2450-EC Electrochemistry Lab System

- Lower cost alternative to potentiostats
- Perform Cyclic, Squarewave, or 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 without the need for a PC
- Create libraries of reusable, customizable experimental software with built-in open source scripting
- Screen capture function allows copying test results from the display to reports
- 10nV and 10fA measurement sensitivity
- Front panel input banana jacks; rear panel input triaxial connections
- Context-sensitive help function minimizes learning
- Front-panel USB 2.0 memory I/O port for transferring data, test scripts, or test configurations

The 2450-EC Electrochemistry Lab System is Keithley’s low cost alternative to traditional electrochemistry potentiostats. The 2450-EC 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 2450-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.

The Keithley 2450-EC Electrochemistry Lab System: A Low Cost Alternative to the Potentiostat

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.

Keithley’s 2450-EC is a smart alternative as a DC/low frequency potentiostat. The 2450-EC has features that, in many cases, can perform as well as a potentiostat at lower cost including a wide range of voltages and currents for sourcing or measuring, nV / fA 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 2450-EC can run internal application test scripts so electrochemistry measurements can be run without the use of an external computer. Results (graphs) are immediately displayed right on the instrument front panel touchscreen. Connecting the 2450-EC to a 2-, 3-, or 4-electrode cell to perform the same tests as a potentiostat is simple with the included translation cable.

The 2450-EC can be easily connected to a 3-electrode cell.
2450-EC Electrochemistry Lab System

**Ordering Information**

2450-EC Electrochemistry Lab System, 200V, 1A, 20W Instrument

**Accessories Supplied**

- Electrochemistry Translation Cable
- Accessory Kit
- 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
- Application Test Scripts and Documentation
- 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)

**Learn Faster; Work Smarter; Invent Easier**

Unlike traditional potentiostats that lack a user-interface front panel to interact with, the 2450-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 2450-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 voltamograms. 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.

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 2450-EC’s built-in open source scripting enables electrochemists, chemists, and materials scientists to create libraries of reusable, customizable experimental software for running tests including cyclic voltammetry, chronamperometry, chronopotentiometry, and more. The following electrochemistry test scripts are loaded in the internal memory of the 2450-EC.

- **Cyclic Voltammetry:** Potential is swept at a user programmable scan rate between two to four defined vertices while current is measured.

- **Linear Sweep Voltammetry:** Potential is swept at a user programmable scan rate between two defined points while current is measured.

- **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 2450-EC sources potential at programmable peak and base levels while current is recorded at a user-defined position on the pulse peak level.

- **Current Pulse and Square Wave with Voltage Measure:** The 2450-EC sources current at programmable peak and base levels while potential is recorded at a user-defined position on the pulse peak level.

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

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

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

All-in-One Instrument
The 2450-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

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

![2450-EC power envelope.](image)
Ease of Use Beyond the Touchscreen

In addition to its five-inch, color touchscreen, the 2450-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.

Comprehensive Built-in Connectivity

Rear panel access to rear-input triax connectors, 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.

Free Instrument Control Start-up Software

The 2450-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](http://www.tektronix.com).

### Test Script Specifications

#### CYCLIC VOLTAMMETRY

- **Potential Range:** ±5V
- **Voltage Step Size During Ramping:**
  - 100mV (0.1mV/s ≤ scan rate < 35mV/s)
  - 1mV (35mV/s ≤ scan rate < 350mV/s)
  - 10mV (350mV/s ≤ scan rate < 3500mV/s)
- **Scan Rate:** 0.1mV/s to 3500mV/s
- **Current Measurement Range (full scale):** 100µA, 1mA, 10mA, 100mA, 1A
- **Number of Cycles:** 1 to 100
- **User Selectable Sampling Interval Units:** Points/Cycle, Seconds/Point, Points/Second, mV/Point, Points/mV, mA/Point, Points/mA
- **Maximum number of readings:** up to 100,000

#### OPEN CIRCUIT POTENTIAL

- **Range:** 0.02 V, 0.2 V, 2 V, 20 V
- **Number of Samples:** 1 ≤ n ≤ 100,000
- **Measure Interval:** 0.75s ≤ measurement interval ≤ 100s

#### POTENTIAL PULSE AND SQUARE WAVE

- **Peak Potential:** Vpeak ≤ ±20 V
- **Base Potential:** Vbase ≤ ±20 V
- **Current Ranges:** 1 µA, 10 µA, 100 µA, 1 mA, 10 mA, 100 mA, 1A
- **Pulse Period and Width:**
  - Irange = 1 µA
    - 200 ms ≤ period ≤ 3600 s
    - 100 ms ≤ pulse width ≤ (0.999 × period)s
  - Irange = 10 µA, 100 µA, 1 mA, 10 mA, 100 mA, 1 A
    - 4 ms ≤ period ≤ 3600 s
    - 2 ms ≤ pulse width ≤ (0.999 × period)s
- **Number of Cycles:** 1 ≤ n ≤ 100,000
- **Program Time:** 10 ms ≤ program time ≤ (100,000 × period)s
- **Sample Time:** 0.01 PLC ≤ sample time ≤ 10 PLC & sample time ≤ (pulse width - 0.001)s

#### CURRENT PULSE AND SQUARE WAVE

- **Peak and Base Current:** Ipeak ≤ ±1A, Ibase ≤ ±1A
- **Potential Ranges:** 0.02 V, 0.2 V, 2 V, 20 V
- **Pulse Period and Width:**
  - Ipeak ≤ 1.05 µA
    - 200 ms ≤ period ≤ 3600 s
    - 100 ms ≤ pulse width ≤ (0.999 × period)s
  - 1.05 µA < Ipeak ≤ 1 A
    - 4 ms ≤ period ≤ 3600 s
    - 2 ms ≤ pulse width ≤ (0.999 × period)s
- **Number of Cycles:** 1 ≤ n ≤ 100,000
- **Program Time:** 10 ms ≤ program time ≤ (100,000 × period)s
- **Sample Time:** 0.01 PLC ≤ sample time ≤ 10 PLC & sample time ≤ (pulse width - 0.001)s

#### CHRONOAMPEROMETRY

- **Step Potential:** Vstep ≤ ±20 V
- **Current Ranges:** 10 nA, 100 nA, 1 µA, 10 µA, 100 µA, 1 mA, 10 mA, 100 mA, 1A
- **Step Duration:** 10 ms ≤ step duration ≤ 99,999 s
- **Measurement Interval:** 10 ms ≤ measurement interval ≤ 100 s
- **Sample Period:** 0.01 PLC ≤ sample period ≤ 10 PLC & sample period ≤ (measurement interval - 0.005)s & sample period ≤ (t – 0.005)s

#### CHRONOPOTENTIOMETRY

- **Step Current:** Istep ≤ ±1.05 A
- **Potential Ranges:** 0.02 V, 0.2 V, 2 V, 20 V
- **Step Duration:** 10 ms ≤ step duration ≤ 99,999 s
- **Measurement Interval:** 10 ms ≤ measurement interval ≤ 100 s
- **Sample Period:** 0.01 PLC ≤ sample period ≤ 10 PLC & sample period ≤ (measurement interval - 0.005)s & sample period ≤ (t – 0.005)s

### ACCESSORIES AVAILABLE

#### TEST LEADS AND PROBES

- **237-ALG-2**: 3-slot Male Triax Connector to 3 Alligator Clips
- **237-BAN-3A**: Triax to Banana Plug
- **2450-TRX-BAN**: Triax to Banana Adapter. Converts the 4 Triax adapters on the rear panel to 5 banana jacks
- **7078-TRX**: 3-slot, Low Noise Triax Cable
- **7078-TRX-GND**: 3-slot Male Triax To BNC Adapter (guard removed)
- **8607**: 2-wire, 1000V Banana Cables, 1m (3.3 ft)
- **CA-18-1**: Shielded Dual Banana Cable, 1.2m (4 ft)
- **CAP-31**: Protective Shield/Cap for 3-lug Triax Connectors
- **CS-1546**: Triax 3-lug Special Shorting Plug, Shorts center pin to outer shield
- **CS-1616-3**: Safety Interlock Mating Connector

#### COMMUNICATION INTERFACES & CABLES

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

#### TRIGGERING AND CONTROL

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

#### RACK MOUNT KITS

- **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 2450-NFP-RACK and 2450-RACK models

### SERVICES AVAILABLE

- **2450-EC-3Y-EW**: 1 Year Factory Warranty extended to 3 years from date of shipment
- **2450-EC-5Y-EW**: 1 Year Factory Warranty extended to 5 years from date of shipment
- **C/2450-5Y-STD**: KeithleyCare® 3 Year ISO 17025 Calibration Plan
- **C/2450-5Y-DATA**: KeithleyCare® 5 Year Calibration w/Data Plan
- **C/2450-5Y-17025**: KeithleyCare® 3 Year ISO 17025 Calibration Plan
- **C/2450-3Y-17025**: KeithleyCare® 3 Year ISO 17025 Calibration Plan
- **C/2450-BASIC-LEVEL**: KeithleyCare® Yearly Basic Level Service Plan
- **C/2450-BASIC-PLATINUM**: KeithleyCare® Yearly Platinum Service Plan
- **C/2450-3Y-DATA**: KeithleyCare® 3 Year Calibration w/Data Plan
- **C/2450-3Y-17025**: KeithleyCare® 3 Year ISO 17025 Calibration Plan
- **C/2450-STD**: KeithleyCare® Yearly Standard Service Plan
- **C/New Data**: Calibration Data for New Units
- **C/New Data ISO**: ISO-17025 Calibration Data for New Units
### Voltage Specifications

<table>
<thead>
<tr>
<th>Range</th>
<th>Resolution</th>
<th>Accuracy (23° ±5°C)</th>
<th>Noise (RMS)</th>
<th>Accuracy (23° ±5°C)</th>
<th>Input Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.0000 mV</td>
<td>500 nV</td>
<td>0.10% + 200 µV</td>
<td>1 µV</td>
<td>10 mV</td>
<td>&gt;10 GΩ</td>
</tr>
<tr>
<td>200.0000 mV</td>
<td>5 pA</td>
<td>0.015% + 200 µV</td>
<td>1 µV</td>
<td>100 mV</td>
<td>&gt;10 GΩ</td>
</tr>
<tr>
<td>2.00000 V</td>
<td>50 µV</td>
<td>0.025% + 300 µV</td>
<td>10 µV</td>
<td>1 mV</td>
<td>&gt;10 GΩ</td>
</tr>
<tr>
<td>20.0000 V</td>
<td>500 µV</td>
<td>0.015% + 2.4 mV</td>
<td>100 µV</td>
<td>100 mV</td>
<td>&gt;10 GΩ</td>
</tr>
<tr>
<td>200.0000 V</td>
<td>5 µV</td>
<td>0.015% + 24 mV</td>
<td>1 µV</td>
<td>1000 mV</td>
<td>&gt;10 GΩ</td>
</tr>
</tbody>
</table>

#### Resistance Measurement Accuracy (Local or Remote Sense)

<table>
<thead>
<tr>
<th>Range</th>
<th>Default Resolution</th>
<th>Default Test Current</th>
<th>Normal Accuracy (23°C ±5°C)</th>
<th>Enhanced Accuracy (23°C ±5°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 Year ±(% rdg. + ohms)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;0.000001 MΩ</td>
<td>1 µΩ</td>
<td>100 nA</td>
<td>±0.008% + 0.003 MΩ</td>
<td>±0.073% + 0.001 MΩ</td>
</tr>
<tr>
<td>0.000001 MΩ</td>
<td>10 µΩ</td>
<td>100 pA</td>
<td>±0.077% + 0.03 MΩ</td>
<td>±0.053% + 0.01 MΩ</td>
</tr>
<tr>
<td>0.00001 MΩ</td>
<td>100 µΩ</td>
<td>100 nA</td>
<td>±0.068% + 0.3 MΩ</td>
<td>±0.045% + 0.1 MΩ</td>
</tr>
<tr>
<td>0.0001 MΩ</td>
<td>1 mΩ</td>
<td>100 µA</td>
<td>±0.063% + 3 Ω</td>
<td>±0.043% + 1 Ω</td>
</tr>
<tr>
<td>0.01 MΩ</td>
<td>10 mΩ</td>
<td>100 µA</td>
<td>±0.065% + 30 Ω</td>
<td>±0.046% + 10 Ω</td>
</tr>
<tr>
<td>0.1 MΩ</td>
<td>100 µΩ</td>
<td>100 µA</td>
<td>±0.11% + 300 Ω</td>
<td>±0.045% + 100 Ω</td>
</tr>
<tr>
<td>1 MΩ</td>
<td>10 Ω</td>
<td>1 µA</td>
<td>±0.11% + 1000 Ω</td>
<td>±0.052% + 500 Ω</td>
</tr>
<tr>
<td>10 MΩ</td>
<td>100 Ω</td>
<td>100 nA</td>
<td>±0.655% + 10 kΩ</td>
<td>±0.349% + 5000 MΩ</td>
</tr>
<tr>
<td>&gt;20 MΩ</td>
<td>—</td>
<td>—</td>
<td>Source IACC + Meas. Vcc</td>
<td>Meas. IACC + Meas. Vcc</td>
</tr>
</tbody>
</table>

#### Operating Characteristics

- **MAX. OUTPUT POWER**: 20W, four-quadrant source or sink operation.
- **SOURCE/SINK LIMITS**: Vsource = ±20V @ ±1.00A, ±200V @ ±100mA.
- **Isource**: ±1.00A @ ±20V, ±100mA @ ±20V.
- **REGULATION**: Voltage: 0.01% of range. Load: 0.01% of range + 100µA.
- **CURRENT**: 0.01% of range. Load: 0.01% of range + 100µA.
- **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.
- **OVERSHOOT**: Voltage Source: <0.1% typical (full scale step, resistive load, 20V range, 10mA I-Limit).
- **Current Source**: <0.1% typical (1mA step, Rsource = 10kΩ, 20V range).
- **VOLTAGE SOURCE**: Noise 10Hz–1MHz (RMS): 2mV typical into a resistive load.
- **OVER VOLTAGE PROTECTION**: User selectable values, 5% tolerance. Factory default = none.
- **OUTPUT SETTLING TIME**: Time required to reach 0.1% of final value. 20V range, 100mA I-Limit: <200µs typical.
- **MAXIMUM SLEW RATE**: 20V/µs.
- **V/I-LIMIT ACCURACY**: Add 0.3% of setting and ±0.02% of reading to base specification.
- **RANGE CHANGE OVERSHOOT**: Overshoot into a fully resistive 100kΩ load, 10Hz to 1MHz BW, adjacent ranges: 100mV typical.

### Current Specifications

<table>
<thead>
<tr>
<th>Range</th>
<th>Resolution</th>
<th>Accuracy (23° ±5°C)</th>
<th>Noise (RMS)</th>
<th>Accuracy (23° ±5°C)</th>
<th>Input Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.0000 nA</td>
<td>500 fA</td>
<td>0.100% + 100 pA</td>
<td>500 fA</td>
<td>±0.10% + 50 pA</td>
<td>&lt;10 GΩ</td>
</tr>
<tr>
<td>100.0000 nA</td>
<td>5 pA</td>
<td>0.060% + 150 pA</td>
<td>100 pA</td>
<td>±0.06% + 100 pA</td>
<td>&lt;10 GΩ</td>
</tr>
<tr>
<td>1.00000 µA</td>
<td>50 pA</td>
<td>0.025% + 400 pA</td>
<td>500 pA</td>
<td>±0.025% + 300 pA</td>
<td>&lt;10 GΩ</td>
</tr>
<tr>
<td>10.00000 µA</td>
<td>500 pA</td>
<td>0.025% + 1.5 nA</td>
<td>1000 pA</td>
<td>±0.025% + 700 pA</td>
<td>&lt;10 GΩ</td>
</tr>
<tr>
<td>100.0000 µA</td>
<td>5 nA</td>
<td>0.020% + 15 nA</td>
<td>100 nA</td>
<td>±0.020% + 6 nA</td>
<td>&lt;10 GΩ</td>
</tr>
<tr>
<td>1.000000 A</td>
<td>50 nA</td>
<td>0.020% + 150 nA</td>
<td>1000 nA</td>
<td>±0.020% + 60 nA</td>
<td>&lt;10 GΩ</td>
</tr>
<tr>
<td>10.000000 A</td>
<td>500 nA</td>
<td>0.020% + 1.5 µA</td>
<td>10000 nA</td>
<td>±0.020% + 600 nA</td>
<td>&lt;10 GΩ</td>
</tr>
<tr>
<td>100.00000 A</td>
<td>5 µA</td>
<td>0.025% + 15 µA</td>
<td>1000 µA</td>
<td>±0.025% + 6 µA</td>
<td>&lt;10 GΩ</td>
</tr>
<tr>
<td>1.0000000 A</td>
<td>50 µA</td>
<td>0.020% + 150 µA</td>
<td>10000 µA</td>
<td>±0.020% + 600 µA</td>
<td>&lt;10 GΩ</td>
</tr>
</tbody>
</table>

#### Temperature Coefficient (0°–18°C and 28°–50°C): ±(0.15 x accuracy specification)/°C.
System Measurement Speeds

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

<table>
<thead>
<tr>
<th>NPLC</th>
<th>Trigger Origin</th>
<th>Measure to Memory</th>
<th>Measure to GPIB/USB/LAN</th>
<th>Source Measure to Memory</th>
<th>Source Measure to GPIB/USB/LAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01 NPLC</td>
<td>Internal</td>
<td>3050 (2800)</td>
<td>2800 (2500)</td>
<td>1700 (1600)</td>
<td>1650 (1550)</td>
</tr>
<tr>
<td>0.01 NPLC</td>
<td>External</td>
<td>2300 (2100)</td>
<td>2150 (2000)</td>
<td>1650 (1550)</td>
<td>1600 (1450)</td>
</tr>
<tr>
<td>0.1 NPLC</td>
<td>Internal</td>
<td>540 (460)</td>
<td>530 (450)</td>
<td>470 (410)</td>
<td>470 (400)</td>
</tr>
<tr>
<td>0.1 NPLC</td>
<td>External</td>
<td>500 (420)</td>
<td>500 (420)</td>
<td>460 (390)</td>
<td>450 (350)</td>
</tr>
<tr>
<td>1 NPLC</td>
<td>Internal</td>
<td>59 (49)</td>
<td>59 (49)</td>
<td>56 (48)</td>
<td>58 (48)</td>
</tr>
<tr>
<td>1 NPLC</td>
<td>External</td>
<td>58 (48)</td>
<td>58 (48)</td>
<td>57 (48)</td>
<td>57 (48)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>NPLC</th>
<th>Trigger Origin</th>
<th>Measure to Memory</th>
<th>Measure to GPIB/USB/LAN</th>
<th>Source Measure to Memory</th>
<th>Source Measure to GPIB/USB/LAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01 NPLC</td>
<td>Internal</td>
<td>3000 (2800)</td>
<td>3000 (2790)</td>
<td>1700 (1600)</td>
<td>1550 (1500)</td>
</tr>
<tr>
<td>0.01 NPLC</td>
<td>External</td>
<td>2330 (2150)</td>
<td>2330 (2150)</td>
<td>1650 (1550)</td>
<td>1500 (1450)</td>
</tr>
<tr>
<td>0.1 NPLC</td>
<td>Internal</td>
<td>540 (460)</td>
<td>540 (460)</td>
<td>470 (410)</td>
<td>460 (400)</td>
</tr>
<tr>
<td>0.1 NPLC</td>
<td>External</td>
<td>510 (430)</td>
<td>510 (430)</td>
<td>470 (400)</td>
<td>460 (390)</td>
</tr>
<tr>
<td>1 NPLC</td>
<td>Internal</td>
<td>59 (49)</td>
<td>59 (49)</td>
<td>56 (48)</td>
<td>58 (48)</td>
</tr>
<tr>
<td>1 NPLC</td>
<td>External</td>
<td>58 (48)</td>
<td>58 (48)</td>
<td>57 (48)</td>
<td>57 (48)</td>
</tr>
</tbody>
</table>

8. Reading rates applicable for voltage or current measurements, autozero off, autorange off, filter off, binary reading format, and source readback off.
9. 2450 SCPI programming mode. Speeds do not apply to 2400 SCPI mode.
Contact Information:

ASEAN / Australia (65) 6356 3900
Austria 00800 2255 4835
Balkans, Israel, South Africa and other ISE Countries +41 52 675 3777
Belgium 00800 2255 4835
Brazil +55 (11) 3759 7627
Canada 1 800 833 9200
Central East Europe and the Baltics +41 52 675 3777
Central Europe & Greece +41 52 675 3777
Denmark +45 80 88 1401
Finland +41 52 675 3777
France 00800 2255 4835
Germany 00800 2255 4835
Hong Kong 400 820 5835
India 000 800 650 1835
Italy 00800 2255 4835
Japan 81 (3) 6714 3010
Luxembourg +41 52 675 3777
Mexico, Central/South America & Caribbean 52 (55) 56 04 50 90
Middle East, Asia, and North Africa +41 52 675 3777
The Netherlands 00800 2255 4835
Norway 800 16098
People’s Republic of China 400 820 5835
Poland +41 52 675 3777
Portugal 80 08 12370
Republic of Korea 001 800 8255 2835
Russia & CIS +7 (495) 6647564
South Africa +41 52 675 3777
Spain 00800 2255 4835
Sweden 00800 2255 4835
Switzerland 00800 2255 4835
Taiwan 886 (2) 2656 6688
United Kingdom & Ireland 00800 2255 4835
USA 1 800 833 9200

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