

# 2410 and 2410-C SourceMeter® Specifications

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

### VOLTAGE PROGRAMMING ACCURACY (LOCAL OR REMOTE SENSE)

| RANGE     | PROGRAMMING RESOLUTION | ACCURACY (1 Year)<br>23°C ±5°C<br>±(% rdg. + volts) | NOISE<br>(peak-peak)<br>0.1Hz – 10Hz |
|-----------|------------------------|---|--------------------------------------|
| 200.00 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                                      | 5 mV                                 |
| 1000.00 V | 50 mV                  | 0.02% + 100 mV                                      | 20 mV                                |

**TEMPERATURE COEFFICIENT (0°-18°C & 28°-50°C):**  $\pm(0.15 \times \text{accuracy specification})/^\circ\text{C}$ .

**MAX. OUTPUT POWER:** 22W, four quadrant source or sink operation.

**SOURCE/SINK LIMITS:**  $\pm 21\text{V}$  @  $\pm 1.05\text{A}$ ,  $\pm 1100\text{V}$  @  $\pm 21\text{mA}$ .

**VOLTAGE REGULATION:** **Line:** 0.01% of range. **Load:** 0.01% of range + 1mV.

**NOISE 10Hz – 1MHz (p-p):** 20mV typical into a resistive load.

**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.

**OVERSHOOT:** <0.1% typical (full scale step, resistive load, 20mA range).

### CURRENT PROGRAMMING ACCURACY (LOCAL OR REMOTE SENSE)

| RANGE                  | PROGRAMMING RESOLUTION | ACCURACY (1 Year) <sup>3</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   | 5 pA                                 |
| 10.0000 µA             | 500 pA                 | 0.033% + 2 nA   | 50 pA                                |
| 100.000 µA             | 5 nA                   | 0.031% + 20 nA  | 500 pA                               |
| 1.00000 mA             | 50 nA                  | 0.034% + 200 nA   | 5 nA                                 |
| 20.0000 mA             | 500 nA                 | 0.045% + 4 µA   | 200 nA                               |
| 100.000 mA             | 5 µA                   | 0.066% + 20 µA  | 1 µA                                 |
| 1.00000 A <sup>2</sup> | 50 µA                  | 0.27% + 900 µA  | 100 µA                               |

**TEMPERATURE COEFFICIENT (0°-18°C & 28°-50°C):**  $\pm(0.15 \times \text{accuracy specification})/^\circ\text{C}$ .

**MAX. OUTPUT POWER:** 22W, four quadrant source or sink operation.

**SOURCE/SINK LIMITS:**  $\pm 1.05\text{A}$  @  $\pm 21\text{V}$ ,  $\pm 21\text{mA}$  @  $\pm 1100\text{V}$ .

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

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

**OVERSHOOT:** <0.1% typical (1mA step, RL = 10kΩ, 20V range).

## ADDITIONAL SOURCE SPECIFICATIONS

**TRANSIENT RESPONSE TIME:** 30µs minimum for the output to recover to its spec. following a step change in load.

**COMMAND PROCESSING TIME:** Maximum time required for the output to begin to change following the receipt of :SOURCE:VOLTageCURRent <nrf> command. **Autorange On:** 10ms. **Autorange Off:** 7ms.

**OUTPUT SETTling TIME:** Time required to reach 0.1% of final value after command is processed. 100µs typical. Resistive load. 10µA to 100mA range.

**OUTPUT SLEW RATE (±30%):**  
0.5V/µs, 1000V range, 20mA compliance.  
0.15V/µs, 20V range, 100mA compliance.

**DC FLOATING VOLTAGE:** Output can be floated up to  $\pm 250\text{VDC}$  from chassis ground.

**REMOTE SENSE:** Up to 1V drop per load lead.

**COMPLIANCE ACCURACY:** Add 0.3% of range and  $\pm 0.02\%$  of reading to base specification.

**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 range changes between 200mV, 2V, and 20V ranges, 100mV typical.

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

- Specifications valid for continuous output currents below 105mA. For operation above 105mA continuous for > 1 minute, derate accuracy 10%/35mA above 105mA.
- Full operation (1A) regardless of load to 30°C. Above 30°C ambient, derate 35mA/°C and prorate 35mA/Ω load. 4-wire mode. For current sink operation on 1A range, maximum continuous power is limited to approximately 1/2 rated power or less, depending on current, up to 30°C ambient. See power equations in the User's Manual to calculate allowable duty cycle for specific conditions.
- For sink mode, 1µA to 100mA range, accuracy is:  
 $\pm(0.5\% + \text{offset} * 3)$   
For 1A range, accuracy is:  
 $\pm(1.5\% + \text{offset} * 3)$

# 2410 and 2410-C SourceMeter<sup>®</sup> Specifications

## MEASURE SPECIFICATIONS<sup>1,2</sup>

### VOLTAGE MEASUREMENT ACCURACY (LOCAL OR REMOTE SENSE)

| RANGE     | DEFAULT RESOLUTION | INPUT RESISTANCE | ACCURACY (1 Year)<br>23°C ±5°C<br>±(% rdg. + volts) |
|-----------|--------------------|------------------|---|
| 200.00 mV | 1 µV               | >10 GΩ           | 0.012% + 300 µV                                     |
| 2.00000 V | 10 µV              | >10 GΩ           | 0.012% + 300 µV                                     |
| 20.0000 V | 100 µV             | >10 GΩ           | 0.015% + 1 mV                                       |
| 1000.00 V | 10 mV              | >10 GΩ           | 0.015% + 50 mV                                      |

TEMPERATURE COEFFICIENT (0°-18°C & 28°-50°C): ±(0.15 × accuracy specification)/ °C.

### CURRENT MEASUREMENT ACCURACY (LOCAL OR REMOTE SENSE)

| RANGE      | DEFAULT RESOLUTION | VOLTAGE BURDEN <sup>3</sup> | ACCURACY (1 Year)<br>23°C ±5°C<br>±(% rdg. + amps) |
|------------|--------------------|-----------------------------|--|
| 1.00000 µA | 10 pA              | <1 mV                       | 0.029% + 300 pA                                    |
| 10.0000 µA | 100 pA             | <1 mV                       | 0.027% + 700 pA                                    |
| 100.000 µA | 1 nA               | <1 mV                       | 0.025% + 6 nA                                      |
| 1.00000 mA | 10 nA              | <1 mV                       | 0.027% + 60 nA                                     |
| 20.0000 mA | 100 nA             | <1 mV                       | 0.035% + 1.2 µA                                    |
| 100.000 mA | 1 µA               | <1 mV                       | 0.055% + 6 µA                                      |
| 1.00000 A  | 10 µA              | <1 mV                       | 0.22% + 570 µA                                     |

TEMPERATURE COEFFICIENT (0°-18°C & 28°-50°C): ±(0.10 × accuracy specification)/ °C.

### RESISTANCE MEASUREMENT ACCURACY (LOCAL OR REMOTE SENSE)

| RANGE                    | DEFAULT RESOLUTION | DEFAULT TEST CURRENT | NORMAL ACCURACY (23°C ±5°C)<br>1 YEAR, ±(% rdg. + ohms) |
|--------------------------|--------------------|----------------------|---|
| <2.00000 Ω <sup>4</sup>  | -                  | -                    | Source I <sub>ACC</sub> + Meas. V <sub>ACC</sub>        |
| 20.0000 Ω                | 100 µΩ             | 100 mA               | 0.11% + 0.006 Ω   |
| 200.000 Ω                | 1 mΩ               | 10 mA                | 0.09% + 0.12 Ω  |
| 2.00000 kΩ               | 10 mΩ              | 1 mA                 | 0.08% + 0.6 Ω   |
| 20.0000 kΩ               | 100 mΩ             | 100 µA               | 0.07% + 6 Ω   |
| 200.000 kΩ               | 1 Ω                | 10 µA                | 0.07% + 60 Ω  |
| 2.00000 MΩ               | 10 Ω               | 1 µA                 | 0.12% + 600 Ω   |
| 20.0000 MΩ               | 100 Ω              | 1 µA                 | 0.12% + 2.4 kΩ  |
| 200.000 MΩ               | 1 kΩ               | 100 nA               | 0.66% + 24 kΩ   |
| >200.000 MΩ <sup>4</sup> | -                  | -                    | Source I <sub>ACC</sub> + Meas. V <sub>ACC</sub>        |

TEMPERATURE COEFFICIENT (0°-18°C & 28°-50°C): ±(0.15 × accuracy specification)/ °C.

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

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

**6-WIRE OHMS MODE:** Available using active ohms guard and guard sense (except on 1A and 1000V ranges). Max. Guard Output Current: 40mA typical. Accuracy is load dependent. Refer to White Paper no. 2033 for calculation formula.

**GUARD OUTPUT IMPEDANCE:** <0.1Ω in ohms mode.

## CONTACT CHECK SPECIFICATIONS

**SPEED:** 350µs for verification and notification.

| CONTACT CHECK:               | 2Ω     | 15Ω    | 50Ω    |
|------------------------------|--------|--------|--------|
| No contact check failure     | <1.00Ω | <13.5Ω | <47.5Ω |
| Always contact check failure | >3.00Ω | >16.5Ω | >52.5Ω |

- Speed = Normal (1 PLC). For 0.1 PLC, add 0.005% of range to offset specifications, except 200mV and 1A ranges, add 0.05%. For 0.01 PLC, add 0.05% of range to offset specifications, except 200mV, and 1A ranges, add 0.5%.
- Accuracies apply to 2- or 4-wire mode when properly zeroed.
- 4-wire mode.
- Manual ohms only.

# 2410 and 2410-C SourceMeter® Specifications

## SYSTEM SPEEDS

### MEASUREMENT<sup>1</sup>

MAXIMUM RANGE CHANGE RATE: 70/second.

MAXIMUM MEASURE AUTORANGE TIME: 40ms (fixed source)<sup>2</sup>.

SWEEP OPERATION<sup>3</sup> READING RATES (rdg./second) FOR 60Hz (50Hz):

| SPEED           | NPLC/TRIGGER ORIGIN | MEASURE     |             | SOURCE-MEASURE <sup>5</sup> |            | SOURCE-MEASURE PASS/FAIL TEST <sup>4,5</sup> |           | SOURCE-MEMORY <sup>4,5</sup> |           |
|-----------------|---------------------|-------------|-------------|-----------------------------|------------|--|-----------|------------------------------|-----------|
|                 |                     | TO MEM.     | TO GPIB     | TO MEM.                     | TO GPIB    | TO MEM.                                      | TO GPIB   | TO MEM.                      | TO GPIB   |
| Fast            | 0.01 / internal     | 2081 (2030) | 1754        | 1551 (1515)                 | 1369       | 902 (900)                                    | 981       | 165 (162)                    | 165       |
| IEEE-488.1 Mode | 0.01 / external     | 1239 (1200) | 1254        | 1018 (990)                  | 1035       | 830 (830)                                    | 886       | 163 (160)                    | 163       |
| Fast            | 0.01 / internal     | 2801 (2030) | 1198 (1210) | 1551 (1515)                 | 1000 (900) | 902 (900)                                    | 809 (840) | 165 (162)                    | 164 (162) |
| IEEE-488.2 Mode | 0.01 / external     | 1239 (1200) | 1079 (1050) | 1018 (990)                  | 916 (835)  | 830 (830)                                    | 756 (780) | 163 (160)                    | 162 (160) |
| Medium          | 0.10 / internal     | 510 (433)   | 509 (433)   | 470 (405)                   | 470 (410)  | 389 (343)                                    | 388 (343) | 133 (126)                    | 132 (126) |
| IEEE-488.2 Mode | 0.10 / external     | 438 (380)   | 438 (380)   | 409 (360)                   | 409 (365)  | 374 (333)                                    | 374 (333) | 131 (125)                    | 131 (125) |
| Normal          | 1.00 / internal     | 59 (49)     | 59 (49)     | 58 (48)                     | 58 (48)    | 56 (47)                                      | 56 (47)   | 44 (38)                      | 44 (38)   |
| IEEE-488.2 Mode | 1.00 / external     | 57 (48)     | 57 (48)     | 57 (48)                     | 57 (47)    | 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 TO GPIB <sup>5</sup> | SOURCE-MEASURE PASS/FAIL TEST <sup>4,5</sup> TO GPIB |
|----------------|---------------------|-----------------|-------------------------------------|--|
| Fast (488.1)   | 0.01 / internal     | 537             | 140                                 | 135  |
| Fast (488.2)   | 0.01 / internal     | 256 (256)       | 79 (83)                             | 79 (83)  |
| Medium (488.2) | 0.10 / internal     | 167 (166)       | 72 (70)                             | 69 (70)  |
| Normal (488.2) | 1.00 / internal     | 49 (42)         | 34 (31)                             | 35 (30)  |

COMPONENT INTERFACE HANDLER TIME FOR 60Hz (50Hz):<sup>4,6</sup>

| SPEED  | NPLC/TRIGGER ORIGIN | MEASURE TO GPIB    | SOURCE PASS/FAIL TEST | SOURCE-MEASURE PASS/FAIL TEST <sup>5,7</sup> TO GPIB |
|--------|---------------------|--------------------|-----------------------|--|
| Fast   | 0.01 / external     | 1.04 ms (1.08 ms)  | 0.5 ms (0.5 ms)       | 4.82 ms (5.3 ms)                                     |
| Medium | 0.10 / external     | 2.55 ms (2.9 ms)   | 0.5 ms (0.5 ms)       | 6.27 ms (7.1 ms)                                     |
| Normal | 1.00 / external     | 17.53 ms (20.9 ms) | 0.5 ms (0.5 ms)       | 21.31 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. Purely resistive load. 1µA and 10µA ranges <65ms.
3. 1000 point sweep was characterized with the source on a fixed range.

4. Pass/Fail test performed using one high limit and one low math limit.
5. Includes time to re-program source to a new level before making measurement.
6. Time from falling edge of START OF TEST signal to falling edge of END OF TEST signal.
7. Command processing time of :SOURCE:VOLTage|CURRent:TRIGgered <nr> command not included.

## GENERAL

### NOISE REJECTION:

|        | NPLC | NMRR  | CMRR                |
|--------|------|-------|---------------------|
| Fast   | 0.01 | -     | 80 dB               |
| Medium | 0.1  | -     | 80 dB               |
| Slow   | 1    | 60 dB | 100 dB <sup>1</sup> |

1. Except lowest 2 current ranges – 90dB.

LOAD IMPEDANCE: Stable into 20,000pF typical.

COMMON MODE VOLTAGE: 250V DC.

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.

MAX. SENSE LEAD RESISTANCE: 50kΩ for rated accuracy.

SENSE INPUT IMPEDANCE: >10<sup>10</sup>Ω.

GUARD OFFSET VOLTAGE: <300µV, typical.

### 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 @ 5.5 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 Enable: 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, diode clamped).

POWER SUPPLY: 100V to 240V rms, 50–60Hz (automatically detected at power up). 210VA.

COOLING: Forced air, variable speed.

WARRANTY: 1 year.

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

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

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).

WEIGHT: 3.3kg (7.3 lbs).

### 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.

ACCESSORIES SUPPLIED: Test Leads, User's Manual, Service Manual, LabVIEW and TestPoint Drivers.

Specifications subject to change without notice.

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