOOT: Overshoot into a fully resistive 100 kΩ load, 10 Hz to 1 MHz BW, adjacent ranges, 100 mV typical, except 20 V/200 V range boundary.

MINIMUM COMPLIANCE VALUE: 0.1 % of range.

MEASURE SPECIFICATIONS ¹

Voltage Measurement Accuracy (4-wire sense)³

Range	6.5 Digit Resolution	Input ² Resistance	Accuracy (23 °C ± 5 °C) 1 Year, ± (% rdg + volts)
200 mV	100 nV	>10 ¹⁶ Ω	0.012 % + 350 μV
2 V	1 μV	>10 ¹⁶ Ω	0.012 % + 350 μV
20 V	10 μV	>10 ¹⁶ Ω	0.015 % + 1.5 mV
200 V	100 μV	>10 ¹⁶ Ω	0.015 % + 10 mV

TEMPERATURE COEFFICIENT (0 °C–18 °C and 28 °C–40 °C):
± (0.15 x accuracy specification) / °C.

ADDITIONAL MEASURE SPECIFICATIONS

CURRENT NOISE: When observed over 1 minute intervals, peak to peak noise will be within 400 aA (typical) during 90 % of the intervals using Autofilter (5s 10 % to 90 % rise time), with triax connectors capped, Autozero OFF, Source Delay = 0, on the 1 pA range for at least 3 minutes.

Current Measurement Accuracy (2- or 4-wire sense)⁴

Range	6.5 Digit Resolution	Voltage Burden ⁵	Accuracy (23 °C ± 5 °C) 1 Year ± (% rdg + amps)
1 pA	1 aA	< 1 mV	1.0 % + 7 fA
10 pA	10 aA	< 1 mV	0.50 % + 7 fA
100 pA	100 aA	< 1 mV	0.15 % + 30 fA
1 nA	1 fA	< 1 mV	0.050 % + 200 fA
10 nA	10 fA	< 1 mV	0.050 % + 2 pA
100 nA	100 fA	< 1 mV	0.050 % + 20 pA
1 μA	1 pA	< 1 mV	0.050 % + 300 pA
10 μA	10 pA	< 1 mV	0.050 % + 2 nA
100 μA	100 pA	< 1 mV	0.025 % + 6 nA
1 mA	1 nA	< 1 mV	0.027 % + 60 nA
10 mA	10 nA	< 1 mV	0.035 % + 600 nA
100 mA	100 nA	< 1 mV	0.055 % + 6 μA

TEMPERATURE COEFFICIENT (0 °C–18 °C and 28 °C–40 °C):
± [(0.15 x accuracy specification) + 1 fA] / °C.

INPUT CURRENT: <3 fA at 23 °C, <40 % RH; typically ±0.5 fA / °C ~23 °C, <40 % RH.

Resistance Measurement Accuracy (4-wire sense with remote preamp)

Source I Mode, Auto Ohms

Range	6.5 Digit Resolution	Default Test Current	Normal Accuracy (23 °C ± 5 °C) 1 Year, ± (% rdg + ohms)	Enhanced Accuracy (23 °C ± 5 °C) ⁷ 1 Year, ± (% rdg + ohms)
<2 Ω ⁶	1 μΩ	—	Source I _{ACC} + Measure V _{ACC}	Source I _{ACC} + Measure V _{ACC}
20 Ω	10 μΩ	100 mA	0.098 % + 0.003 Ω	0.068 % + 0.001 Ω
200 Ω	100 μΩ	10 mA	0.077 % + 0.03 Ω	0.048 % + 0.01 Ω
2 kΩ	1 mΩ	1 mA	0.066 % + 0.3 Ω	0.040 % + 0.1 Ω
20 kΩ	10 mΩ	100 μA	0.063 % + 3 Ω	0.038 % + 1 Ω
200 kΩ	100 mΩ	10 μA	0.082 % + 30 Ω	0.064 % + 10 Ω
2 MΩ	1 Ω	1 μA	0.082 % + 300 Ω	0.064 % + 100 Ω
20 MΩ	10 Ω	1 μA	0.085 % + 1 kΩ	0.067 % + 500 Ω
200 MΩ	100 Ω	100 nA	0.085 % + 10 kΩ	0.068 % + 5 kΩ
2 GΩ	1 kΩ	10 nA	0.085 % + 100 kΩ	0.070 % + 50 kΩ
20 GΩ	10 kΩ	1 nA	0.085 % + 1 MΩ	0.070 % + 500 kΩ
200 GΩ	100 kΩ	100 pA	0.205 % + 10 MΩ	0.185 % + 5 MΩ
2 TΩ	1 MΩ	10 pA	0.822 % + 100 MΩ	0.619 % + 50 MΩ
20 TΩ	10 MΩ	1 pA	2.06 % + 1 GΩ	1.54 % + 500 MΩ
>20 TΩ ⁶	—	—	Source I _{ACC} + Measure V _{ACC}	Source I _{ACC} + Measure V _{ACC}

Resistance Measurement Accuracy (4-wire sense without remote preamp)

Source I Mode, Auto Ohms

Range	6.5 Digit Resolution	Default Test Current	Normal Accuracy (23 °C ± 5 °C) 1 Year, ± (% rdg + ohms)	Enhanced Accuracy (23 °C ± 5 °C) ⁷ 1 Year, ± (% rdg + ohms)
<2 Ω ⁶	1 μΩ	—	Source I _{ACC} + Measure V _{ACC}	Source I _{ACC} + Measure V _{ACC}
20 Ω	10 μΩ	100 mA	0.098 % + 0.003 Ω	0.068 % + 0.001 Ω
200 Ω	100 μΩ	10 mA	0.077 % + 0.03 Ω	0.048 % + 0.01 Ω
2 kΩ	1 mΩ	1 mA	0.066 % + 0.3 Ω	0.040 % + 0.1 Ω
20 kΩ	10 mΩ	100 μA	0.063 % + 3 Ω	0.038 % + 1 Ω
200 kΩ	100 mΩ	10 μA	0.082 % + 30 Ω	0.040 % + 10 Ω
2 MΩ	1 Ω	1 μA	0.082 % + 300 Ω	0.042 % + 100 Ω
20 MΩ	10 Ω	1 μA	0.085 % + 1 kΩ	0.045 % + 500 Ω
>200 MΩ ⁶	—	—	Source I _{ACC} + Measure V _{ACC}	Source I _{ACC} + Measure V _{ACC}

TEMPERATURE COEFFICIENT (0 °C–18 °C and 28 °C–40 °C):
± (0.15 x accuracy specification) / °C.

SOURCE I MODE, MANUAL OHMS: Total uncertainty = I source accuracy + V measure accuracy (4-wire sense).

SOURCE V MODE: Total uncertainty = V source accuracy + I measure accuracy (4-wire sense).

6-WIRE OHMS MODE: Available using active ohms guard and guard sense (main-frame rear panel ONLY).

Max. Guard Output Current: 50 mA. Accuracy is load dependent. Refer to manual for calculation formula.

MAINFRAME GUARD OUTPUT RESISTANCE: 0.1 Ω in ohms mode.

¹ Speed = 10 PLC, Autofilter ON, properly zeroed and settled.

² Source I mode, I = 0.

³ Voltage measurement accuracy is not affected by the remote preamp.

⁴ Current measurement accuracy is not affected by the remote preamp; however, the 1 pA through 100 nA ranges are available only when using a preamp.

⁵ 4-wire mode.

⁶ Manual ohms mode only.

⁷ Source readback enabled, offset compensation ON. Source delay must be programmed such that the source is fully settled for each reading.

SYSTEM SPEEDS

MEASUREMENT¹

MAXIMUM RANGE CHANGE RATE: 75/second.

SWEEP OPERATION² READING RATES (rdg/second) FOR 60 Hz (50 Hz):

Speed	NPLC/Trigger Origin	Measure		Source-Measure		Source-Measure Pass/Fail Test ³		Source-Memory ³	
		To Mem.	To GPIB	To Mem.	To GPIB	To Mem.	To GPIB	To Mem.	To GPIB
Fast	0.01 / internal	2080 (2030)	1210 (1210)	1550 (1515)	1010 (1010)	930 (900)	840 (840)	163 (162)	163 (162)
	0.01 / external	1250 (1200)	1090 (1050)	1030 (990)	920 (920)	860 (830)	780 (780)	161 (160)	161 (160)
Medium	0.10 / internal	505 (433)	505 (433)	465 (405)	465 (405)	390 (343)	390 (343)	132 (126)	132 (126)
	0.10 / external	435 (380)	435 (380)	405 (360)	405 (360)	375 (333)	375 (333)	130 (125)	130 (125)
Normal	1.00 / internal	59 (49)	59 (49)	58 (48)	58 (48)	57 (47)	57 (47)	44 (38)	44 (38)
	1.00 / external	57 (48)	57 (48)	57 (48)	57 (48)	56 (47)	56 (47)	44 (38)	44 (38)

SINGLE READING OPERATION READING RATES (rdg/second) FOR 60Hz (50 Hz):

Speed	NPLC/Trigger Origin	Measure To GPIB	Source-Measure ⁴ To GPIB	Source-Measure Pass/Fail Test ^{3,4} To GPIB
Fast	0.01 / internal	256 (256)	83 (83)	83 (83)
Medium	0.10 / internal	181 (166)	73 (70)	73 (70)
Normal	1.00 / internal	49 (42)	35 (31)	34 (30)

COMPONENT HANDLER INTERFACE TIME: ^{3,5}

Speed	NPLC/Trigger Origin	Measure Pass/Fail Test	Source Pass/Fail Test	Source-Measure Pass/Fail Test ⁶
Fast	0.01 / external	1.01 ms (1.08 ms)	0.5 ms (0.5 ms)	5.3 ms (5.3 ms)
Medium	0.10 / external	2.5 ms (2.9 ms)	0.5 ms (0.5 ms)	6.7 ms (7.1 ms)
Normal	1.00 / external	17.5 ms (20.9 ms)	0.5 ms (0.5 ms)	21.7 ms (25.0 ms)

¹ Reading rates applicable for voltage or current measurements. Auto zero off, autorange off, filter off, display off, trigger delay = 0, source auto clear off, and binary reading format.

² 1000 point sweep was characterized with the source on a fixed range.

³ Pass/Fail test performed using one high limit and one low math limit.

⁴ Includes time to re-program source to a new level before making measurement.

⁵ Time from falling edge of START OF TEST signal to falling edge of END OF TEST signal.

⁶ Command processing time of :SOURCE:VOLTage|CURRent:TRIGgered <nrf> command not included.

GENERAL

NOISE REJECTION:

	NPLC	NMRR	CMRR
Fast	0.01	—	80 dB
Medium	0.1	—	80 dB
Normal	1	60 dB	90 dB

LOAD IMPEDANCE: Stable into 20,000 pF on the 100 mA through 100 µA ranges, 470 pF on the 10 µA and 1 µA ranges, and 100 pF on the nA and pA ranges. Refer to the User's Manual for details on measuring large capacitive loads.

COMMON MODE VOLTAGE: ±42 VDC maximum.

COMMON MODE ISOLATION: >10⁹ Ω, <1000 pF.

OVERRANGE: 105 % of range, source and measure.

MAX. VOLTAGE DROP BETWEEN INPUT/OUTPUT AND SENSE TERMINALS:

5 V. (To meet specified accuracy with 4-wire sense, refer to the User's Manual.)

MAX. SENSE LEAD RESISTANCE: 10 Ω for rated accuracy.

SENSE INPUT RESISTANCE: 1 MΩ.

MAINFRAME GUARD OFFSET VOLTAGE: 300 µV, typical.

PREAMP GUARD OFFSET VOLTAGE: 1 mV, typical.

PREAMP GUARD OUTPUT RESISTANCE: 110 kΩ.

SOURCE OUTPUT MODES:

- Fixed DC level
- Memory List (mixed function)
- Stair (linear and log)

SOURCE MEMORY LIST: 100 points max.

MEMORY BUFFER: 5,000 readings @ 5H digits (two 2,500 point buffers).

Includes selected measured value(s) and time stamp. Lithium battery backup (3 yr+ battery life).

PROGRAMMABILITY: IEEE-488 (SCPI-1996.0), RS-232, 5 user-definable power-up states plus factory default and *RST.

DIGITAL INTERFACE:

Output Enabled: Active low input.

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 sink, diode clamped).

POWER SUPPLY: 100 V–240 V rms, 50–60 Hz (automatically detected at power up), 100 VA max.

WARRANTY: 1 year.

EMC: Conforms to European Union EMC Directive.

SAFETY: Conforms to European Union Low Voltage Directive.

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

WARM-UP: 1 hour to rated accuracies.

DIMENSIONS: 89 mm high × 213 mm wide × 370 mm deep (3 1/2 in × 8 3/8 in × 14 9/16 in). Bench Configuration (with handle and feet): 104 mm high × 238 mm wide × 370 mm deep (4 1/8 in × 9 3/8 in × 14 9/16 in).

Amplifier: 20 mm high × 57 mm wide × 97 mm deep (0.783 in × 2.225 in × 3.75 in).

WEIGHT: 3.45 kg (7.61 lbs).

ENVIRONMENT:

For Indoor Use Only: Maximum 2000 m above sea level.

Operating: 0 °C–40 °C, 60 % R.H. (non-condensing) up to 35 °C. Derate 5 % R.H./ °C, 35 °C–40 °C.

Storage: –25 °C to 65 °C. Non-condensing humidity.

ACCESSORIES SUPPLIED:

- Model 6430-322-1 Low Noise Triax Cable, 3-slot triax to alligator clips, 20 cm (8 in)
- Model 8607 Safety High Voltage Dual Test Leads
- Model CA-186-1 Banana Lead to Screw Terminal Adapter