

2460-EC Graphical Potentiostats

Datasheet

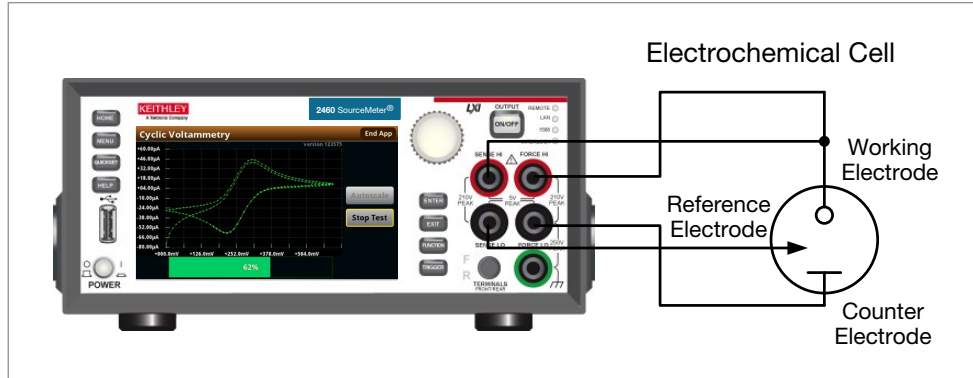


The 2460-EC Graphical Potentiostat brings speed, flexibility, and simplicity right to your fingertips. Its innovative graphical user interface (GUI) and advanced, capacitive touchscreen technology allow intuitive usage and minimize the learning curve to enable researchers, scientists, and students to learn faster, work smarter, and invent easier. The 2460-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 2460-EC includes a wide range of voltages and currents for sourcing or measuring, $\mu\text{V}/\text{pA}$ sensitivities, and high impedance sense leads with a typical input resistance of 50 G ohms and only 1 pA of input bias current, typically acceptable with a wide variety of reference electrodes. The 2460-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 2460-EC to a 2-, 3-, or 4-electrode cell is simple with the included translation cable.



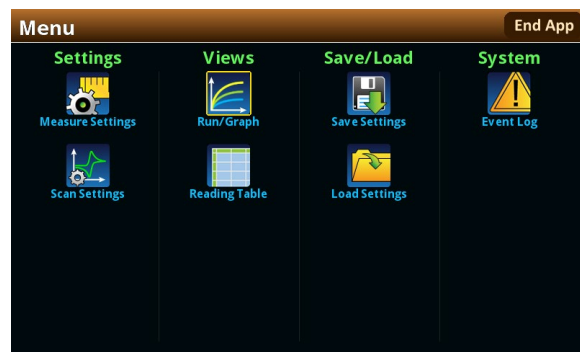
The 2460-EC can be easily connected to a 3-electrode cell.

Learn Faster; Work Smarter; Invent Easier

Unlike traditional potentiostats that lack a user-interface front panel to interact with, the 2460-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 2460-EC inherently easy to use for basic and advanced measurement applications, regardless of your experience level with electrochemistry instruments.

Convert Raw Data into Information

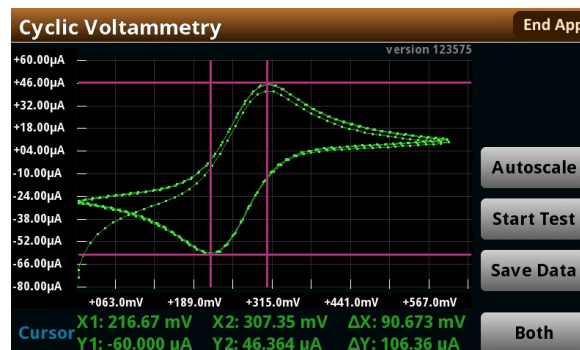
A full graphical plotting window converts raw data and displays it immediately as useful information, such as cyclic voltammograms. The touch screen interface makes it easy to observe, interact with, and explore measurements with “zoom and pinch” simplicity. By using the built-in graphing cursors, you 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.



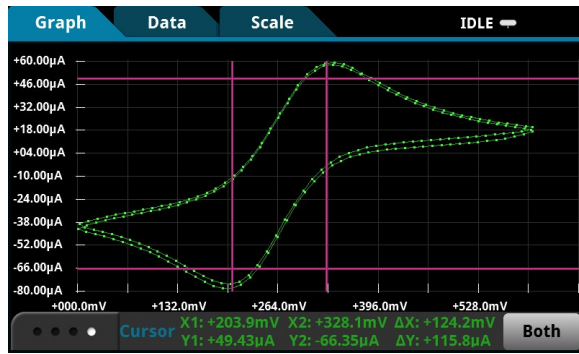
2460-EC Cyclic Voltammetry Menu



2460-EC Cyclic Voltammetry Test Configuration Screen



Graph view of results



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

| 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 |

Test Applications

The 2460-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 2460-EC.

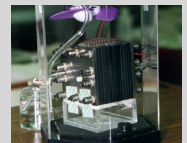
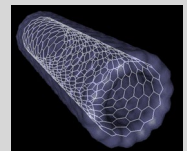
- **Cyclic Voltammetry:** Potential is swept at a user programmable scan rate between two to four defined vertices while current is measured. Current is measured using an analog integration method. This application can also be used to perform Linear Sweep Voltammetry.
- **Open Circuit Potential:** Measures 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 2460-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 2460-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:

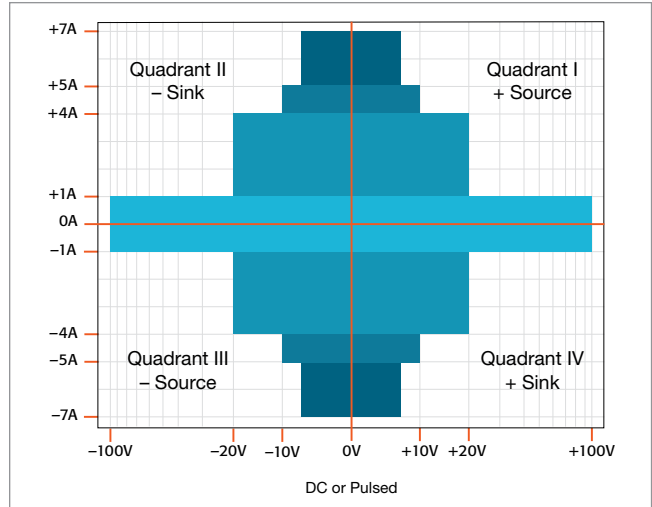
- Basic Analytical Research
 - Electrochemical cells
 - Electrode studies
 - Solid electrolytes
- Materials Research
 - Electrode compositions
 - Electrolyte solutions
 - Ceramics, polymers, ferro/ piezoelectrics
 - Organic semiconductors
 - Low-k dielectrics
 - Biomaterials
 - Nanomaterials
 - Electrodesposition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



All-in-One Instrument

The 2460-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:

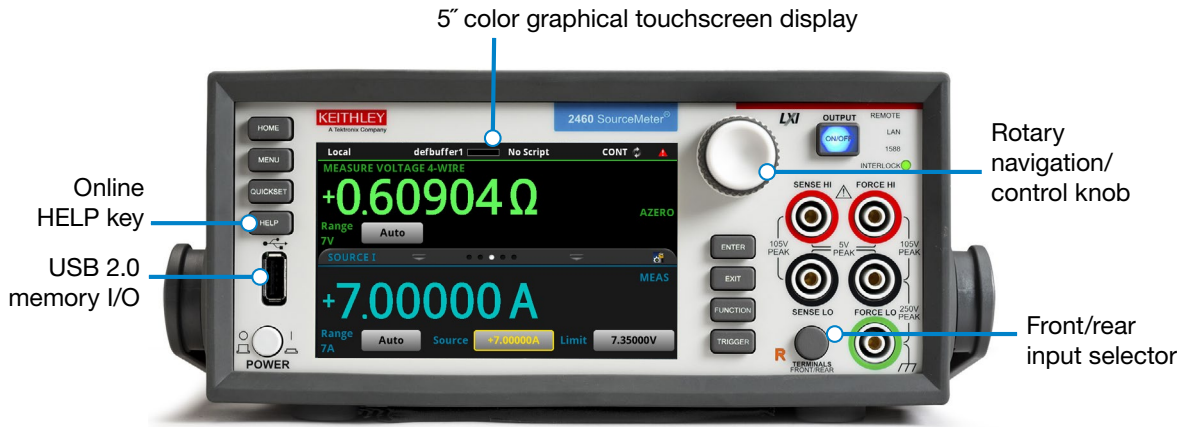
- Precision power supply with V and I readback
- True current source
- Digital multimeter (DCV, DCI, ohms, and power with 6½-digit resolution)
- Precision electronic load
- Trigger controller



2460-EC power envelope.

Ease of Use Beyond the Touchscreen

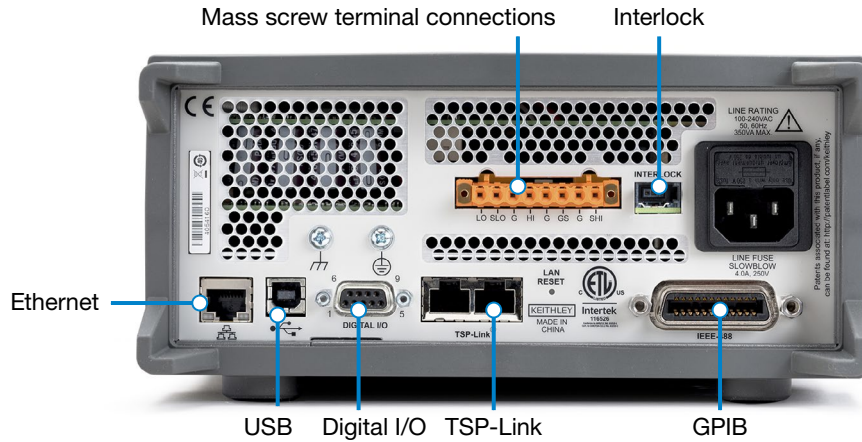
In addition to its five-inch, color touchscreen, the 2460-EC front panel has many features that supplement its speed, user-friendliness, and learnability, including a USB 2.0 memory I/O port, a HELP key, a rotary navigation/control knob, a front/rear input selector button, and banana jacks for basic 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.



2460-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.



Rear panel connections are optimized for signal integrity.

Free Instrument Control Start-up Software

The 2460-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.

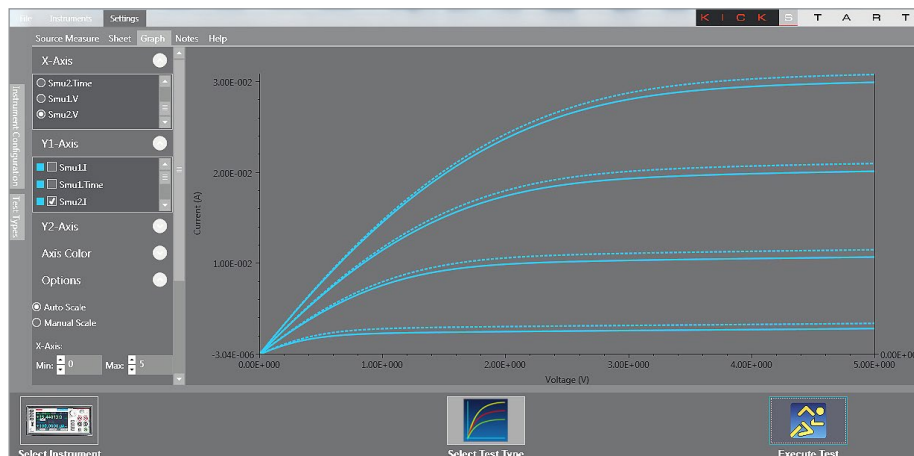
KickStart offers the following functionality:

- 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

2460-EC Cyclic Voltammetry Specifications

| | |
|-------------------------------------|--|
| Potential Range | $-20\text{ V} \leq E \leq +20\text{ V}$ |
| 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 ($0.1\text{ mV/s} \leq \text{scan rate} < 35\text{ mV/s}$) 1 mV ($35\text{ mV/s} \leq \text{scan rate} < 350\text{ mV/s}$) 10 mV ($350\text{ mV/s} \leq \text{scan rate} \leq 3500\text{ mV/s}$) |
| 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 |

2460-EC Open Circuit Potential Specifications

| | |
|--------------------------|---|
| Potential Measure Ranges | 200 mV, 2 V, 7 V, 10 V, 20 V |
| Sample Interval | $0.75\text{ s} \leq \text{sample interval} \leq 100\text{ s}$ |
| Number of Samples | 1 to 100,000 |

2460-EC Potential Pulse and Square Wave Specifications

| | |
|---------------------------|---|
| Peak Potential | $-20\text{ V} \leq E_{\text{peak}} \leq +20\text{ V}$ |
| Base Potential | $-20\text{ V} \leq E_{\text{base}} \leq +20\text{ V}$ |
| 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 | <p>Current Measure Range = 100 μA $80\text{ ms} \leq \text{period} \leq 3600\text{ s}$ $40\text{ ms} \leq \text{pulse width} \leq (0.99 \times \text{period})$</p> <p>Current Measure Range > 100 μA $10\text{ ms} \leq \text{period} \leq 3600\text{ s}$ $5\text{ ms} \leq \text{pulse width} \leq (0.99 \times \text{period})$</p> |
| 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 | $(1 \times \text{period}) \leq \text{program time} \leq (100,000 \times \text{period})$ |

2460-EC Current Pulse and Square Wave Specifications

| | |
|--|--|
| Peak Current | $-7.35A \leq I_{\text{peak}} \leq +7.35A$ |
| Base Current | $-7.35A \leq I_{\text{base}} \leq +7.35A$ |
| Potential Measure Ranges | 200 mV, 2V, 7V, 10V, 20V |
| Source Limit (Compliance) | 105% of selected potential range |
| Pulse Period and Width | |
| $I_{\text{peakI}} \text{ and } I_{\text{baseI}} \leq 1.05 \mu\text{A}$ | 80 ms \leq period \leq 3600 s 40 ms \leq pulse width \leq (0.99 \times period) |
| $I_{\text{peakI}} \text{ or } I_{\text{baseI}} > 1.05 \mu\text{A}$ | 10 ms \leq period \leq 3600 s 5 ms \leq pulse width \leq (0.99 \times 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 \times period) \leq program time \leq (100,000 \times period) |

2460-EC Chronoamperometry Specifications

| | |
|---------------------------|---|
| Step Potential | $-20 \text{ V} \leq E_{\text{step}} \leq +20 \text{ V}$ |
| 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 \leq step duration \leq 99,999 s |
| Sample Interval | 10 ms \leq sample interval \leq 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 |

2460-EC Chronopotentiometry Specifications

| | |
|---------------------------|---|
| Step Current | $-7.35A \leq I_{\text{step}} \leq +7.35A$ |
| Potential Measure Ranges | 20 mV, 200 mV, 2 V, 20 V |
| Source Limit (Compliance) | 100% of selected potential range |
| Number of Steps | 1 to 10 |
| Step Duration | 10 ms \leq step duration \leq 99,999 s |
| Sample Interval | 10 ms \leq sample interval \leq 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 |

Specifications

Voltage Specifications 1, 2

| Range | Max. Current | Source | | | Measure ³ | | |
|-------------|--------------|------------|--|----------------------|-------------------------|------------------|---|
| | | Resolution | Accuracy (23° ±5°C), 1 Year ±(% setting+volts) | Noise (RMS) (<10 Hz) | Resolution ⁴ | Input Resistance | Accuracy (23° ±5°C), 1 Year ±(% rdg. + volts) |
| 200.0000 mV | 7.35 A | 5 µV | 0.015 % + 200 µV | 1 µV | 100 nV | >10 GΩ | 0.012 % + 200µV |
| 2.000000 V | 7.35 A | 50 µV | 0.015 % + 300 µV | 10 µV | 1 µV | >10 GΩ | 0.012 % + 300µV |
| 7.000000 V | 7.35 A | 250 µV | 0.015 % + 2.4 mV | 100 µV | 1 µV | >10 GΩ | 0.015 % + 1 mV |
| 10.00000 V | 5.25 A | 500 µV | 0.015 % + 2.4 mV | 100 µV | 10 µV | >10 GΩ | 0.015 % + 1 mV |
| 20.00000 V | 4.20 A | 500 µV | 0.015 % + 2.4 mV | 100 µV | 10 µV | >10 GΩ | 0.015 % + 1 mV |
| 100.0000 V | 1.05 A | 2.5 mV | 0.015 % + 15 mV | 1 mV | 100 µV | >10 GΩ | 0.015 % + 5 mV |

Current Specifications 1, 2, 5

| Range | Max. Voltage | Source | | | Measure ³ | | |
|-------------|--------------|------------|---|----------------------|-------------------------|-----------------------------|--|
| | | Resolution | Accuracy (23° ±5°C), 1 Year ±(% setting + amps) | Noise (RMS) (<10 Hz) | Resolution ⁴ | Voltage Burden ⁶ | Accuracy (23° ±5°C), 1 Year ±(% rdg. + amps) |
| 1.000000 µA | 105 V | 50 pA | 0.025 % + 1 nA | 40 pA | 10 pA | <100 µV | 0.025 % + 700 pA |
| 10.00000 µA | 105 V | 500 pA | 0.025 % + 1.5 nA | 40 pA | 10 pA | <100 µV | 0.025 % + 1 nA |
| 100.0000 µA | 105 V | 5 nA | 0.020 % + 15 nA | 100 pA | 100 pA | <100 µV | 0.020 % + 10 nA |
| 1.000000 mA | 105 V | 50 nA | 0.020 % + 150 nA | 1 nA | 1 nA | <100 µV | 0.020 % + 100 nA |
| 10.00000 mA | 105 V | 500 nA | 0.020 % + 1.5 µA | 10 nA | 10 nA | <100 µV | 0.020 % + 1 µA |
| 100.0000 mA | 105 V | 5 µA | 0.020 % + 15 µA | 100 nA | 100 nA | <100 µV | 0.020 % + 10 µA |
| 1.000000 A | 105 V | 50 µA | 0.050 % + 750 µA | 5 µA | 1 µA | <100 µV | 0.050 % + 500 µA |
| 4.000000 A | 21 V | 250 µA | 0.100 % + 3 mA | 25 µA | 1 µA | <100 µV | 0.100 % + 2.5 mA |
| 5.000000 A | 10.5 V | 250 µA | 0.100 % + 3 mA | 25 µA | 1 µA | <100 µV | 0.100 % + 2.5 mA |
| 7.000000 A | 7.35 V | 500 µA | 0.150 % + 6 mA | 125 µA | 1 µA | <100 µV | 0.150 % + 5 mA |

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

±(0.10 × accuracy specification)/°C.

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. Accuracy specifications guaranteed when using 2460-KIT screw terminal accessory.
6. Four-wire mode.

Resistance Measurement Accuracy (Local or Remote Sense) ^{1, 2, 3}

| Range | Default 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} |
| 20.000000 Ω | 10 μΩ | 100 mA | 0.05 % + 0.003 Ω | 0.04 % + 0.001 Ω |
| 200.00000 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 |
| >20.0000 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 = 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).

Notes

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

Supplemental Characteristics**Max. Output Power** 100 W, four-quadrant source or sink operation.**Source Limits****V_{source}** ±7.35 V (≤7 A range), ±10.5 V (≤5 A range), ±21 V (≤4 A range), ±105 V (≤1 A range).**I_{source}** ±7.35 A (≤7 V range), ±5.25 mA (≤10 V range), ±4.2 A (≤20 V range), ±1.05 mA (≤100 V range).**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-Limit / I-Limit Accuracy** Add 0.3% of setting and ±0.02% of reading to base specification.**Overshoot****Voltage Source** <0.1% typical (full scale step, resistive load, 20 V range, 10 mA I-Limit).**Current Source** <0.1% typical (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 BW, adjacent ranges: <250 mV typical**Output Settling Time** Time required to reach 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% ±0.5V tolerance. Factory default = none.

Voltage Source Noise 10 Hz–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-C mode valid for ≥100 μA ranges.

Max. Voltage Drop Between Force and Sense Terminals
5 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 60Hz (50Hz), 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 60Hz (50Hz), 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.

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 logarithmic), Sweep (dual linear and dual logarithmic). |
| Memory Buffer | >250,000 readings. Includes selected measured value(s) and time stamp. |
| Real-Time Clock | Lithium battery backup (3 yr. + battery life). |
| Remote Interfaces | |
| GPIB | IEEE-488.1 compliant. Supports IEEE-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 (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 (Abs. minimum), +5.25 V (Abs. maximum) |
| Maximum Source Current | +2.0 mA @ >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 | User definable 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 | 5 inch capacitive touch, color TFT WVGA (800x480) 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). |
| VA Rating | 350 volt-amps max. |
| Altitude | Maximum 2000 meters 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: 4.35 kg (9.6 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 |
| CA-180-3A | TSP-Link/Ethernet Cable |
| CS-1616-3 | Safety Interlock Mating Connector |
| USB-B-1 | USB Cable, Type A to Type B, 1 m (3.3 ft) |

Documentation CD

Application Test Scripts and Documentation on USB Flash Drive

SMU Potentiostats and EC-Upgrade Kit Quick Start 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 |

Cables, Connectors, Adapters

| | |
|-----------|---|
| 2460-BAN | Screw Terminal Connector to Banana Cable |
| 2460-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. |

Test Fixtures

| | |
|----------|-----------------|
| 8101-PIV | DC Test Fixture |
|----------|-----------------|

Software Options

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

Available Services

| | |
|-----------------|---|
| 2460-3Y-EW | 1 Year Factory Warranty extended to 3 years from date of shipment |
| 2460-5Y-EW | 1 Year Factory Warranty extended to 5 years from date of shipment |
| C/2460-3Y-17025 | KeithleyCare® 3 Year ISO 17025 Calibration Plan |
| C/2460-3Y-DATA | KeithleyCare 3 Year Calibration w/Data Plan |
| C/2460-3Y-STD | KeithleyCare 3 Year Std. Calibration Plan |
| C/2460-5Y-17025 | KeithleyCare 5 Year ISO 17025 Calibration Plan |
| C/2460-5Y-DATA | KeithleyCare 5 Year Calibration w/Data Plan |
| C/2460-5Y-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 |

Ordering Information

2460-EC

Graphical Potentiostat, 105 V, 7 A, 100 W Instrument

Warranty Information

Warranty Summary

This section summarizes the warranties of the 2460. For complete warranty information, refer to the 2460 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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