# 2461-EC Graphical Potentiostat
Datasheet

The 2461-EC Graphical Potentiostat brings speed, flexibility, and simplicity right to your fingertips. Its innovative graphical user interface (GUI) and advanced, capacitive touchscreen technology allow intuitive usage and minimize the learning curve to enable researchers, scientists, and students to learn faster, work smarter, and invent easier. The 2461-EC is a versatile instrument, particularly well-suited for research and development in fundamental electrochemical lab research, characterizing the next generation of materials and electrolytes, new energy storage devices, and faster, smaller sensors.

Key Features

- Perform Cyclic, Squarewave, Galvanic Voltammetry, Chronoamperometry, and Chronopotentiometry
- Simplified user interface for faster test setup and analysis of results
- Real-time plotting of voltammograms on the front panel
- Analytical graph cursors for immediate analysis of results current without the need for a PC
- Create libraries of reusable, customizable experimental software with built-in scripting
- Screen capture function allows copying test results from the display to reports
- Wide coverage up to 105 V, 7 A DC/7 A pulse, 100 W max.
- Front panel input banana jacks; rear panel input mass termination screw connections
- Context-sensitive help function minimizes learning
- Front-panel USB 2.0 memory I/O port for transferring data, test scripts, or test configurations

While potentiostats are excellent instruments for electrochemistry applications, they typically lack any front panel display and control knobs, often are 2-quadrant systems only, and must be completely controlled by a computer with software that is not always open for users to customize tests beyond what the software can do.

The 2461-EC includes a wide range of voltages and currents for sourcing or measuring, µV/pA sensitivities, and high impedance sense leads with a typical input resistance of 50G ohms and only 1pA of input bias current, typically acceptable with a wide variety of reference electrodes. The 2461-EC can run internal application test scripts so electrochemistry measurements can be run without the use of an external computer. Results are immediately displayed right on the instrument front panel touchscreen. Connecting the 2461-EC to a 2-, 3-, or 4-electrode cell is simple with the included translation cable.

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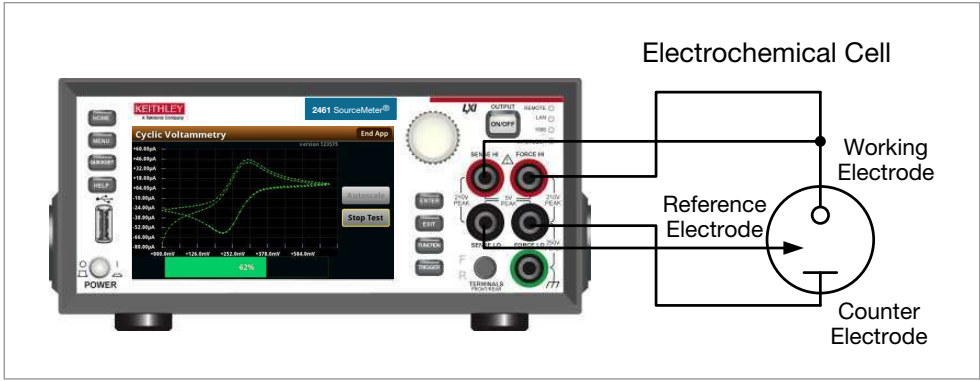
The 2461-EC can be easily connected to a 3-electrode cell.

Learn Faster; Work Smarter; Invent Easier

Unlike traditional potentiostats that lack a user-interface front panel to interact with, the 2461-EC features a five-inch, full-color, high resolution touchscreen that facilitates ease of use, and optimizes overall speed and productivity. Built-in, context-sensitive help enables intuitive operation and minimizes the need to review a separate manual. These capabilities combined with its application versatility make the 2461-EC inherently easy to use for basic and advanced measurement applications, regardless of your experience level with electrochemistry instruments.

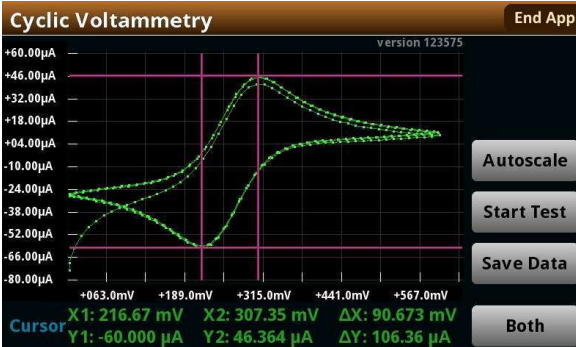## Convert Raw Data into Information

A full graphical plotting window converts raw data and displays it immediately as useful information, such as cyclic voltammograms. The touch screen interface makes it easy to observe, interact with, and explore measurements with "zoom and pinch" simplicity. By using the built-in graphing cursors, you can immediately analyze your data without a computer. All graphic screens can be saved to a USB thumb drive for incorporation into reports and journals. Using the graphical sheet view, test data can also be displayed in tabular form. The instrument supports exporting data to a spreadsheet for further analysis, dramatically improving productivity for research and development. This combination of high performance and high ease of use offers unparalleled insight into your test results.

2461-EC Cyclic Voltammetry Menu

2461-EC Cyclic Voltammetry Test Configuration Screen

Graph view of results

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READING TABLE

Buffer | Active (cvBuffer)

Buffer Index	Time	Reading	Source
1	10/25 13:35:32.968686	-0.07454 mA	+0.000000 V
2	10/25 13:35:33.229296	-0.06051 mA	+0.012000 V
3	10/25 13:35:33.469267	-0.05294 mA	+0.024000 V
4	10/25 13:35:33.709260	-0.04764 mA	+0.036000 V
5	10/25 13:35:33.949270	-0.04370 mA	+0.048000 V
6	10/25 13:35:34.209295	-0.04034 mA	+0.061000 V
7	10/25 13:35:34.449267	-0.03782 mA	+0.073000 V
8	10/25 13:35:34.689266	-0.03567 mA	+0.085000 V
9	10/25 13:35:34.929289	-0.03377 mA	+0.097000 V
10	10/25 13:35:35.189288	-0.03191 mA	+0.110000 V

Built-in real-time graphing, charting, scope-like cursors, and data display spreadsheet for export simplifies converting test results into useful information.

Test Applications

The 2461-EC's built-in scripting language enables electrochemists, chemists, and materials scientists to create libraries of reusable, customizable experimental software for running tests including cyclic voltammetry, chronoamperometry, chronopotentiometry, and more. The following electrochemistry test scripts are loaded in the internal memory of the 2461-EC.

- **Cyclic Voltammetry:** Potential is swept at a user programmable scan rate between two to four defined vertices while current is measured. Current is measured using an analog integration method. This application can also be used to perform Linear Sweep Voltammetry.

- **Open Circuit Potential:** Measures the cell potential difference between two electrodes with high input impedance as a function of time.

- **Potential Pulse and Square Wave with Current Measure:** The 2461-EC sources potential at programmable peak and base levels and the resulting current is recorded at the pulse peak level.

- **Current Pulse and Square Wave with Voltage Measure:** The 2461-EC sources current at programmable peak and base levels and the resulting potential is recorded at the pulse peak level.

- **Chronoamperometry:** The potential is stepped to a programmed value and the resulting current is measured as a function of time.

- **Chronopotentiometry:** The current is stepped to a programmed value and the resulting potential is measured as a function of time.

In addition to pre-loaded test scripts, the built-in scripting language enables the user to create their own library of electrochemistry test scripts that can be modified as the test and measurements evolve.

Typical Applications

Ideal for electrochemical research and development in a wide variety of applications studies, including:

- Basic Analytical Research
  - Electrochemical cells
  - Electrode studies
  - Solid electrolytes
- Materials Research
  - Electrode compositions
  - Electrolyte solutions
  - Ceramics, polymers, ferro/piezoelectrics
  - Organic semiconductors
  - Low-κ dielectrics
  - Biomaterials
  - Nanomaterials
  - Electrodeposition
- Energy Systems and Storage
  - Dye-sensitized solar cells
  - Batteries
  - Fuel cells, flow batteries
  - Supercapacitors
- Sensors
  - Environmental monitoring
  - Industrial process control
  - Healthcare/medical

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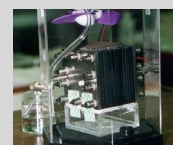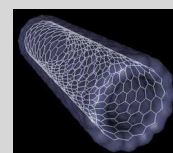
All-in-One Instrument

The 2461-EC offers a highly flexible, four-quadrant voltage and current source/load coupled with precision voltage and current meters. When not used in potentiostat type applications, this all-in one instrument can be repurposed as a general lab instrument, including use as a:

- Precision power supply with V and I readback
- True current source
- Digital multimeter (DCV, DCI, ohms, and power with 6½-digit resolution)
- Precision electronic load
- Trigger controller

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	100 V	10 A
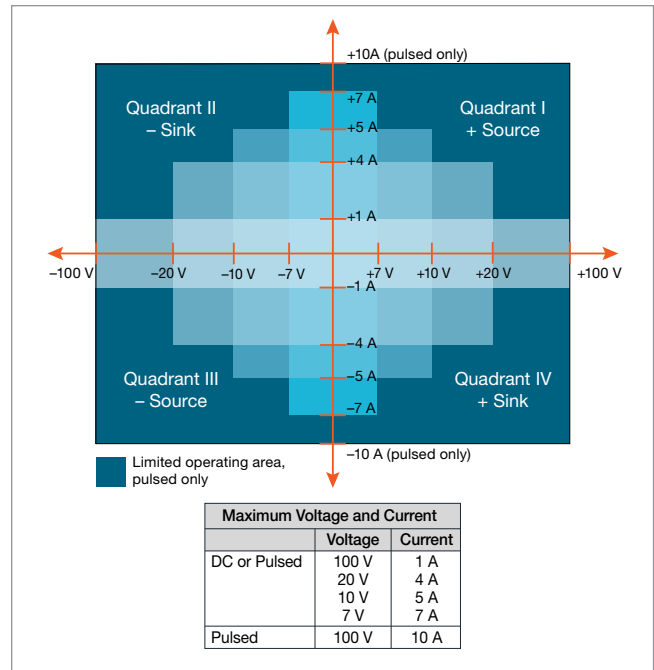
2461-EC power envelope.

Ease of Use Beyond the Touchscreen

In addition to its five-inch, color touchscreen, the 2461-EC front panel has many features that supplement its speed, user-friendliness, and learnability, including a USB 2.0 memory I/O port, a HELP key, a rotary navigation/control knob, a front/rear input selector button, and banana jacks for basic bench applications. The USB 2.0 memory port supports easy data storing, saving instrument configurations, loading test scripts, and system upgrades. Plus, all front panel buttons are backlit to enhance visibility in low-light environments.
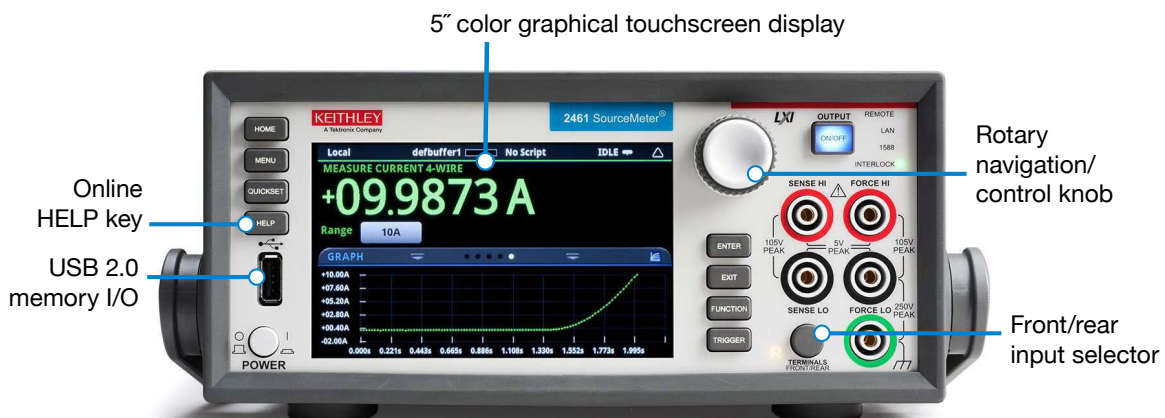
2461-EC front panel with high-resolution, capacitive touchscreen.

Comprehensive Built-in Connectivity

Rear panel access to rear-input connector, remote control interfaces (GPIB, USB 2.0, and LXI/Ethernet), D-sub 9-pin digital I/O port (for internal/external trigger signals and handler control), instrument interlock control, and TSP-Link® jacks enables easy configuration of multiple instrument test solutions and eliminates the need to invest in additional adapter accessories.

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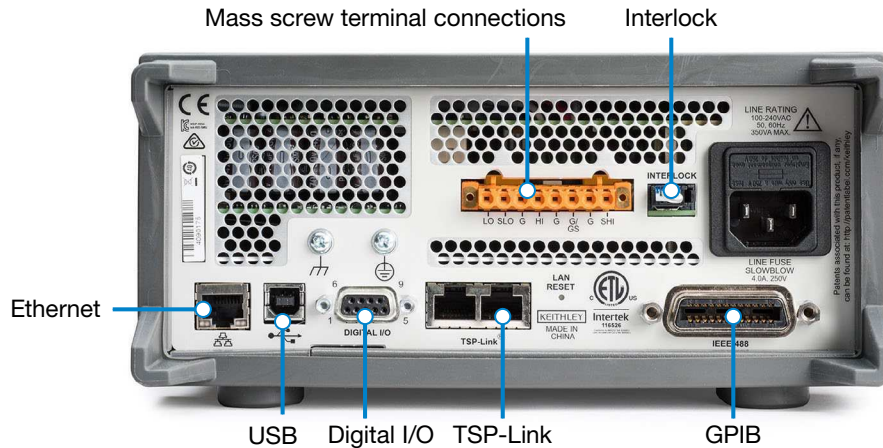
Rear panel connections are optimized for signal integrity.

Free Instrument Control Start-up Software

The 2461-EC can be repurposed for applications beyond electrochemistry as a general purpose lab tool, e.g. I-V testing, leakage testing, battery charge/discharge profiling, etc. KickStart, Keithley's instrument control non-programming start-up software, lets users start taking measurements in minutes for typical current versus voltage applications. In most cases, users merely need to make quick measurements, graph the data, and store the data to disk to perform analysis in software environments such as Excel.

KickStart offers the following functionality:

- Instrument configuration control to perform I-V characterization

- Native X-Y graphing, panning, and zooming
- Spreadsheet/tabular viewing of data
- Saving and exporting data for further analysis
- Saving of test setups
- Screenshot capturing of graph
- Annotation of tests
- Command line dialog for sending and receiving data
- HTML help
- GPIB, USB 2.0, Ethernet compliant

Simplified Programming with Ready-to-Use Instrument Drivers

For those who prefer to create their own customized application software, native National Instruments LabVIEW® drivers, as well as IVI-C and IVI-COM drivers are available at www.tektronix.com.
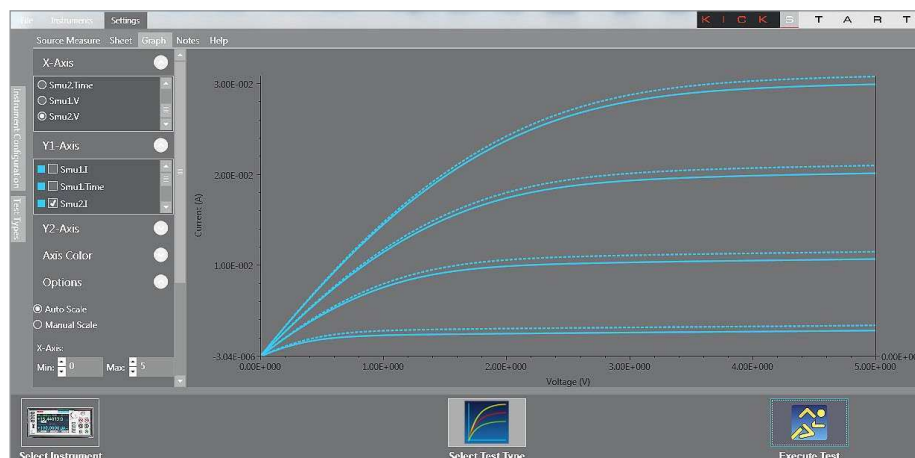
With KickStart start-up software, users are ready to take measurements in minutes.

Test Script Specifications

2461-EC Cyclic Voltammetry Specifications

Potential Range	−20 V ≤ E ≤ +20 V
Current Measure Ranges	1 mA, 10 mA, 100 mA, 1 A, 4 A, 5 A, 7 A
Source Limit (Compliance)	100% of selected current range
Scan Rate	0.1 mV/s to 3500 mV/s
Potential Step Size During Scanning	
	100 µV (0.1 mV/s ≤ scan rate < 35 mV/s) 1 mV (35 mV/s ≤ scan rate < 350 mV/s) 10 mV (350 mV/s ≤ scan rate ≤ 3500 mV/s)
Number of Cycles	1 to 100
User Selectable Sampling Intervals	Points/Test (10 to 10000) Points/Cycle (10 to 10000) Seconds/Point (0.01 to 100) Points/Second (0.01 to 100)
Maximum Total Number of Samples	100,000

2461-EC Open Circuit Potential Specifications

Potential Measure Ranges	200 mV, 2 V, 7 V, 10 V, 20 V
Sample Interval	0.75 s ≤ sample interval ≤ 100 s
Number of Samples	1 to 100,000

2461-EC Potential Pulse and Square Wave Specifications

Peak Potential	−20 V ≤ Epeak ≤ +20 V
Base Potential	−20 V ≤ Ebase ≤ +20 V
Current Measure Ranges	1 µA, 10 µA, 100 µA, 1 mA, 10 mA, 100 mA, 1 A, 4 A, 5 A, 7 A
Source Limit (Compliance)	105% of selected current range
Pulse Period and Width	
Current Measure Range = ≤100 µA	
	80 ms ≤ period ≤ 3600 s 40 ms ≤ pulse width ≤ (0.99 × period)
Current Measure Range > 100 µA	
	10 ms ≤ period ≤ 3600 s 5 ms ≤ pulse width ≤ (0.99 × period)
Sample Time	Minimum is 166.667 µs. Maximum is lesser of 166.667 ms and (pulse width − 1 ms)
Number of Cycles	1 to 100,000
Program Time	(1 × period) ≤ program time ≤ (100,000 × period)

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2461-EC Current Pulse and Square Wave Specifications

Peak Current	–7.35 A ≤ Ipeak ≤ +7.35 A
Base Current	–7.35A ≤ Ipeak ≤ +7.35A
Potential Measure Ranges	200 mV, 2 V, 7 V, 10 V, 20 V
Source Limit (Compliance)	105% of selected potential range
Pulse Period and Width	
Ipeak and Ibase ≤ 1.05 µA	80 ms ≤ period ≤ 3600 s 40 ms ≤ pulse width ≤ (0.99 × period)
Ipeak or Ibase > 1.05 µA	10 ms ≤ period ≤ 3600 s 5 ms ≤ pulse width ≤ (0.99 × period)
Sample Time	Minimum is 166.667 µs. Maximum is lesser of 166.667 ms and (pulse width – 1 ms)
Number of Cycles	1 to 100,000
Program Time	(1 × period) ≤ program time ≤ (100,000 × period)

2461-EC Chronoamperometry Specifications

Step Potential	–20 V ≤ Estep ≤ +20 V
Current Measure Ranges	1 µA, 10 µA, 100 µA, 1 mA, 10 mA, 100 mA, 1 A, 4 A, 5 A, 7 A
Source Limit (Compliance)	100% of selected current range
Number of Steps	1 to 10
Step Duration	10 ms ≤ step duration ≤ 99,999 s
Sample Interval	10 ms ≤ sample interval ≤ 100 s
Sample Time	Minimum is 166.667 µs. Maximum is lesser of 166.667 ms and (sample interval – 5 ms) and (step duration – 5 ms)
Maximum Number of Samples	100,000 total for all steps

2461-EC Chronopotentiometry Specifications

Step Current	–7.35 A ≤ Istep ≤ +7.35 A
Potential Measure Ranges	200 mV, 2 V, 7 V, 10 V, 20 V
Source Limit (Compliance)	100% of selected potential range
Number of Steps	1 to 10
Step Duration	10 ms ≤ step duration ≤ 99,999 s
Sample Interval	10 ms ≤ sample interval ≤ 100 s
Sample Time	Minimum is 166.667 µs. Maximum is lesser of 166.667 ms and (sample interval – 5 ms) and (step duration – 5 ms)
Maximum Number of Samples	100,000 total for all steps

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Specifications

Voltage Specifications [1, 2]

Range	Max. DC Current	Source			Measure [3]		
		Resolution	Accuracy (23° ±5°C), 1 Year ±(% setting+volts)	Noise (RMS) (<10 Hz)	Resolution[4]	Accuracy (23° ±5°C), 1 Year ±(% reading + volts)	Digitizer Accuracy [5] 23° ±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 % + 1mV	0.05 % + 8 mV
10.00000 V	5.25 A	250 µV	0.015 % + 2.4 mV	20 µV	10 µV	0.015 % + 1mV	0.05 % + 8 mV
20.00000 V	4.20 A	500 µV	0.015 % + 2.4 mV	20 µV	10 µV	0.015 % + 1mV	0.05 % + 8 mV
100.0000 V	1.05 A	2.5 mV	0.015 % + 15 mV	200 µV	100 µV	0.015 % + 5mV	0.05 % + 40 mV

Measure Input Resistance	>10 GΩ all ranges.
Temperature Coefficient	±(0.10 × accuracy specification)/°C, 0° to 18°C and 28° to 50°C.

Current Specifications [1, 2, 6]

Range	Max. DC Voltage	Source			Measure [3]		
		Resolution	Accuracy (23° ±5°C), 1 Year ±(% setting+amps)	Noise (RMS) (<10 Hz)	Resolution[4]	Accuracy (23° ±5°C), 1 Year ±(% reading + amps)	Digitizer Accuracy [5] 23° ±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 [7]	7.35 V	500 µA	0.150 % + 6 mA	125 µA	10 µA	0.150 % + 5 mA	0.15 % + 10 mA

Voltage Burden [8]	<100 µV all ranges.
Temperature Coefficient	±(0.10 × accuracy specification)/°C, 0° to 18°C and 28° to 50°C.

Notes

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 1µs intervals. Internal temperature within ±5°C and 1 week of ACAL.
6. Accuracy specifications guaranteed when using 2461-KIT screw terminal accessory for 2461.
7. 10 A range DC specifications valid up to 7.35 A. Operation >7.35 A 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.
8. 4-wire mode.

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Resistance Measurement Accuracy (Local or Remote Sense) [1, 2, 3]

Range	Resolution [4]	Default Test Current	Normal Accuracy (23°C ±5°C), 1 Year ±(% rdg. + ohms)	Enhanced Accuracy [5] (23°C ±5°C), 1 Year ±(% rdg. + ohms)
<2.000000 Ω [6]	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 % + 1 kΩ	0.12 % + 500 Ω
200.0000 MΩ	100 Ω	100 nA	1.04 % + 10 kΩ	0.74 % + 5 kΩ
>200.0000 MΩ [6]	—	User defined	Source I_{ACC} + Meas. V_{ACC}	Meas. I_{ACC} + Meas. V_{ACC}

Temperature Coefficient (0°–18°C and 28°–50°C)

±(0.10 × accuracy specification)/°C.

Source Current, Measure Resistance Mode

Total uncertainty = Isource accuracy + Vmeasure accuracy (4-wire remote sense).

Source Voltage, Measure Resistance Mode

Total uncertainty = Vsource accuracy + Imeasure accuracy (4-wire remote sense).

Notes

1. Speed = 1 PLC.
2. All specifications are guaranteed with output ON.
3. Accuracies apply to 2- and 4-wire mode when properly zeroed.
4. 6.5-digit measure resolution.
5. Source readback enabled. Offset compensation ON.
6. Source current, measure resistance or source voltage, measure resistance only.

Additional Pulse Mode Source Specifications

Minimum Programmable Pulse Width

150 µs. **Note:** Time for settling and/or measuring may be longer than 150 µs.

Maximum Extended Range Pulse Width

2.5 ms for 7 A and lower ranges, 1 ms for 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, A_{CQIN} Readings = OFF.

Maximum Pulse Duty Cycle   10% for 20 V and lower ranges, 5% for 100 V range.

Typical Pulse Performance (Best fixed range, 4W 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

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Contact Check

Contact Check Speed <100 μs for verification and notification.

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

Digitizer Characteristics

Maximum Resolution 18 bits.

Available Measurement Functions Voltage, Current, Simultaneous Voltage and Current, Resistance, Power.

Sampling Rate[1] Programmable 1 k through 1 million samples per second .

Volatile Sample Memory With Timestamp
27.5 million.

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 million.

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.

Notes

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

Supplemental Characteristics

Max. Output Power 105 W pulse, 105 W DC, four quadrant source or sink operation.

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 single value. Min. 10% of range.

    Current Source Voltage Limit Bipolar voltage limit set with single value. Min. 10% of range.

V/I-Limit Accuracy Add 0.3% of setting 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 step, RLoad = 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).

Over Voltage 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.

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Noise Rejection (Typical)

NPLC	NMRR	CMRR
0.01	—	60 dB
0.1	—	60 dB
1	60 dB	100dB

Load Impedance

Normal Mode	20 nF typical.
High Capacitance Mode	Stable into 50 µF typical. High-capacitance mode valid for ≥100 µA ranges.

Max. Voltage Drop Between Force and Sense Terminals
5 V.

Max. Force Lead Voltage Drop   1 V.

Max. Sense Lead Resistance   1 MΩ for rated accuracy.

Sense Input Impedance   >10 GΩ.

Guard Offset Voltage   <300 µV typical.

System Measurement Speeds [1]

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)

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)

Notes

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

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Digitize, Typical

Sampling Rate	Digits	Resolution, bits	Measure to USB
10 kS/s	5½	18	Up to 10 kS/s
20 kS/s	4½	16	Up to 20 kS/s
50 kS/s	4½	16	Up to 50 kS/s
100 kS/s	4½	15	Up to 100 kS/s
1 MS/s	3½	12	At least 100 kS/s

SCPI Programmed. Buffer style is compact.

General Characteristics (default mode unless specified)

Factory Default Standard Power-Up	SCPI Mode.
Source Output Modes	Fixed DC Level, Memory/Configuration List (mixed function), Sweep (linear and log), Sweep (dual linear and dual log).
Memory Buffer	>2 million readings, user adjustable. Includes selected measured value(s) and time stamp.
Real-Time Clock	Lithium battery backup (3 yr. + battery life).
Remote Interfaces	
GPIB	IEEE-488.2.
USB Device (rear panel, type B)	2.0 Full Speed USBTMC.
USB Device (front panel, type A)	USB 2.0, support for thumb drives.
Ethernet	RJ-45 (10/100BT)
Digital I/O Interface	
Lines	6 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. 0mA @ >2.7 V (per pin).
Maximum Sink Current	−50 mA @ 0.7 V (per pin, solid-state fuse protected).
5V Power Supply Pin	Limited to 500 mA @ >4 V (solid-state fuse protected).
Handler Interface	Start of test, end of test, 4 category bits.
Programmability	SCPI or TSP command sets.
TSP Mode	Embedded Test Script Processor (TSP) accessible from any host interface.
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	1.4 LXI Core 2011.
Display	Five-inch capacitive touch, color TFT WVGA (800×480) with LED backlight.
Input Signal Connections	**Front:** Banana. **Rear:** Mass termination screw terminal.
Interlock	Active high-input.
Cooling	Forced air, variable speed.
Over Temperature Protection	Internally sensed temperature overload puts unit in standby mode.
Power Supply	100 V to 240 V RMS, 50–60 Hz (automatically detected at power up).

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VA Rating	350 volt-amps max.
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	1 hour to rated accuracies.
Dimensions	**With handle and bumpers:** 106 mm high × 255 mm wide × 425 mm deep (4.18 in × 10.05 in × 16.75 in). **Without handle and bumpers:** 88 mm high × 213 mm wide × 397 mm deep (3.46 in × 8.39 in × 15.63 in.)
Weight	**With bumpers and handle:** 4.75 kg (10.5 lbs.). **Without bumpers and handle:** 4.55 kg (10.0 lbs.).
Environment	**Operating:** 0°–50°C, 70% R.H. up to 35°C. Derate 3% R.H./°C, 35°–50°C, non-condensing. **Storage:** –25°C to 65°C.

Supplied Accessories

Electrochemistry Translation Cable Accessory Kit	
2460-KIT	Rear Panel Mating Mass Terminated Screw Connector
8608	High Performance Test Leads
USB-B-1	USB Cable, Type A to Type B, 1m (3.3 ft)
CS-1616-3	Safety Interlock Mating Connector
CA-180-3A	TSP-Link/Ethernet Cable
Documentation CD	
2461 QuickStart Guide	
Test Script Builder Software (available at www.tektronix.com)	
KickStart Startup Software (available at www.tektronix.com)	
LabVIEW and IVI Drivers (available at www.tektronix.com)	

Available Accessories

Test Leads and Probes

1754	2-wire Universal 10-Piece Test Lead Kit
5805	Kelvin (4-Wire) Spring-Loaded Probes
5806	Kelvin Clip Lead Set
5808	Low Cost Single-pin Kelvin Probe Set
5809	Low Cost Kelvin Clip Lead Set
8605	High Performance Modular Test Leads
8606	High Performance Modular Probe Kit
8608	High Performance Clip Lead Set

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Cables, Connectors, Adapters

2461-BAN	Screw Terminal Connector to Banana Cable
2461-KIT	Mating Mass Termination Connector
8607	2-Wire, 1000 V Banana Cables, 1 m (3.3 ft.)
CS-1616-3	Safety Interlock Mating Connector

Communication Interfaces and Cables

7007-1	Shielded GPIB Cable, 1 m (3.3 ft)
7007-2	Shielded GPIB Cable, 1 m (6.6 ft)
CA-180-3A	CAT5 Crossover Cable for TSP-Link/Ethernet
KPCI-488LPA	IEEE-488 Interface for PCI Bus
KUSB-488B	IEEE-488 USB-to-GPIB Interface Adapter
USB-B-1	USB Cable, Type A to Type B, 1 m (3.3 ft)

Triggering and Control

2450-TLINK	DB-9 to Trigger Link Connector Adapter.
8501-1	Trigger Link Cable, DIN-to-DIN, 1 m (3.3 ft)
8501-2	Trigger Link Cable, DIN-to-DIN, 2 m (6.6 ft)

Rack Mount Kits

2450-BenchKit	Ears and Handle for 2450-NFP-RACK and 2450-RACK models
4299-8	Single Fixed Rack Mount Kit
4299-9	Dual Fixed Rack Mount Kit
4299-10	Dual Fixed Rack Mount Kit. Mount one 2450 and one Series 26xxB
4299-11	Dual Fixed Rack Mount Kit. Mount one 2450 and one Series 2400, Series 2000, etc.
2450-BenchKit	Ears and Handle for 2461-NFP-RACK and 2461-RACK models

Software Options

Kickstart	Instrument Control Software
ACS Basic Edition	Semiconductor Parametric Test Software for Component and Discrete Devices

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Available Services

2461-3Y-EW	1 Year Factory Warranty extended to 3 years from date of shipment
2461-5Y-EW	1 Year Factory Warranty extended to 5 years from date of shipment
C/2461-3Y-17025	KeithleyCare® 3 Year ISO 17025 Calibration Plan
C/2461-3Y-DATA	KeithleyCare 3 Year Calibration w/Data Plan
C/2461-3Y-STD	KeithleyCare 3 Year Std. Calibration Plan
C/2461-5Y-17025	KeithleyCare 5 Year ISO 17025 Calibration Plan
C/2461-5Y-DATA	KeithleyCare 5 Year Calibration w/Data Plan
C/2461-5Y-STD	KeithleyCare 5 Year Std. Calibration Plan
C/NEW DATA	Calibration Data for New Units
C/NEW DATA ISO	ISO-17025 Calibration Data for New Units
Vibration	MIL-PRF-28800F Class 3 Random.

Ordering Information

2461-EC	Graphical Potentiostat, 100 V, 10 A, 1000 W Instrument

Warranty Information

Warranty Summary	This section summarizes the warranties of the 2461. For complete warranty information, refer to the 2461 Reference Manual. Any portion of the product that is not manufactured by Keithley is not covered by this warranty and Keithley will have no duty to enforce any other manufacturer's warranties.
Hardware Warranty	Keithley Instruments, Inc. warrants the Keithley manufactured portion of the hardware for a period of one year from defects in materials or workmanship; provided that such defect has not been caused by use of the Keithley hardware which is not in accordance with the hardware instructions. The warranty does not apply upon any modification of Keithley hardware made by the customer or operation of the hardware outside the environmental specifications.
Software Warranty	Keithley warrants for the Keithley produced portion of the software or firmware will conform in all material respects with the published specifications for a period of ninety (90) days; provided the software is used on the product for which it is intended in accordance with the software instructions. Keithley does not warrant that operation of the software will be uninterrupted or error-free, or that the software will be adequate for the customer's intended application. The warranty does not apply upon any modification of the software made by the customer.

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