

### SOURCE SPECIFICATIONS<sup>1</sup>

#### Voltage Programming Accuracy (4-wire sense)<sup>2</sup>

| Range      | Programming Resolution | Accuracy (1 Year)<br>23°C ±5°C<br>±(%rdg + volts) | Noise<br>(peak-peak)<br>0.1Hz – 10Hz |
|------------|------------------------|---|--------------------------------------|
| 200.000 mV | 5 µV                   | 0.02% + 600 µV                                    | 5 µV                                 |
| 2.00000 V  | 50 µV                  | 0.02% + 600 µV                                    | 50 µV                                |
| 20.0000 V  | 500 µV                 | 0.02% + 2.4 mV                                    | 500 µV                               |
| 200.000 V  | 5 mV                   | 0.02% + 24 mV                                     | 5 mV                                 |

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

**MAX. OUTPUT POWER:** 2.2W (four quadrant source or sink operation).

**SOURCE/SINK LIMITS:** ±21V @ ±105mA, ±210V @ ±10.5mA.

**VOLTAGE REGULATION:** Line: 0.01% of range.

Load: 0.01% of range + 100µV.

**NOISE 10Hz–1MHz (p-p):** 10mV.

**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) <sup>1</sup><br>23°C ±5°C<br>±(%rdg + amps) | Noise<br>(peak-peak)<br>0.1Hz – 10Hz |
|------------|------------------------|---|--------------------------------------|
| 1.00000 pA | 50 aA                  | 1.0 % + 10 fA   | 5 fA                                 |
| 10.0000 pA | 500 aA                 | 0.50 % + 30 fA  | 10 fA                                |
| 100.000 pA | 5 fA                   | 0.15 % + 40 fA  | 20 fA                                |
| 1.00000 nA | 50 fA                  | 0.050% + 200 fA   | 50 fA                                |
| 10.0000 nA | 500 fA                 | 0.050% + 2 pA   | 500 fA                               |
| 100.000 nA | 5 pA                   | 0.050% + 20 pA  | 3 pA                                 |
| 1.00000 µA | 50 pA                  | 0.050% + 300 pA   | 20 pA                                |
| 10.0000 µA | 500 pA                 | 0.050% + 2 nA   | 200 pA                               |
| 100.000 µA | 5 nA                   | 0.031% + 20 nA  | 500 pA                               |
| 1.00000 mA | 50 nA                  | 0.034% + 200 nA   | 5 nA                                 |
| 10.0000 mA | 500 nA                 | 0.045% + 2 µA   | 50 nA                                |
| 100.000 mA | 5 µA                   | 0.066% + 20 µA  | 500 nA                               |

#### Current Programming Accuracy (without remote preamp)

| Range      | Programming Resolution | Accuracy (1 Year) <sup>1</sup><br>23°C ±5°C<br>±(%rdg + amps) | Noise<br>(peak-peak)<br>0.1Hz – 10Hz |
|------------|------------------------|---|--------------------------------------|
| 1.00000 µA | 50 pA                  | 0.035% + 600 pA   | 20 pA                                |
| 10.0000 µA | 500 pA                 | 0.033% + 2 nA   | 200 pA                               |
| 100.000 µA | 5 nA                   | 0.031% + 20 nA  | 500 pA                               |
| 1.00000 mA | 50 nA                  | 0.034% + 200 nA   | 5 nA                                 |
| 10.0000 mA | 500 nA                 | 0.045% + 2 µA   | 50 nA                                |
| 100.000 mA | 5 µA                   | 0.066% + 20 µA  | 50 nA                                |

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

**MAX. OUTPUT POWER:** 2.2W (four quadrant source or sink operation).

**SOURCE/SINK LIMITS:** ±10.5mA @ 210V, ±105mA @ 21V.

**CURRENT REGULATION:** Line: 0.01% of range.

Load: 0.01% of range + 1fA.

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

<sup>1</sup> For sink mode, 1pA to 100mA range, accuracy is ±(0.15% + offset\*4).

<sup>2</sup> 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:** 10ms. **Autorange Off:** 7ms.

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

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

**COMMON MODE VOLTAGE:** ±42VDC maximum.

**4-WIRE SENSE:** Up to 1V drop per load lead, 10Ω maximum per sense lead, 100µA range and up. For details on using 4-wire sense with the 10µA 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 100kΩ load, 10Hz to 1MHz BW, adjacent ranges, 100mV typical, except 20V/200V range boundary.

**MINIMUM COMPLIANCE VALUE:** 0.1% of range.

### MEASURE SPECIFICATIONS <sup>1</sup>

#### Voltage Measurement Accuracy (4-wire sense)<sup>3</sup>

| Range      | Max. Resolution | Input <sup>2</sup> Resistance | Accuracy (23°C ± 5°C) 1 Year, ±(%rdg + volts) |
|------------|-----------------|-------------------------------|---|
| 200.000 mV | 1 µV            | >10 <sup>16</sup> Ω           | 0.012% + 350 µV                               |
| 2.00000 V  | 10 µV           | >10 <sup>16</sup> Ω           | 0.012% + 350 µV                               |
| 20.0000 V  | 100 µV          | >10 <sup>16</sup> Ω           | 0.015% + 1.5 mV                               |
| 200.000 V  | 1 mV            | >10 <sup>16</sup> Ω           | 0.015% + 10 mV                                |

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

#### ADDITIONAL MEASURE SPECIFICATIONS

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

**CURRENT NOISE:** When observed over 1 minute intervals, peak to peak noise will be within 400aA (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 1pA range for at least 3 minutes.

#### Current Measurement Accuracy (2- or 4-wire sense)<sup>4</sup>

| Range      | Max. Resolution | Voltage Burden <sup>5</sup> | Accuracy (23°C ± 5°C) 1 Year ±(%rdg + amps) |
|------------|-----------------|-----------------------------|---|
| 1.00000 pA | 10 aA           | < 1mV                       | 1.0 % + 7 fA                                |
| 10.0000 pA | 100 aA          | < 1mV                       | 0.50 % + 7 fA                               |
| 100.000 pA | 1 fA            | < 1mV                       | 0.15 % + 30 fA                              |
| 1.00000 nA | 10 fA           | < 1mV                       | 0.050% + 200 fA                             |
| 10.0000 nA | 100 fA          | < 1mV                       | 0.050% + 2 pA                               |
| 100.000 nA | 1 pA            | < 1mV                       | 0.050% + 20 pA                              |
| 1.00000 µA | 10 pA           | < 1mV                       | 0.050% + 300 pA                             |
| 10.0000 µA | 100 pA          | < 1mV                       | 0.050% + 2 nA                               |
| 100.000 µA | 1 nA            | < 1mV                       | 0.025% + 6 nA                               |
| 1.00000 mA | 10 nA           | < 1mV                       | 0.027% + 60 nA                              |
| 10.0000 mA | 100 nA          | < 1mV                       | 0.035% + 600 nA                             |
| 100.000 mA | 1 µA            | < 1mV                       | 0.055% + 6 µA                               |

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

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

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

Source I Mode, Auto Ohms

| Range                    | Max. Resolution | Default Test Current | Normal Accuracy (23°C ± 5°C) 1 Year, ±(%rdg + ohms) | Enhanced Accuracy (23°C ± 5°C) <sup>7</sup> 1 Year, ±(%rdg + ohms) |
|--------------------------|-----------------|----------------------|---|--|
| <2.00000 Ω <sup>6</sup>  | 1 µΩ            | —                    | Source I <sub>ACC</sub> + Measure V <sub>ACC</sub>  | Measure I <sub>ACC</sub> + Measure V <sub>ACC</sub>                |
| 20.0000 Ω                | 100 µΩ          | 100 mA               | 0.098%+ 0.003 Ω                                     | 0.068% + 0.001 Ω   |
| 200.000 Ω                | 1 mΩ            | 10 mA                | 0.077%+ 0.03 Ω                                      | 0.048% + 0.01 Ω  |
| 2.00000 kΩ               | 10 mΩ           | 1 mA                 | 0.066%+ 0.3 Ω                                       | 0.040% + 0.1 Ω   |
| 20.0000 kΩ               | 100 mΩ          | 100 µA               | 0.063%+ 3 Ω   | 0.038% + 1 Ω   |
| 200.000 kΩ               | 1 Ω             | 10 µA                | 0.082%+ 30 Ω  | 0.064% + 10 Ω  |
| 2.00000 MΩ               | 10 Ω            | 1 µA                 | 0.082%+ 300 Ω                                       | 0.064% + 100 Ω   |
| 20.0000 MΩ               | 100 Ω           | 1 µA                 | 0.085%+ 1 kΩ  | 0.067% + 500 Ω   |
| 200.000 MΩ               | 1 kΩ            | 100 nA               | 0.085%+ 10 kΩ                                       | 0.068% + 5 kΩ  |
| 2.00000 GΩ               | 10 kΩ           | 10 nA                | 0.085%+ 100 kΩ                                      | 0.070% + 50 kΩ   |
| 20.0000 GΩ               | 100 kΩ          | 1 nA                 | 0.085%+ 1 MΩ  | 0.070% + 500 kΩ  |
| 200.000 GΩ               | 1 MΩ            | 100 pA               | 0.205%+ 10 MΩ                                       | 0.185% + 5 MΩ  |
| 2.00000 TΩ               | 10 MΩ           | 10 pA                | 0.822%+ 100 MΩ                                      | 0.619% + 50 MΩ   |
| 20.0000 TΩ               | 100 MΩ          | 1 pA                 | 2.06% + 1 GΩ  | 1.54% + 500 MΩ   |
| >20.0000 TΩ <sup>6</sup> | —               | —                    | Source I <sub>ACC</sub> + Measure V <sub>ACC</sub>  | Measure I <sub>ACC</sub> + Measure V <sub>ACC</sub>                |

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

Source I Mode, Auto Ohms

| Range                   | Max. Resolution | Default Test Current | Normal Accuracy (23°C ± 5°C) 1 Year, ±(%rdg + ohms) | Enhanced Accuracy (23°C ± 5°C) <sup>7</sup> 1 Year, ±(%rdg + ohms) |
|-------------------------|-----------------|----------------------|---|--|
| <2.00000 Ω <sup>6</sup> | 1 µΩ            | —                    | Source I <sub>ACC</sub> + Measure V <sub>ACC</sub>  | Measure I <sub>ACC</sub> + Measure V <sub>ACC</sub>                |
| 20.0000 Ω               | 100 µΩ          | 100 mA               | 0.098%+ 0.003 Ω                                     | 0.068% + 0.001 Ω   |
| 200.000 Ω               | 1 mΩ            | 10 mA                | 0.077%+ 0.03 Ω                                      | 0.048% + 0.01 Ω  |
| 2.00000 kΩ              | 10 mΩ           | 1 mA                 | 0.066%+ 0.3 Ω                                       | 0.040% + 0.1 Ω   |
| 20.0000 kΩ              | 100 mΩ          | 100 µA               | 0.063%+ 3 Ω   | 0.038% + 1 Ω   |
| 200.000 kΩ              | 1 Ω             | 10 µA                | 0.082%+ 30 Ω  | 0.040% + 10 Ω  |
| 2.00000 MΩ              | 10 Ω            | 1 µA                 | 0.082%+ 300 Ω                                       | 0.042% + 100 Ω   |
| 20.0000 MΩ              | 100 Ω           | 1 µA                 | 0.085%+ 1 kΩ  | 0.045% + 500 Ω   |
| 200.000 MΩ              | 1 kΩ            | 100 nA               | 0.085%+ 10 kΩ                                       | 0.349% + 5 kΩ  |

**TEMPERATURE COEFFICIENT (0°–18°C & 28°–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 (mainframe rear panel ONLY). **Max. Guard Output Current:** 50 mA. Accuracy is load dependent. Refer to manual for calculation formula.

**MAINFRAME GUARD OUTPUT RESISTANCE:** 0.1Ω in ohms mode.

<sup>1</sup> Speed = 10 PLC, Autofilter ON, properly zeroed and settled.

<sup>2</sup> Source I mode, I = 0.

<sup>3</sup> Voltage measurement accuracy is not affected by the remote preamp.

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

<sup>5</sup> 4-wire mode.

<sup>6</sup> Manual ohms mode only.

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

## SYSTEM SPEEDS

MEASUREMENT<sup>1</sup>

MAXIMUM RANGE CHANGE RATE: 75/second.

SWEEP OPERATION<sup>2</sup> READING RATES (rdg/second) FOR 60Hz (50Hz):

| Speed  | NPLC/Trigger Origin | Measure     |             | Source-Measure |             | Source-Measure Pass/Fail Test <sup>3</sup> |           | Source-Memory <sup>3</sup> |           |
|--------|---------------------|-------------|-------------|----------------|-------------|--|-----------|----------------------------|-----------|
|        |                     | 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 (50Hz):

| Speed  | NPLC/Trigger Origin | Measure To GPIB | Source-Measure <sup>4</sup> To GPIB | Source-Measure Pass/Fail Test <sup>4</sup> 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: <sup>3, 5</sup>

| Speed  | NPLC/Trigger Origin | Measure Pass/Fail Test | Source Pass/Fail Test | Source-Measure Pass/Fail Test <sup>6</sup> |
|--------|---------------------|------------------------|-----------------------|--|
| 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)                          |

<sup>1</sup> 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.

<sup>2</sup> 1000 point sweep was characterized with the source on a fixed range.

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

<sup>4</sup> Includes time to re-program source to a new level before making measurement.

<sup>5</sup> Time from falling edge of START OF TEST signal to falling edge of END OF TEST signal.

<sup>6</sup> 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 20,000pF on the 100mA through 100μA ranges, 470pF on the 10μA and 1μA ranges, and 100pF on the nA and pA ranges. Refer to the User's Manual for details on measuring large capacitive loads.

**COMMON MODE VOLTAGE:** ±42VDC maximum.

**COMMON MODE ISOLATION:** >10<sup>9</sup>Ω, <1000pF.

**OVERRANGE:** 105% of range, source and measure.

**MAX. VOLTAGE DROP BETWEEN INPUT/OUTPUT AND SENSE TERMINALS:** 5V. (To meet specified accuracy with 4-wire sense, refer to the User's Manual.)

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

**SENSE INPUT RESISTANCE:** 1MΩ.

**MAINFRAME GUARD OFFSET VOLTAGE:** 300μV, typical.

**PREAMP GUARD OFFSET VOLTAGE:** 1mV, typical.

**PREAMP GUARD OUTPUT RESISTANCE:** 110kΩ.

## 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. +5V @ 300mA supply.  
**Digital I/O:** 1 trigger input, 4 TTL/Relay Drive outputs (33V @ 500mA sink, diode clamped).

**POWER SUPPLY:** 100V–240V rms, 50–60Hz (automatically detected at power up), 100VA 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:** 89mm high × 213mm wide 370mm deep (3 1/2 in × 8 3/8 in × 14 9/16 in).

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

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

**WEIGHT:** 3.45kg (7.61 lbs).

## ENVIRONMENT:

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

**Operating:** 0°–40°C, 60% R.H. (non-condensing) up to 35°C. Derate 5% R.H./°C, 35°–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, 20cm (8 in)
- Model 8607 Safety High Voltage Dual Test Leads
- Model CA-186-1 Banana Lead to Screw Terminal Adapter