Model 2461 Interactive SourceMeter® Instrument

Specifications

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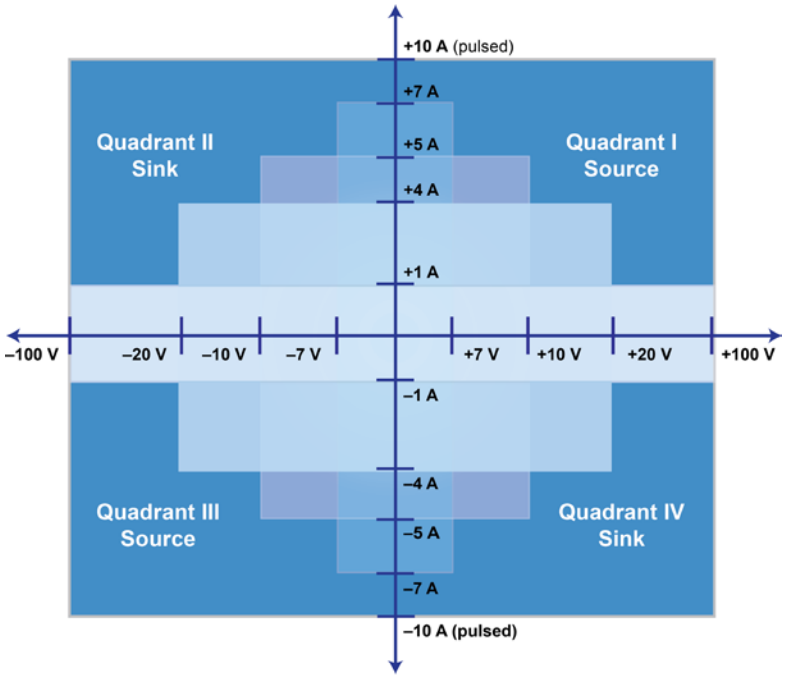
SPECIFICATION CONDITIONS

This document contains specifications and supplemental information for the Model 2461 Interactive SourceMeter® Instrument. Specifications are the standards against which the Model 2461 is tested. Upon leaving the factory, the Model 2461 meets these specifications. Supplemental and typical values are nonwarranted, apply at 23 °C, and are provided solely as useful information.

DC POWER SPECIFICATIONS

	Voltage	Current
Maximum output power and source limits	105 W maximum DC; 1050 W pulse ▪ ± 105 V (≤ 1 A range; ≤ 10 A pulsed) ▪ Four-quadrant source or sink operation	105 W maximum; 1050 W pulse ▪ ± 1.05 A; ± 10.5 A pulsed (≤ 100 V range) ▪ Four-quadrant source or sink operation
Maximum DC voltage and current ratings	105 V	1.05 A
	21 V	4.2 A
	10.5 V	5.25 A
	7.35 V	7.35 A



Maximum voltage and current		
	Voltage	Current
DC or pulsed	100 V	1 A
	20 V	4 A
	10 V	5 A
	7 V	7 A
Pulsed	105 V	10 A

VOLTAGE SPECIFICATIONS[1,2]

Source					Measure[3]		
Range	**Maximum DC current**	**Resolution**	**Accuracy 23 °C ± 5 °C 1 year ± (% setting + volts)**	**Noise (RMS) <10Hz**	**Resolution[4]**	**Accuracy 23 °C ± 5 °C 1 year** ± (% reading + volts)	**Digitizer accuracy[5] 23 °C ± 5 °C 1 week** ± (% reading + volts)
200.0000 mV	7.35 A	5 µV	0.015 % + 200 µV	1 µV	100 nV	0.012 % + 200 µV	0.05 % + 1.2 mV
2.000000 V	7.35 A	50 µV	0.015 % + 300 µV	2 µV	1 µV	0.012 % + 300 µV	0.05 % + 1.2 mV
7.000000 V	7.35 A	250 µV	0.015 % + 2.4 mV	20 µV	1 µV	0.015 % + 1 mV	0.05 % + 8 mV
10.00000 V	5.25 A	250 µV	0.015 % + 2.4 mV	20 µV	10 µV	0.015 % + 1 mV	0.05 % + 8 mV
20.00000 V	4.2 A	500 µV	0.015 % + 2.4 mV	20 µV	10 µV	0.015 % + 1 mV	0.05 % + 8 mV
100.0000 V	1.05 A	2.5 mV	0.015 % + 15 mV	200 µV	100 µV	0.015 % + 5 mV	0.05 % + 40 mV

Measure Input Resistance: > 10 GΩ all ranges

Temperature coefficient: ± (0.10 × accuracy specification)/°C
0 °C to 18 °C and 28 °C to 50 °C

CURRENT SPECIFICATIONS[1,2,6]

Source					Measure[3]		
Range	**Maximum DC voltage**	**Resolution**	**Accuracy 23 °C ± 5 °C 1 year ± (% setting + amps)**	**Noise (RMS) <10Hz**	**Resolution[4]**	**Accuracy 23 °C ± 5 °C 1 year** ± (% reading + amps)	**Digitizer accuracy[7] 23 °C ± 5 °C 1 week** ± (% reading + amps)
1.000000 µA	105 V	50 pA	0.025 % + 1 nA	40 pA	1 pA	0.025 % + 700 pA	0.05 % + 4 nA
10.00000 µA	105 V	500 pA	0.025 % + 1.5 nA	40 pA	10 pA	0.025 % + 1 nA	0.05 % + 8 nA
100.0000 µA	105 V	5 nA	0.020 % + 15 nA	100 pA	100 pA	0.020 % + 10 nA	0.05 % + 80 nA
1.000000 mA	105 V	50 nA	0.020 % + 150 nA	1 nA	1 nA	0.020 % + 100 nA	0.05 % + 800 nA
10.00000 mA	105 V	500 nA	0.020 % + 1.5 µA	10 nA	10 nA	0.020 % + 1 µA	0.05 % + 8 µA
100.0000 mA	105 V	5 µA	0.020 % + 15 µA	100 nA	100 nA	0.020 % + 10 µA	0.05 % + 80 µA
1.000000 A	105 V	50 µA	0.050 % + 750 µA	5 µA	1 µA	0.050 % + 500 µA	0.05 % + 1 mA
4.000000 A	21 V	250 µA	0.100 % + 3 mA	25 µA	1 µA	0.100 % + 2.5 mA	0.10 % + 5 mA
5.000000 A	10.5 V	250 µA	0.100 % + 3 mA	25 µA	1 µA	0.100 % + 2.5 mA	0.10 % + 5 mA
7.000000 A	7.35 V	500 µA	0.150 % + 6 mA	125 µA	1 µA	0.150 % + 5 mA	0.15 % + 10 mA
10.00000 A[8]	7.35 V	500 µA	0.150 % + 6 mA	125 µA	10 µA	0.150 % + 5 mA	0.15 % + 10 mA

Voltage burden:[9] < 100 µV all ranges

Temperature coefficient: ± (0.10 × accuracy specification)/°C
0 °C to 18 °C and 28 °C to 50 °C

[1] Speed = 1 PLC.
[2] All specifications guaranteed with output ON.
[3] Accuracies apply to 2-wire and 4-wire modes when properly zeroed.
[4] Measure resolution 6.5 digits. Digitizer resolution limited by noise.
[5] 18-bit ADC. Average of 1000 samples taken at 1 µs intervals. Internal temperature within ± 5 °C and 1 week of automatic calibration (ACAL).
[6] Accuracy specifications guaranteed when using Model 2460-KIT screw terminal accessory.
[7] 18-bit ADC. Average of 1000 samples taken at 1 µs intervals. Internal temperature within ± 5 °C and 1 week of automatic calibration (ACAL).
[8] 10 A range DC specifications valid up to 7.35 A. Operation > 7.35A only in pulse mode. Pulse width and duty cycle limits apply. See Pulse Specifications and Typical Pulse Performance sections for more details on pulse operation.
[9] Four-wire mode.

RESISTANCE MEASUREMENT ACCURACY (LOCAL OR REMOTE SENSE)[10,11,12]

Range	Resolution[13]	Default test current	Normal accuracy 23 °C ± 5 °C 1 year ± (% reading + ohms)	Enhanced accuracy[14] 23 °C ± 5 °C 1 year ± (% reading + ohms)
< 2.000000 Ω[15]	1 µΩ	User-defined	Source I_{ACC} + Meas V_{ACC}	Meas I_{ACC} + Meas V_{ACC}
2.000000 Ω	1 µΩ	100 mA	0.05 % + 0.003 Ω	0.04 % + 0.001 Ω
20.00000 Ω	10 µΩ	100 mA	0.05 % + 0.003 Ω	0.04 % + 0.001 Ω
200.0000 Ω	100 µΩ	10 mA	0.05 % + 0.03 Ω	0.04 % + 0.01 Ω
2.000000 kΩ	1 mΩ	1 mA	0.05 % + 0.3 Ω	0.04 % + 0.1 Ω
20.00000 kΩ	10 mΩ	100 µA	0.05 % + 3 Ω	0.04 % + 1 Ω
200.0000 kΩ	100 mΩ	10 µA	0.05 % + 30 Ω	0.05 % + 10 Ω
2.000000 MΩ	1 Ω	10 µA	0.06 % + 100 Ω	0.06 % + 50 Ω
20.00000 MΩ	10 Ω	1 µA	0.14 % + 1000 Ω	0.12 % + 500 Ω
200.0000 MΩ	100 Ω	100 nA	1.04 % + 10000 Ω	0.74 % + 5000 Ω
> 200.00000 MΩ[15]	------	User-defined	Source I_{ACC} + Meas V_{ACC}	Meas I_{ACC} + Meas V_{ACC}
Temperature coefficient: ± (0.10 × accuracy specification)/°C 0 °C to 18 °C and 28 °C to 50 °C				
Source current, measure resistance mode	Total uncertainty = I source accuracy + V measure accuracy (4-wire remote sense)			
Source voltage, measure resistance mode	Total uncertainty = V source accuracy + I measure accuracy (4-wire remote sense)			

CONTACT CHECK

Contact check speed	< 100 µs for verification and notification, script (TSP®) programmed		
Resistance settings:	**2 Ω**	**15 Ω**	**50 Ω**
No contact check failure	< 1.0 Ω	< 10.0 Ω	< 40.0 Ω
Always contact check failure	> 6.0 Ω	> 20.0 Ω	> 60.0 Ω

[10] Speed = 1 PLC.
[11] All specifications guaranteed with output ON.
[12] Accuracies apply to 2-wire and 4-wire modes when properly zeroed.
[13] Measure resolution 6.5 digits.
[14] Source readback enabled; offset compensation on.
[15] Source current, measure resistance or source voltage, measure resistance only.

PULSE SPECIFICATIONS

Minimum programmable pulse width	150 µs; Note: Time for settling or measuring may be longer than 150 µs
Maximum extended range pulse width	2.5 ms for the 7 A and lower ranges, 1 ms for the 10 A range
Maximum DC pulse width	10,000 seconds
Pulse width programming resolution	Variable; limited by pulse width and pulse-width jitter
Pulse width jitter	< (50 µs + 10 % of pulse width), typical, acquire readings = OFF
Maximum pulse duty cycle	10 % for 20 V and lower ranges, 5 % for 100 V range

TYPICAL PULSE PERFORMANCE (Best fixed range, 4-wire sense)

Source value	Limit range and value	Load	Rise time (10 % to 90 %)	Settling time (1 % of range)
100 V	10.5 A	10 Ω	300 µs	520 µs
100 V	1.05 A	200 Ω	180 µs	320 µs
20 V	10 A	2 Ω	150 µs	340 µs
10 A	105 V	10 Ω	300 µs	700 µs
7 A	7.35 V	1 Ω	120 µs	360 µs
5 A	10.5 V	2 Ω	110 µs	280 µs

DIGITIZER CHARACTERISTICS

Maximum resolution	18 bits
Available measurement functions	Voltage, current, simultaneous voltage and current, resistance, power
Sampling rate[16]	Programmable 1,000 through 1,000,000 samples per second
Volatile sample memory with timestamp	27,500,000
Minimum record time	1 µs
Timestamp resolution	1 ns with standard or full buffer style 1 µs with compact buffer style
Maximum record length	5,000,000
Range selection	Fixed-range required for digitizer measurements
Measurement settling time	Range and load dependent; accuracy limited by settling time for 10 mA and lower current ranges

[16] Sample rate is not continuously adjustable. For valid discrete settings, see the Model 2461 Reference Manual.

SUPPLEMENTAL SPECIFICATIONS

Overrange	105 % of range, source and measure		
Regulation	**Voltage** ▪ Line: 0.01 % of range ▪ Load: 0.01 % of range + 100 µV **Current** ▪ Line: 0.01 % of range ▪ Load: 0.01 % of range + 100 pA		
Source limits	**Voltage source current limit:** ▪ Bipolar current limit set with a single value ▪ Minimum value is 10 % of range **Current source voltage limit:** ▪ Bipolar voltage limit set with a single value ▪ Minimum value is 10 % of range		
V-limit and I-limit accuracy	Add 0.3 % of range and ±0.02 % of reading to base specification		
Overshoot	**Voltage source:** ▪ < 0.1 % typical ▪ Step size = Full scale, resistive load, 20 V range, 10 mA I-limit **Current source:** ▪ < 0.1 % typical ▪ Step size = 1 mA, R_{Load} = 10 kΩ, 20 V range		
Range change overshoot	Overshoot into a fully resistive 100 kΩ load, 10 Hz to 20 MHz bandwidth, adjacent ranges: < 250 mV typical		
Output settling time	Time required to reach within 0.1 % of final value: 20 V range, 100 mA I-limit: < 200 µs typical		
Maximum slew rate	1 V per µs, 100 V range, 100 mA limit into a 20 kΩ load (typical) 0.6 V per µs, 20 V range, 100 mA limit into a 20 kΩ load (typical)		
Overvoltage protection	User-selectable values, 5 % ±0.5 V tolerance; factory default = none		
Voltage source noise	10 Hz to 20 MHz (RMS): < 4.5 mV typical into a resistive load		
Common mode voltage	250 V DC		
Common mode isolation	> 1 GΩ, < 1000 pF		
Noise rejection (typical)	**NPLC**	**NMRR**	**CMRR**
	0.01	-----	60 dB
	0.1	-----	60 dB
	1	60 dB	100 dB

Load impedance	**Normal mode** ▪ 20 nF typical	**High-capacitance mode** ▪ Stable into 50 µF typical ▪ High-capacitance mode valid for ≥ 100 µA ranges
Maximum voltage drop between force and sense terminals	5 V	
Maximum force lead voltage drop	1 V	
Maximum sense lead resistance	1 MΩ for rated accuracy	
Sense input impedance	> 10 GΩ	
Guard offset voltage	< 300 µV typical	

SYSTEM MEASUREMENT SPEEDS[17]

Reading rates (readings per second) typical for 60 Hz (50 Hz), script (TSP®) programmed

NPLC	Trigger origin	Measure to memory	Measure to GPIB/USB/LAN	Source measure to memory	Source measure to GPIB/USB/LAN
0.01 NPLC	Internal	3050 (2800)	2800 (2500)	1700 (1600)	1650 (1550)
0.01 NPLC	External	2300 (2100)	2150 (2000)	1650 (1550)	1600 (1450)
0.1 NPLC	Internal	540 (460)	530 (450)	470 (410)	470 (400)
0.1 NPLC	External	500 (420)	500 (420)	460 (390)	450 (350)
1 NPLC	Internal	59 (49)	59 (49)	58 (48)	58 (48)
1 NPLC	External	58 (48)	58 (48)	57 (48)	57 (46)

[17] Reading rates applicable for voltage or current measurements, autozero off, autorange off, filter off, binary reading format, and source readback off.

Reading rates (readings per second) typical for 60 Hz (50 Hz), SCPI programmed

NPLC	Trigger origin	Measure to memory	Measure to GPIB/USB/LAN	Source measure to memory	Source measure to GPIB/USB/LAN
0.01 NPLC	Internal	3000 (2800)	3000 (2790)	1700 (1600)	1550 (1500)
0.01 NPLC	External	2330 (2150)	2330 (2150)	1650 (1550)	1500 (1450)
0.1 NPLC	Internal	540 (460)	540 (460)	470 (410)	460 (400)
0.1 NPLC	External	510 (430)	510 (430)	470 (400)	460 (390)
1 NPLC	Internal	59 (49)	59 (49)	58 (48)	58 (48)
1 NPLC	External	58 (49)	58 (49)	58 (48)	58 (48)

Digitize, typical

Sampling rate	Digits	Resolution, bits	Measure to USB
10 kS/s	5 ½	18	Up to 10 kS/s
20 kS/s	4 ½	16	Up to 20 kS/s
50 kS/s	4 ½	16	Up to 50 kS/s
100 kS/s	4 ½	15	Up to 100 kS/s
1 MS/s	3 ½	12	At least 100 kS/s
SCPI programmed; buffer style is compact.			

GENERAL CHARACTERISTICS

(Default mode unless specified)

Factory default standard power-up setting	**SCPI mode**
Source output modes	▪ Fixed DC level ▪ Memory/configuration list (mixed function) ▪ Sweep (linear and logarithmic) ▪ Sweep (dual linear and dual logarithmic)
Memory buffer	> 250,000 readings with selected measured values and timestamp
Real-time clock	Lithium battery backup (3 years plus battery life)
Remote interfaces	**GPIB:** IEEE Std 488.1 compliant; supports IEEE Std 488.2 common commands and status model topology **USB device (rear panel, type B):** 2.0 full-speed USBTMC **USB host (front panel, type A):** USB 2.0, support for flash drives, FAT32 **Ethernet:** RJ-45 connector, 10/100 BT
IP configuration	Static or DHCP
Expansion interface	The TSP-Link® expansion interface allows TSP-enabled instruments to trigger and communicate with each other

LXI compliance	LXI version 1.4 Core 2011	
TSP mode	Embedded Test Script Processor (TSP®) accessible from any host interface	
Display	Five-inch capacitive touch, color TFT WVGA (800 × 480) with LED backlight	
Input signal connections	**Front:** Banana **Rear:** Mass termination screw terminal	
Programmability	SCPI or TSP command sets	
Interlock	Active high-input	
Digital I/O	**Lines**	Six input/output, user-defined, for digital I/O or triggering
	Connector	9-pin female D
	Input signal levels	0.7 V (maximum logic low) 3.7 V (minimum logic high)
	Input voltage limits	−0.25 V (absolute minimum) +5.25 V (absolute maximum)
	Maximum source current	+2.0 mA at > 2.7 V (per pin)
	Maximum sink current	−50 mA at 0.7 V (per pin, solid-state fuse protected)
	5 V power supply pin	Limited to 500 mA at > 4 V (solid-state fuse protected)
	Handler	User-definable start of test, end of test, four category bits
Cooling	Forced air, variable speed	
Overtemperature protection	Internally sensed temperature overload puts instrument in standby mode	
Power supply	100 V to 240 V_{RMS}, 50 Hz to 60 Hz (automatically detected at power up)	
VA rating	350 V A maximum	
Altitude	Maximum 2000 meters (6562 feet) above sea level	
EMC	Conforms to European Union EMC Directive	
Safety	Compliance with CE and NRTL listed to UL61010-1 and UL61010-2-30 Conforms with European Union Low Voltage Directive	
Vibration	MIL-PRF-28800F Class 3 Random	
Warm up	One hour to rated accuracies	
Dimensions	**With handle and bumpers:** 106 mm × 255 mm × 425 mm deep (4.18 in. high × 10.05 in. wide × 16.75 in.) **Without handle and bumpers:** 88 mm × 213 mm × 397 mm deep (3.46 in. high × 8.39 in. wide × 15.63 in.)	
Weight	**With handle and bumpers:** 4.75 kg (10.5 lb) **Without handle and bumpers:** 4.55 kg (10.0 lb)	
Environment	**Operating:** 0 °C to 50 °C, 70 % relative humidity up to 35 °C; derate 3 % relative humidity per °C, 35 °C to 50 °C, noncondensing **Storage:** −25 °C to 65 °C	