

# 2600B System SourceMeter® SMU Instruments

## Datasheet



The Series 2600B System SourceMeter SMU Instruments are the industry's leading current/voltage source and measure solutions, and are built from Keithley's third generation SMU technology. The Series 2600B offers single- and dual-channel models that combine the capabilities of a precision power supply, true current source, 6½-digit DMM, arbitrary waveform generator, pulse generator, and electronic load – all into one tightly integrated instrument. The result is a powerful solution that significantly boosts productivity in applications ranging from bench-top I-V characterization through highly automated production test. Built-in web browser based software enables I-V testing through any computer from anywhere in the world. Or, use your Android smart device to perform plug & play I-V testing with fingertip control with the Keithley IVy application. For automated system applications, the Series 2600B's Test Script Processor (TSP®) runs complete test programs from inside the instrument for industry-best throughput. In larger, multi-channel applications, Keithley's TSP-Link® Technology works together with TSP Technology to enable high-speed, SMU-per-pin parallel testing. Because Series 2600B SourceMeter SMU Instruments have fully isolated channels that do not require a mainframe, they can be easily reconfigured and re-deployed as your test applications evolve.

## Key Features

- Tightly integrated, 4-quadrant voltage/current source and measure instruments offer best in class performance with 6½-digit resolution
- Family of models offer industry's widest dynamic range: 10A pulse to 0.1fA and 200V to 100nV
- Built-in web browser based software enables remote control through any browser, on any computer, from anywhere in the world
- Compatibility with the Keithley IVy mobile app enables true plug & play I/V characterization and test through any Android device
- TSP (Test Script Processing) technology embeds complete test programs inside the instrument for best-in-class system-level throughput
- TSP-Link expansion technology for multi-channel parallel test without a mainframe
- Software emulation for Keithley's 2400 SourceMeter SMU Instrument
- USB 2.0, LXI-C, GPIB, RS-232, and digital I/O interfaces
- Free software drivers and development/debug tools
- Optional ACS-Basic semiconductor component characterization software

## Perform Quick I-V characterization with Android™ Devices

The Series 2600B is compatible with the Keithley IVy application that is the fastest and easiest way to perform current-voltage (I-V) characterization, troubleshoot your

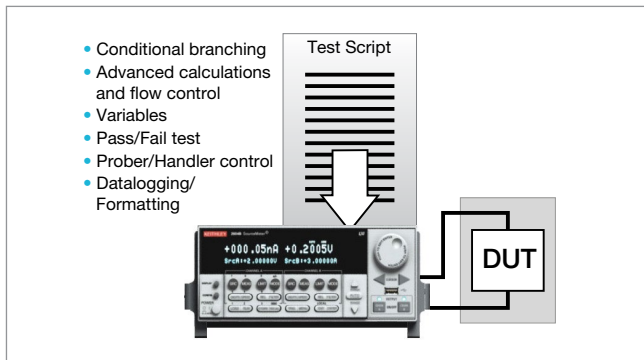


Perform quick I-V characterization with fingertip control to gain insight into your DUT.

device under test (DUT), and share the measurement results with others. It allows you to visualize, interact with, and share measurement results without programming, while gaining a deeper understanding of your DUT. These unique capabilities boost productivity across a wide range of applications in R&D, education, QA/FA, and more.

### Unmatched Throughput for Automated Test with TSP Technology

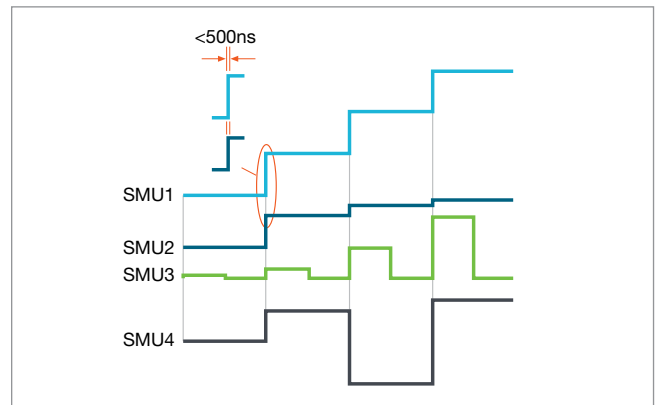
For test applications that demand the highest levels of automation and throughput, the 2600B's TSP technology delivers industry-best performance. TSP technology goes far beyond traditional test command sequencers — it fully embeds then executes complete test programs from within the SMU instrument itself. This virtually eliminates all the time-consuming bus communications to and from the PC controller, and thus dramatically improves overall test times.



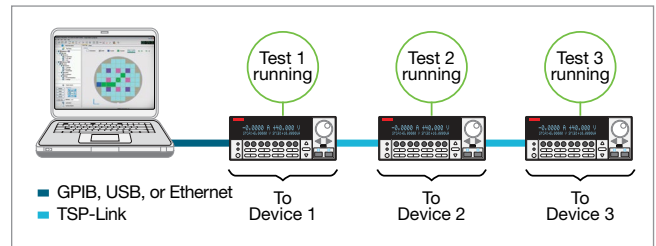
TSP technology executes complete test programs from the 2600B's non-volatile memory.

### SMU-Per-Pin Parallel Testing with TSP-Link Technology

TSP-Link is a channel expansion bus that enables multiple Series 2600B's to be inter-connected and function as a single, tightly-synchronized, multi-channel system. The 2600B's TSP-Link Technology works together with its TSP technology to enable high-speed, SMU-per-pin parallel testing. Unlike other high-speed solutions such as large ATE systems, the 2600B achieves parallel test performance without the cost or burden of a mainframe. The TSP-Link based system also enables superior flexibility, allowing for quick and easy system re-configuration as test requirements change.



All channels in the TSP-Link system are synchronized to under 500ns.



SMU-Per-Pin Parallel Testing using TSP and TSP-Link improves test throughput and lowers the cost of test.

### 2400 Software Emulation

The Series 2600B is compatible with test code developed for Keithley's 2400 SourceMeter SMU instrument. This enables an easier upgrade from 2400-based test systems to Series 2600B, and can improve test speeds by as much as 80%. In addition, it provides a migration path from SCPI programming to Keithley's TSP technology, which when implemented can improve test times even more. For complete support of legacy test systems, the 2400's Source-Memory-List test sequencer is also fully supported in this mode.

### Third-generation SMU Instrument Design Ensures Faster Test Times

Based on the proven architecture of earlier Series 2600 instruments, the Series 2600B's SMU instrument design enhances test speed in several ways. For example, while earlier designs used a parallel current ranging topology, the Series 2600B uses a patented series ranging topology, which provides faster and smoother range changes and outputs that settle more quickly.

The Series 2600B SMU instrument design supports two modes of operation for use with a variety of loads. In normal mode, the SMU instrument provides high bandwidth performance for maximum throughput. In high capacitance (high-C) mode, the SMU instrument uses a slower bandwidth to provide robust performance with higher capacitive loads.

### Simplify Semiconductor Component Test, Verification, and Analysis

The optional ACS Basic Edition software maximizes the productivity of customers who perform packaged part characterization during development, quality verification, or failure analysis. Key features include:

- Rich set of easy-to-access test libraries
- Script editor for fast customization of existing tests
- Data tool for comparing results quickly
- Formulator tool that analyzes captured curves and provides a wide range of math functions

For more information about the ACS Basic Edition software, please refer to the ACS Basic Edition data sheet.

### Powerful Software Tools

In addition to compatibility with the Keithley IVy smart device app, embedded web browser based software, and optional ACS Basic Edition software, the free Test Script Builder software tool is provided to help users create, modify, debug, and store TSP test scripts. **Table 1** describes key features of Series 2600B software tools.

| Feature/Functionality | Keithley IVy Mobile App  | Built-in Web Browser Based App   | Test Script Builder (TSB)                                     | ACS Basic Edition  |
|-----------------------|--|--|---|--|
| Description           | Quick I-V characterization tool for bench and lab users to visualize, interact and share measurement data via Android devices.   | Built-in web browser based software for I-V characterization   | Custom script writing tool for TSP instruments                | Semiconductor characterization software for component test, verification, and analysis |
| Capability            | Basic  | General  | Advanced  | High Performance   |
| Supported Hardware    | Series 2600B   | Series 2600B   | Series 2600B, Series 3700                                     | Series 2400, Series 2600B, 4200-SCS  |
| Supported Buses       | Not Applicable   | LAN/LXI  | GPIB, RS-232, LAN/LXI, USB                                    | GPIB, LAN/LXI  |
| Functionality         | Visualize data in time mode, two terminal I-V mode and family of curves mode.<br>Analyze collected data interactively with smart device's built-in capabilities.<br>Share data instantly via mobile networks/Wi-Fi | Linear/Log Sweeps, Pulsing, Custom sweeps, Single point source-measures. Note: Uses new 2600B's new API's for precision timing and channel synchronization | Custom scripts with total flexibility, full featured debugger | Intuitive, wizard-based GUI, Rich set of test libraries, curve trace capability        |
| Data Management       | .csv and graphic data export   | .csv export  | User defined  | Formulator tool with wide range of math functions                                      |
| Installation          | Free download from app stores  | Not necessary. Embedded in the instrument.   | Free Download or CD Install on PC.                            | Optional purchase  |

Table 1. Series 2600B software tools

### Three New Dual-Channel Bench-Top Models of Series 2600B Offer Industry-Best Value and Performance

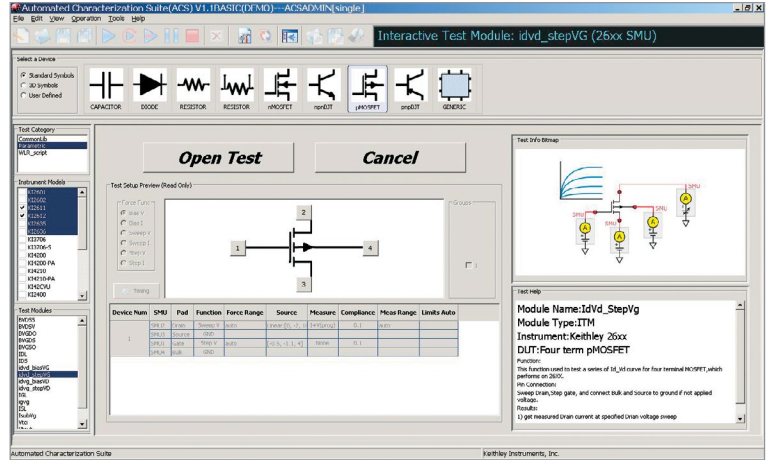
For applications that do not require leading-edge system-level automation capabilities, Keithley has expanded the Series 2600B to include 3 new value-priced “bench-top” models – the 2604B, 2614B, and 2634B. These models offer similar performance to Models 2602B, 2612B, and 2636B, respectively, however do not include TSP-Link, Contact Check, and Digital I/O capabilities.

### Complete Automated System Solutions

Keithley’s S500 Integrated Test Systems are highly configurable, instrument-based systems for semiconductor characterization at the device, wafer, or cassette level. Built on our proven Series 2600B System SourceMeter SMU instruments, our S500 Integrated Test Systems provide innovative measurement features and system flexibility, scalable to your needs. The unique measurement capability, combined with the powerful and flexible Automated Characterization Suite (ACS) software, provides a comprehensive range of applications and features not offered on other comparable systems on the market.



The flexible software architecture of ACS Basic Edition allows configuring systems with a wide range of controllers and test fixtures, as well as the exact number of SourceMeter SMU instruments the application requires.

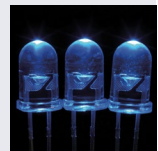
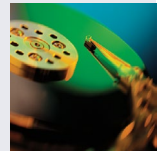
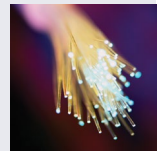
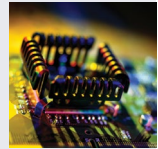


When you need to acquire data on a packaged part quickly, the wizard-based user interface of ACS Basic Edition makes it easy to find and run the test you want, like this common FET curve trace test.

### Typical Applications

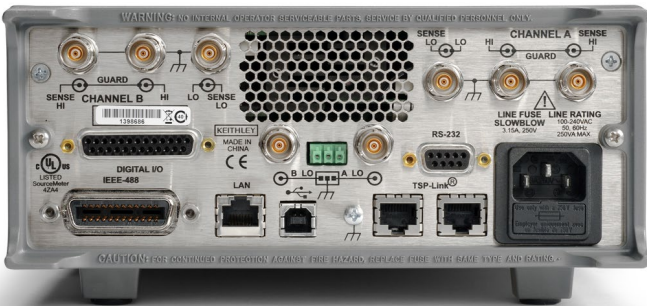
I-V functional test and characterization of a wide range of devices, including:

- Discrete and passive components
  - Two-leaded – Sensors, disk drive heads, metal oxide varistors (MOVs), diodes, zener diodes, sensors, capacitors, thermistors
  - Three-leaded – Small signal bipolar junction transistors (BJTs), field-effect transistors (FETs), and more
- Simple ICs – Optos, drivers, switches, sensors, converters, regulators
- Integrated devices – small scale integrated (SSI) and large scale integrated (LSI)
  - Analog ICs
  - Radio frequency integrated circuits (RFICs)
  - Application specific integrated circuits (ASICs)
  - System on a chip (SOC) devices
- Optoelectronic devices such as light-emitting diodes (LEDs), laser diodes, high brightness LEDs (HBLEDs), vertical cavity surface-emitting lasers (VCSELs), displays
- Wafer level reliability
  - NBTI, TDDDB, HCI, electromigration
- Solar Cells
- Batteries
- And more...



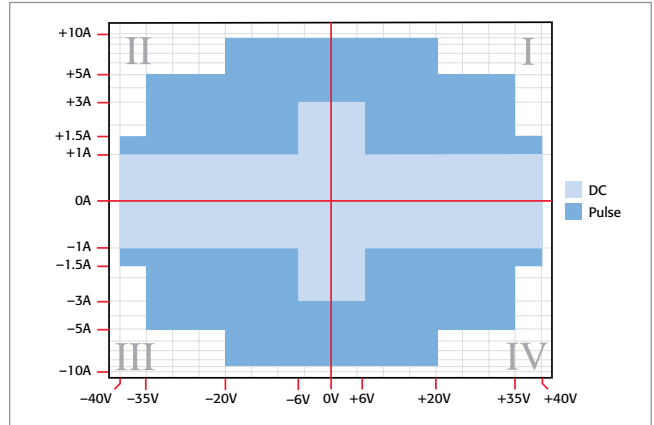


2604B/2614B rear panel (Single channels 2601B, 2611B, 2635B not shown)

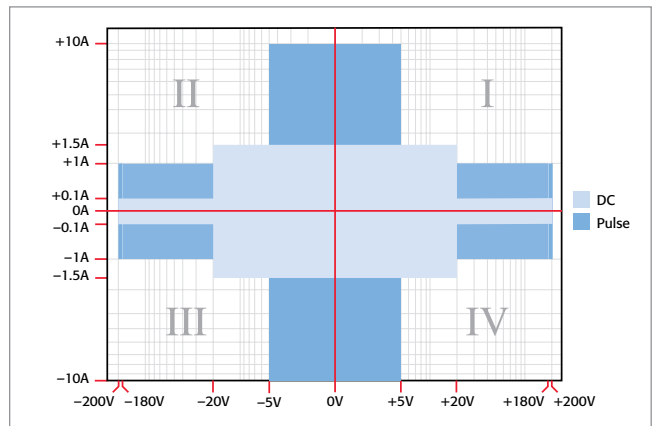


2636B rear panel

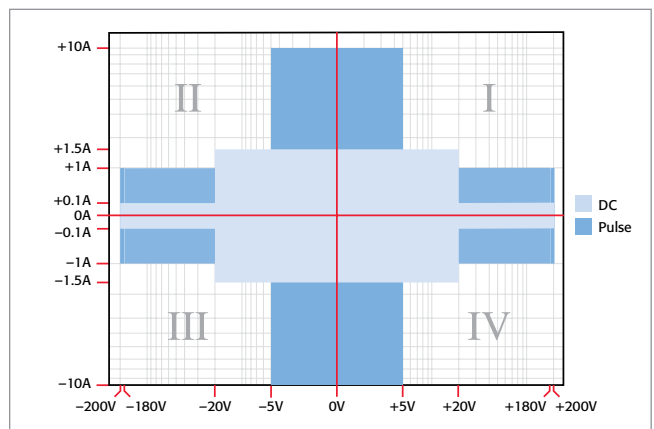
In the first and third quadrants, Series 2600B SMU instruments operate as a source, delivering power to a load. In the second and fourth quadrants, they operate as a sink, dissipating power internally.



Models 2601B, 2602B, and 2604B I-V capability



Models 2611B, 2612B, and 2614B I-V capability



Models 2634B, 2635B, and 2636B I-V capability

## Specification Conditions (2601B, 2602B, 2604B)

This document contains specifications and supplemental information for the Models 2601B, 2602B, and 2604B System SourceMeter® SMU instruments. Specifications are the standards against which the Models 2601B, 2602B, and 2604B are tested. Upon leaving the factory, the 2601B, 2602B, and 2604B meet these specifications. Supplemental and typical values are non-warranted, apply at 23°C, and are provided solely as useful information.

Accuracy specifications are applicable for both normal and high capacitance modes.

The source and measurement accuracies are specified at the SourceMeter CHANNEL A (2601B, 2602B, and 2604B) or SourceMeter CHANNEL B (2602B and 2604B) terminals under the following conditions:

1. 23°C ± 5°C, <70% relative humidity
2. After 2 hour warm-up
3. Speed normal (1 NPLC)
4. A/D auto-zero enabled
5. Remote sense operation or properly zeroed local operation
6. Calibration period = 1 year

## Source Specifications (2601B, 2602B, 2604B)

### Voltage Source Specifications

#### Voltage Programming Accuracy<sup>1</sup>

| Range  | Programming Resolution | Accuracy (1 Year), 23°C ±5°C<br>±(% rdg. + volts) | Typical Noise (peak-peak)<br>0.1Hz–10Hz |
|--------|------------------------|---|---|
| 100 mV | 5 µV                   | 0.02% + 250 µV                                    | 20 µV                                   |
| 1 V    | 50 µV                  | 0.02% + 400 µV                                    | 50 µV                                   |
| 6 V    | 50 µV                  | 0.02% + 1.8 mV                                    | 100 µV                                  |
| 40 V   | 500 µV                 | 0.02% + 12 mV                                     | 500 µV                                  |

#### Temperature Coefficient (0°–18°C and 28°–50°C)<sup>2</sup>

±(0.15 × accuracy specification)/°C. Applicable for normal mode only. Not applicable for high capacitance mode.

#### Maximum Output Power and Source/Sink Limits<sup>3</sup>

40.4 W per channel maximum. ±40.4 V @ ±1.0 A, ±6.06 V @ ±3.0 A, four quadrant source or sink operation.

#### Voltage Regulation

**Line:** 0.01% of range. **Load:** ±(0.01% of range + 100 µV).

#### Noise 10 Hz–20 MHz

<20 mV peak-peak (typical), <3 mV RMS (typical), 6 V range.

#### Current Limit/Compliance<sup>4</sup>

Bipolar current limit (compliance) set with single value. Minimum value is 10 nA. Accuracy same as current source.

#### Overshoot

<±(0.1% + 10 mV) typical. Step size = 10% to 90% of range, resistive load, maximum current limit/compliance.

#### Guard Offset Voltage

<4 mV typical. Current <10 mA.

### NOTES

1. Add 50 µV to source accuracy specifications per volt of HI lead drop.
2. High Capacitance Mode accuracy is applicable at 23°C ±5°C only.
3. Full power source operation regardless of load to 30°C ambient. Above 30°C and/or power sink operation, refer to "Operating Boundaries" in the Series 2600B Reference Manual for additional power derating information.
4. For sink mode operation (quadrants II and IV), add 0.06% of limit range to the corresponding current limit accuracy specifications. Specifications apply with sink mode operation enabled.

## Current Source Specifications

### Current Programming Accuracy

| Range               | Programming Resolution | Accuracy (1 Year), 23°C ±5°C<br>±(% rdg. + amps) | Typical Noise (peak-peak)<br>0.1Hz–10Hz |
|---------------------|------------------------|--|---|
| 100 nA              | 2 pA                   | 0.06% + 100 pA                                   | 5 pA                                    |
| 1 µA                | 20 pA                  | 0.03% + 800 pA                                   | 25 pA                                   |
| 10 µA               | 200 pA                 | 0.03% + 5 nA                                     | 60 pA                                   |
| 100 µA              | 2 nA                   | 0.03% + 60 nA                                    | 3 nA                                    |
| 1 mA                | 20 nA                  | 0.03% + 300 nA                                   | 6 nA                                    |
| 10 mA               | 200 nA                 | 0.03% + 6 µA                                     | 200 nA                                  |
| 100 mA              | 2 µA                   | 0.03% + 30 µA                                    | 600 nA                                  |
| 1 A <sup>1</sup>    | 20 µA                  | 0.05% + 1.8 mA                                   | 70 µA                                   |
| 3 A <sup>1</sup>    | 20 µA                  | 0.06% + 4 mA                                     | 150 µA                                  |
| 10 A <sup>1,2</sup> | 200 µA                 | 0.5% + 40 mA (typical)                           |   |

Temperature Coefficient (0°–18°C and 28°–50°C)<sup>3</sup>  
±(0.15 × accuracy specification)/°C.

Maximum Output Power and Source/Sink Limits<sup>4</sup>  
40.4 W per channel maximum. ±1.01 A @ ±40.0 V, ±3.03 A @ ±6.0 V, four quadrant source or sink operation.

Current Regulation **Line:** 0.01% of range. **Load:** ±(0.01% of range + 100 pA).

Voltage Limit/Compliance<sup>5</sup> Bipolar voltage limit (compliance) set with a single value. Minimum value is 10 mV. Accuracy is the same as voltage source.

Overshoot <±0.1% typical (step size = 10% to 90% of range, resistive load; see Current Source Output Settling Time for additional test conditions).

### NOTES

1. Full power source operation regardless of load to 30°C ambient. Above 30°C and/or power sink operation, refer to "Operating Boundaries" in the Series 2600B Reference Manual for additional power derating information.
2. 10 A range accessible only in pulse mode.
3. High Capacitance Mode accuracy is applicable at 23°C ±5°C only.
4. Full power source operation regardless of load to 30°C ambient. Above 30°C and/or power sink operation, refer to "Operating Boundaries" in the Series 2600B Reference Manual for additional power derating information.
5. For sink mode operation (quadrants II and IV), add 10% of compliance range and ±0.02% of limit setting to corresponding voltage source specification. For 100 mV range add an additional 60 mV of uncertainty.

## Additional Source Specifications

Transient Response Time <70 µs for the output to recover to within 0.1% for a 10% to 90% step change in load.

Voltage Source Output Settling Time  
Time required to reach within 0.1% of final value after source level command is processed on a fixed range.

100 mV, 1 V Ranges <50 µs typical.

6 V Range <100 µs typical.

40 V Range<sup>1</sup> <150 µs typical.

### NOTES

1. Add 150 µs when measuring on the 1 A range.

**Current Source Output Settling Time**

Time required to reach within 0.1% of final value after source level command is processed on a fixed range. Values below for  $I_{out} \times R_{load} = 1\text{ V}$  unless noted.

|   |   |
|---|---|
| <b>3 A Range</b>                          | <80 $\mu\text{s}$ typical (current less than 2.5 A, $R_{load} > 2\ \Omega$ ). |
| <b>1 A–10 mA Ranges</b>                   | <80 $\mu\text{s}$ typical ( $R_{load} > 6\ \Omega$ ).                         |
| <b>1 mA Range</b>                         | <100 $\mu\text{s}$ typical.   |
| <b>100 <math>\mu\text{A}</math> Range</b> | <150 $\mu\text{s}$ typical.   |
| <b>10 <math>\mu\text{A}</math> Range</b>  | <500 $\mu\text{s}$ typical.   |
| <b>1 <math>\mu\text{A}</math> Range</b>   | <2.5 ms typical.  |
| <b>100 nA Range</b>                       | <25 ms typical.   |

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

**Remote Sense Operating Range<sup>1</sup>** Maximum voltage between HI and SENSE HI = 3 V.  
Maximum voltage between LO and SENSE LO = 3 V.

**Voltage Output Headroom**

|                   |   |
|-------------------|---|
| <b>40 V Range</b> | Max. output voltage = 42 V – total voltage drop across source leads (maximum 1 $\Omega$ per source lead). |
| <b>6 V Range</b>  | Max. output voltage = 8 V – total voltage drop across source leads (maximum 1 $\Omega$ per source lead).  |

**Over Temperature Protection** Internally sensed temperature overload puts unit in standby mode.

**Voltage Source Range Change Overshoot** <300 mV + 0.1% of larger range (typical). Overshoot into an 100 k $\Omega$  load, 20 MHz BW.

**Current Source Range Change Overshoot** <5% of larger range + 300 mV/ $R_{load}$  (typical with source settling set to SETTLE\_SMOOTH\_100NA). See Current Source Output Settling Time for additional test conditions.

**NOTES**

1. Add 50  $\mu\text{V}$  to source accuracy specifications per volt of HI lead drop.



## Pulse Specifications

| Region | Maximum Current Limit | Maximum Pulse Width <sup>1</sup> | Maximum Duty Cycle <sup>2</sup> |
|--------|-----------------------|----------------------------------|---------------------------------|
| 1      | 1 A @ 40 V            | DC, no limit                     | 100%                            |
| 1      | 3 A @ 6 V             | DC, no limit                     | 100%                            |
| 2      | 1.5 A @ 40 V          | 100 ms                           | 25%                             |
| 3      | 5 A @ 35 V            | 4 ms                             | 4%                              |
| 4      | 10 A @ 20 V           | 1.8 ms                           | 1%                              |

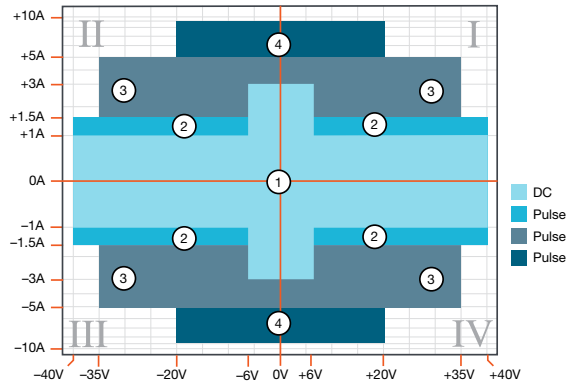
**Minimum Programmable Pulse Width<sup>3,4</sup>** 100  $\mu$ s.  
**Note:** Minimum pulse width for settled source at a given I/V output and load can be longer than 100  $\mu$ s.

**Pulse Width Programming Resolution** 1  $\mu$ s.

**Pulse Width Programming Accuracy<sup>4</sup>**  $\pm 5 \mu$ s.

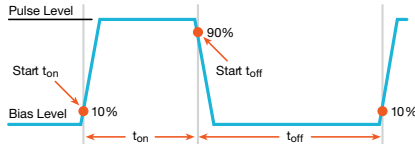
**Pulse Width Jitter** 2  $\mu$ s (typical).

### Quadrant Diagram



### NOTES

1. Times measured from the start of pulse to the start off-time; see figure below.

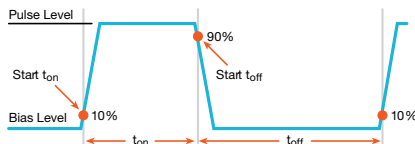


- 2. Thermally limited in sink mode (quadrants II and IV) and ambient temperatures above 30°C. See power equations in the reference manual for more information.
- 3. Typical performance for minimum settled pulse widths:

| Source Value | Load        | Source Settling (% of range) | Min. Pulse Width |
|--------------|-------------|------------------------------|------------------|
| 6 V          | 2 $\Omega$  | 0.2%                         | 150 $\mu$ s      |
| 20 V         | 2 $\Omega$  | 1%                           | 200 $\mu$ s      |
| 35 V         | 7 $\Omega$  | 0.5%                         | 500 $\mu$ s      |
| 40 V         | 27 $\Omega$ | 0.1%                         | 400 $\mu$ s      |
| 1.5 A        | 27 $\Omega$ | 0.1%                         | 1.5 ms           |
| 3 A          | 2 $\Omega$  | 0.2%                         | 150 $\mu$ s      |
| 5 A          | 7 $\Omega$  | 0.5%                         | 500 $\mu$ s      |
| 10 A         | 2 $\Omega$  | 0.5%                         | 200 $\mu$ s      |

Typical tests were performed using remote operation, 4W sense, and best, fixed measurement range. For more information on pulse scripts, see the Series 2600B Reference Manual.

4. Times measured from the start of pulse to the start off-time; see figure below.



## Meter Specifications (2601B, 2602B, 2604B)

### Voltage Measurement Accuracy <sup>1, 2</sup>

| Range  | Default Display Resolution <sup>3</sup> | Input Resistance | Accuracy (1 Year), 23°C ±5°C<br>±(% rdg. + volts) |
|--------|---|------------------|---|
| 100 mV | 100 nV                                  | >10 GΩ           | 0.015% + 150 μV                                   |
| 1 V    | 1 μV                                    | >10 GΩ           | 0.015% + 200 μV                                   |
| 6 V    | 10 μV                                   | >10 GΩ           | 0.015% + 1 mV                                     |
| 40 V   | 10 μV                                   | >10 GΩ           | 0.015% + 8 mV                                     |

### Temperature Coefficient (0°–18°C and 28°–50°C) <sup>4</sup>

±(0.15 × accuracy specification)/°C. Applicable for normal mode only. Not applicable for high capacitance mode.

### Current Measurement Accuracy <sup>2</sup>

| Range             | Default Display Resolution <sup>5</sup> | Voltage Burden <sup>6</sup> | Accuracy (1 Year), 23°C ±5°C<br>±(% rdg. + amps) |
|-------------------|---|-----------------------------|--|
| 100 nA            | 100 fA                                  | <1 mV                       | 0.05% + 100 pA                                   |
| 1 μA              | 1 pA                                    | <1 mV                       | 0.025% + 500 pA                                  |
| 10 μA             | 10 pA                                   | <1 mV                       | 0.025% + 1.5 nA                                  |
| 100 μA            | 100 pA                                  | <1 mV                       | 0.02% + 25 nA                                    |
| 1 mA              | 1 nA                                    | <1 mV                       | 0.02% + 200 nA                                   |
| 10 mA             | 10 nA                                   | <1 mV                       | 0.02% + 2.5 μA                                   |
| 100 mA            | 100 nA                                  | <1 mV                       | 0.02% + 20 μA                                    |
| 1 A               | 1 μA                                    | <1 mV                       | 0.03% + 1.5 mA                                   |
| 3 A               | 1 μA                                    | <1 mV                       | 0.05% + 3.5 mA                                   |
| 10 A <sup>7</sup> | 10 μA                                   | <1 mV                       | 0.4% + 25 mA (typical)                           |

### Current Measure Settling Time (time for measurement to settle after a $V_{step}$ ) <sup>8</sup>

Time required to reach within 0.1% of final value after source level command is processed on a fixed range. Values for  $V_{out} = 1$  V unless noted.

**Current Range** 1 mA.

**Settling Time** <100 μs (typical).

### Temperature Coefficient (0°–18°C and 28°–50°C) <sup>9</sup>

±(0.15 × accuracy specification)/°C. Applicable for normal mode only. Not applicable for high capacitance mode.

### NOTES

1. Add 50μV to source accuracy specifications per volt of HI lead drop.
2. e-rate accuracy specifications for NPLC setting <1 by increasing error term. Add appropriate % of range term using table below.

| NPLC Setting | 100 mV Range | 1 V–40 V Ranges | 100 nA Range | 1 μA–100 mA Ranges | 1 A–3 A Ranges |
|--------------|--------------|-----------------|--------------|--------------------|----------------|
| 0.1          | 0.01%        | 0.01%           | 0.01%        | 0.01%              | 0.01%          |
| 0.01         | 0.08%        | 0.07%           | 0.1%         | 0.05%              | 0.05%          |
| 0.001        | 0.8 %        | 0.6 %           | 1%           | 0.5 %              | 1.1 %          |

3. Applies when in single channel display mode.
4. High Capacitance Mode accuracy is applicable for 23°C ±5°C only.
5. Applies when in single channel display mode.
6. Four-wire remote sense only with current meter mode selected. Voltage measure set to 100mV or 1V range only.
7. 10 A range accessible only in pulse mode.
8. Compliance equal to 100mA.
9. High Capacitance Mode accuracy is applicable for 23°C ±5°C only.

Contact Check<sup>1</sup> (not available on Model 2604B)

| Speed  | Maximum Measurement Time To Memory For 60Hz (50Hz) | Accuracy (1 Year), 23°C ±5°C<br>±(%rdg. + ohms) |
|--------|--|---|
| FAST   | 1 (1.2) ms   | 5% + 10 Ω                                       |
| MEDIUM | 4 (5) ms   | 5% + 1 Ω  |
| SLOW   | 36 (42) ms   | 5% + 0.3 Ω                                      |

## NOTES

1. Includes measurement of SENSE HI to HI and SENSE LO to LO contact resistances.

## Additional Meter Specifications

**Maximum Load Impedance** Normal Mode: 10 nF (typical). High Capacitance Mode: 50 μF (typical).

**Common Mode Voltage** 250 VDC.

**Common Mode Isolation** >1 GΩ, <4500 pF.

**Overrange** 101% of source range, 102% of measure range.

**Maximum Sense Lead Resistance** 1 kΩ for rated accuracy.

**Sense Input Impedance** >10 GΩ.

High Capacitance Mode<sup>1, 2, 3</sup>

## Voltage Source Output Settling Time

Time required to reach 0.1% of final value after source level command is processed on a fixed range. Current limit = 1 A.

| Voltage Source Range | Settling Time with C <sub>load</sub> = 4.7 μF |
|----------------------|---|
| 100 mV               | 200 μs (typical)                              |
| 1 V                  | 200 μs (typical)                              |
| 6 V                  | 200 μs (typical)                              |
| 40 V                 | 7 ms (typical)                                |

## Current Measure Settling Time

Time required to reach 0.1% of final value after voltage source is stabilized on a fixed range. Values below for V<sub>out</sub> = 1V unless noted.

| Current Measure Range | Settling Time                               |
|-----------------------|---|
| 3 A – 1 A             | <120 μs (typical) (R <sub>load</sub> > 2 Ω) |
| 100 mA – 10 mA        | <100 μs (typical)                           |
| 1 mA                  | < 3 ms (typical)                            |
| 100 μA                | < 3 ms (typical)                            |
| 10 μA                 | < 230 ms (typical)                          |
| 1 μA                  | < 230 ms (typical)                          |

Capacitor Leakage Performance Using HIGH-C Scripts<sup>4</sup>

Load = 5 μF||10 MΩ. Test: 5 V step and measure. 200 ms (typical) @ 50 nA.

## NOTES

- High Capacitance Mode specifications are for DC measurements only.
- 100 nA range is not available in High Capacitance Mode.
- High Capacitance Mode utilizes locked ranges. Auto Range is disabled.
- Part of KI Factory scripts. See reference manual for details.

## Mode Change Delay

## 100 μA Current Range and Above

Delay into High Capacitance Mode: 10 ms.  
Delay out of High Capacitance Mode: 10 ms.

## 1 μA and 10 μA Current Ranges

Delay into High Capacitance Mode: 230 ms.  
Delay out of High Capacitance Mode: 10 ms.

## Voltmeter Input Impedance

10 GΩ in parallel with 3300 pF.

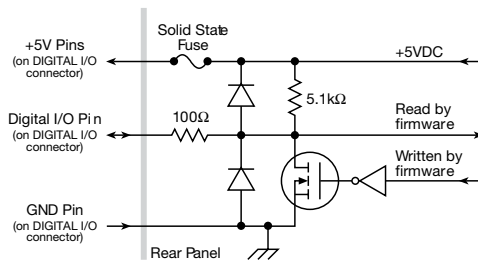
Noise, 10 Hz–20 MHz (6 V Range) <30 mV peak-peak (typical).

**Voltage Source Range Change Overshoot**

<400 mV + 0.1% of larger range (typical). Overshoot into a 100 kΩ load, 20 MHz BW.

## General (2601B, 2602B, 2604B)

|                       |  |
|-----------------------|--|
| IEEE-488              | IEEE-488.1 compliant. Supports IEEE-488.2 common commands and status model topology.   |
| USB Control (rear)    | USB 2.0 device, TMC488 protocol.   |
| RS-232                | Baud rates from 300 bps to 115200 bps.   |
| Ethernet              | RJ-45 connector, LXI Class C, 10/100BT, no auto MDIX.  |
| Expansion Interface   | The TSP-Link expansion interface allows TSP enabled instruments to trigger and communicate with each other. (Not available on 2604B.)  |
| Cable Type            | Category 5e or higher LAN crossover cable.   |
| Length                | 3 meters maximum between each TSP enabled instrument.  |
| LXI Compliance        | LXI Class C 1.4.   |
| LXI Timing            | <b>Total Output Trigger Response Time:</b> 245 μs min., 280 μs typ., (not specified) max.<br><b>Receive LAN[0-7] Event Delay:</b> Unknown.<br><b>Generate LAN[0-7] Event Delay:</b> Unknown. |
| Digital I/O Interface | (Not available on Model 2604B)   |



|  |  |
|--|--|
| Connector  | 25-pin female D.   |
| Input/Output Pins  | 14 open drain I/O bits.  |
| Absolute Maximum Input Voltage                               | 5.25 V.  |
| Absolute Minimum Input Voltage                               | -0.25 V.   |
| Maximum Logic Low Input Voltage                              | 0.7 V, +850 μA max.  |
| Minimum Logic High Input Voltage                             | 2.1 V, +570 μA.  |
| Maximum Source Current (flowing out of Digital I/O bit)      | +960 μA.   |
| Maximum Sink Current @ Maximum Logic Low Voltage (0.7V)      | -5.0 mA.   |
| Absolute Maximum Sink Current (flowing into Digital I/O pin) | -11 mA (not including 2604B).  |
| 5V Power Supply Pins   | Limited to 250 mA total for all three pins, solid state fuse protected.  |
| Output Enable  | Active high input pulled down internally to ground with a 10 kΩ resistor; when the output enable input function has been activated, each SourceMeter channel will not turn on unless the output enable pin is driven to >2.1 V (nominal current = 2.1 V/10 kΩ = 210 μA). |

|                                |   |
|--------------------------------|---|
| <b>USB File System (Front)</b> | <b>USB 2.0 Host:</b> Mass storage class device.   |
| <b>Power Supply</b>            | 100 V to 250 VAC, 50–60 Hz (auto sensing), 240 VA max.  |
| <b>Cooling</b>                 | Forced air. Side intake and rear exhaust. One side must be unobstructed when rack mounted.  |
| <b>EMC</b>                     | Conforms to European Union Directive 2004/108/EEC, EN 61326-1.  |
| <b>Safety</b>                  | Conforms to European Union Directive 73/23/EEC, EN 61010-1, and UL 61010-1.   |
| <b>Dimensions</b>              | 89 mm high × 213 mm wide × 460 mm deep (3½ in × 8⅝ in × 17½ in).<br><b>Bench Configuration (with handle and feet):</b> 104mm high × 238mm wide × 460mm deep (4⅛ in × 9⅝ in × 17½ in). |
| <b>Weight</b>                  | <b>2601B:</b> 4.75 kg (10.4 lbs). <b>2602B, 2604B:</b> 5.50 kg (12.0 lbs).  |
| <b>Environment</b>             | For indoor use only.  |
| <b>Altitude</b>                | Maximum 2000 meters above sea level.  |
| <b>Operating</b>               | 0°–50°C, 70% R.H. up to 35°C. Derate 3% R.H./°C, 35°–50°C.  |
| <b>Storage</b>                 | –25°C to 65°C.  |

See pages 30 and 31 for measurement speeds and other specifications.

## Specification Conditions (2611B, 2612B, 2614B)

This document contains specifications and supplemental information for the 2611B, 2612B, and 2614B System SourceMeter® SMU instruments. Specifications are the standards against which the 2611B, 2612B, and 2614B are tested. Upon leaving the factory the 2611B, 2612B, and 2614B meet these specifications. Supplemental and typical values are non-warranted, apply at 23°C, and are provided solely as useful information.

Accuracy specifications are applicable for both normal and high capacitance modes.

The source and measurement accuracies are specified at the SourceMeter CHANNEL A (2611B, 2612B, and 2614B) or SourceMeter CHANNEL B (2612B, 2614B) terminals under the following conditions:

1. 23°C ± 5°C, <70% relative humidity
2. After 2 hour warm-up
3. Speed normal (1 NPLC)
4. A/D auto-zero enabled
5. Remote sense operation or properly zeroed local operation
6. Calibration period = 1 year

## Source Specifications (2611B, 2612B, 2614B)

### Voltage Source Specifications

#### Voltage Programming Accuracy<sup>1</sup>

| Range  | Programming Resolution | Accuracy (1 Year), 23°C ±5°C<br>±(% rdg. + volts) | Typical Noise (peak-peak)<br>0.1Hz–10Hz |
|--------|------------------------|---|---|
| 200 mV | 5 µV                   | 0.02% + 375 µV                                    | 20 µV                                   |
| 2 V    | 50 µV                  | 0.02% + 600 µV                                    | 50 µV                                   |
| 20 V   | 500 µV                 | 0.02% + 5 mV                                      | 300 µV                                  |
| 200 V  | 5 mV                   | 0.02% + 50 mV                                     | 2 mV                                    |

#### Temperature Coefficient (0°–18°C and 28°–50°C)<sup>2</sup>

±(0.15 × accuracy specification)/°C. Applicable for normal mode only. Not applicable for high capacitance mode.

#### Maximum Output Power and Source/Sink Limits<sup>3</sup>

30.3W per channel maximum. ±20.2 V @ ±1.5 A, ±202 V @ ±100 mA, four quadrant source or sink operation.

#### Voltage Regulation

**Line:** 0.01% of range. **Load:** ±(0.01% of range + 100 µV).

#### Noise 10 Hz–20 MHz

<20 mV peak-peak (typical), <3 mV RMS (typical), 20 V range.

#### Current Limit/Compliance<sup>4</sup>

Bipolar current limit (compliance) set with single value. Minimum value is 10 nA. Accuracy same as current source.

#### Overshoot

<±(0.1% + 10 mV) typical. Step size = 10% to 90% of range, resistive load, maximum current limit/compliance.

#### Guard Offset Voltage

<4 mV typical. Current <10 mA.

### NOTES

1. Add 50 µV to source accuracy specifications per volt of HI lead drop.
2. High Capacitance Mode accuracy is applicable at 23°C ±5°C only.
3. Full power source operation regardless of load to 30°C ambient. Above 30°C and/or power sink operation, refer to "Operating Boundaries" in the Series 2600B Reference Manual for additional power derating information.
4. For sink mode operation (quadrants II and IV), add 0.06% of limit range to the corresponding current limit accuracy specifications. Specifications apply with sink mode operation enabled.

## Current Source Specifications

### Current Programming Accuracy <sup>1</sup>

| Range               | Programming Resolution | Accuracy (1 Year), 23°C ±5°C<br>±(% rdg. + amps) | Typical Noise (peak-peak)<br>0.1Hz–10Hz |
|---------------------|------------------------|--|---|
| 100 nA              | 2 pA                   | 0.06% + 100 pA                                   | 5 pA                                    |
| 1 µA                | 20 pA                  | 0.03% + 800 pA                                   | 25 pA                                   |
| 10 µA               | 200 pA                 | 0.03% + 5 nA                                     | 60 pA                                   |
| 100 µA              | 2 nA                   | 0.03% + 60 nA                                    | 3 nA                                    |
| 1 mA                | 20 nA                  | 0.03% + 300 nA                                   | 6 nA                                    |
| 10 mA               | 200 nA                 | 0.03% + 6 µA                                     | 200 nA                                  |
| 100 mA              | 2 µA                   | 0.03% + 30 µA                                    | 600 nA                                  |
| 1 A <sup>2</sup>    | 20 µA                  | 0.05% + 1.8 mA                                   | 70 µA                                   |
| 1.5 A <sup>2</sup>  | 20 µA                  | 0.06% + 4 mA                                     | 150 µA                                  |
| 10 A <sup>2,3</sup> | 200 µA                 | 0.5% + 40 mA (typical)                           |   |

### Temperature Coefficient (0°–18°C and 28°–50°C) <sup>4</sup>

±(0.15 × accuracy specification)/°C. Applicable for normal mode only. Not applicable for high capacitance mode.

### Maximum Output Power and Source/Sink Limits <sup>5</sup>

30.3 W per channel maximum. ±1.515 A @ ±20 V, ±101 mA @ ±200 V, four quadrant source or sink operation.

### Current Regulation

**Line:** 0.01% of range. **Load:** ±(0.01% of range + 100 pA).

### Voltage Limit/Compliance <sup>6</sup>

Bipolar voltage limit (compliance) set with a single value. Minimum value is 20 mV. Accuracy is the same as voltage source.

### Overshoot

<±0.1% typical. Step size = 10% to 90% of range, resistive load; see Current Source Output Settling Time for additional test conditions).

## Additional Source Specifications

### Transient Response Time

<70 µs for the output to recover to within 0.1% for a 10% to 90% step change in load.

### Voltage Source Output Settling Time

Time required to reach within 0.1% of final value after source level command is processed on a fixed range.

#### 100 mV, 1 V Ranges

<50 µs typical.

#### 6 V Range

<100 µs typical.

#### 40 V Range <sup>6</sup>

<150 µs typical.

## NOTES

- Accuracy specifications do not include connector leakage. Derate accuracy by  $V_{out}/2E11$  per °C when operating between 18°–28°C. Derate accuracy by  $V_{out}/2E11 + (0.15 \cdot V_{out}/2E11)$  per °C when operating <18°C and >28°C.
- Full power source operation regardless of load to 30°C ambient. Above 30°C and/or power sink operation, refer to "Operating Boundaries" in the Series 2600B Reference Manual for additional power derating information.
- 10 A range accessible only in pulse mode.
- High Capacitance Mode accuracy is applicable at 23°C ±5°C only.
- Full power source operation regardless of load to 30°C ambient. Above 30°C and/or power sink operation, refer to "Operating Boundaries" in the Series 2600B Reference Manual for additional power derating information.
- For sink mode operation (quadrants II and IV), add 10% of compliance range and ±0.02% of limit setting to corresponding voltage source specification. For 200 mV range add an additional 120 mV of uncertainty.

**Current Source Output Settling Time**

Time required to reach within 0.1% of final value after source level command is processed on a fixed range. Values below for  $I_{out} \times R_{load} = 1\text{ V}$  unless noted.

|   |   |
|---|---|
| <b>3 A Range</b>                          | <80 $\mu\text{s}$ typical (current less than 2.5 A, $R_{load} > 2\ \Omega$ ). |
| <b>1 A–10 mA Ranges</b>                   | <80 $\mu\text{s}$ typical ( $R_{load} > 6\ \Omega$ ).                         |
| <b>1 mA Range</b>                         | <100 $\mu\text{s}$ typical.   |
| <b>100 <math>\mu\text{A}</math> Range</b> | <150 $\mu\text{s}$ typical.   |
| <b>10 <math>\mu\text{A}</math> Range</b>  | <500 $\mu\text{s}$ typical.   |
| <b>1 <math>\mu\text{A}</math> Range</b>   | <2.5 ms typical.  |
| <b>100 nA Range</b>                       | <25 ms typical.   |

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

**Remote Sense Operating Range<sup>1</sup>** Maximum voltage between HI and SENSE HI = 3 V.  
Maximum voltage between LO and SENSE LO = 3 V.

**Voltage Output Headroom**

|                   |   |
|-------------------|---|
| <b>40 V Range</b> | Max. output voltage = 42 V – total voltage drop across source leads (maximum 1 $\Omega$ per source lead). |
| <b>6 V Range</b>  | Max. output voltage = 8 V – total voltage drop across source leads (maximum 1 $\Omega$ per source lead).  |

**Over Temperature Protection** Internally sensed temperature overload puts unit in standby mode.

**Voltage Source Range Change Overshoot** <300 mV + 0.1% of larger range (typical). Overshoot into an 100 k $\Omega$  load, 20 MHz BW.

**Current Source Range Change Overshoot** <5% of larger range + 300 mV/ $R_{load}$  (typical with source settling set to SETTLE\_SMOOTH\_100NA). See Current Source Output Settling Time for additional test conditions.

**NOTES**

1. Add 50  $\mu\text{V}$  to source accuracy specifications per volt of HI lead drop.

**Pulse Specifications**

| Region         | Maximum Current Limit | Maximum Pulse Width <sup>1</sup> | Maximum Duty Cycle <sup>2</sup> |
|----------------|-----------------------|----------------------------------|---------------------------------|
| 1              | 100 mA @ 200 V        | DC, no limit                     | 100%                            |
| 1              | 1.5 A @ 20 V          | DC, no limit                     | 100%                            |
| 2              | 1 A @ 180 V           | 8.5 ms                           | 1%                              |
| 3 <sup>3</sup> | 1 A @ 200 V           | 2.2 ms                           | 1%                              |
| 4              | 10 A @ 5 V            | 1 ms                             | 2.2%                            |

**Minimum Programmable Pulse Width<sup>4,5</sup>** 100  $\mu\text{s}$ .  
**Note:** Minimum pulse width for settled source at a given I/V output and load can be longer than 100  $\mu\text{s}$ .

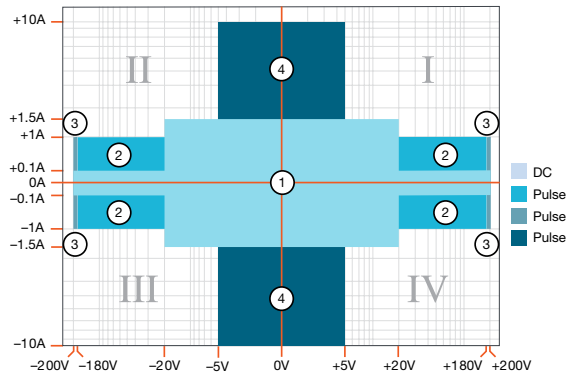
**Pulse Width Programming Resolution** 1  $\mu\text{s}$ .

**Pulse Width Programming Accuracy<sup>5</sup>**  $\pm 5\ \mu\text{s}$ .

**Pulse Width Jitter** 2  $\mu\text{s}$  (typical).

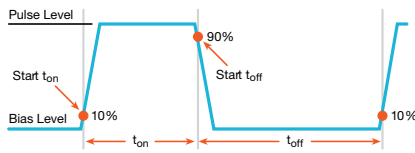


Quadrant Diagram



NOTES

1. Times measured from the start of pulse to the start off-time; see figure below.

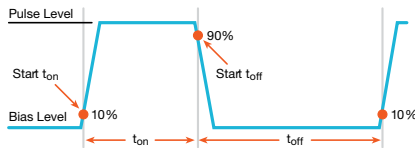


2. Thermally limited in sink mode (quadrants II and IV) and ambient temperatures above 30°C. See power equations in the reference manual for more information.
3. Voltage source operation with 1.5 A current limit.
4. Typical performance for minimum settled pulse widths:

| Source Value        | Load  | Source Settling (% of range) | Min. Pulse Width |
|---------------------|-------|------------------------------|------------------|
| 5 V                 | 0.5 Ω | 1%                           | 300 μs           |
| 20 V                | 200 Ω | 0.2%                         | 200 μs           |
| 180 V               | 180 Ω | 0.2%                         | 5 ms             |
| 200 V (1.5 A Limit) | 200 Ω | 0.2%                         | 1.5 ms           |
| 100 mA              | 200 Ω | 1%                           | 200 μs           |
| 1 A                 | 200 Ω | 1%                           | 500 μs           |
| 1 A                 | 180 Ω | 0.2%                         | 5 ms             |
| 10 A                | 0.5 Ω | 0.5%                         | 300 μs           |

Typical tests were performed using remote operation, 4W sense, and best, fixed measurement range. For more information on pulse scripts, see the Series 2600B Reference Manual.

5. Times measured from the start of pulse to the start off-time; see figure below.



## Meter Specifications (2611B, 2612B, 2614B)

### Voltage Measurement Accuracy<sup>1, 2</sup>

| Range  | Default Display Resolution <sup>3</sup> | Input Resistance | Accuracy (1 Year), 23°C ±5°C<br>±(% rdg. + volts) |
|--------|---|------------------|---|
| 200 mV | 100 nV                                  | >10 GΩ           | 0.015% + 225 μV                                   |
| 2 V    | 1 μV                                    | >10 GΩ           | 0.02% + 350 μV                                    |
| 20 V   | 10 μV                                   | >10 GΩ           | 0.015% + 5 mV                                     |
| 200 V  | 100 μV                                  | >10 GΩ           | 0.015% + 50 mV                                    |

### Temperature Coefficient (0°–18°C and 28°–50°C)<sup>4</sup>

±(0.15 × accuracy specification)/°C. Applicable for normal mode only. Not applicable for high capacitance mode.

### Current Measurement Accuracy<sup>2, 5</sup>

| Range             | Default Display Resolution <sup>6</sup> | Voltage Burden <sup>7</sup> | Accuracy (1 Year), 23°C ±5°C<br>±(% rdg. + amps) |
|-------------------|---|-----------------------------|--|
| 100 nA            | 100 fA                                  | <1 mV                       | 0.06% + 100 pA                                   |
| 1 μA              | 1 pA                                    | <1 mV                       | 0.025% + 500 pA                                  |
| 10 μA             | 10 pA                                   | <1 mV                       | 0.025% + 1.5 nA                                  |
| 100 μA            | 100 pA                                  | <1 mV                       | 0.02% + 25 nA                                    |
| 1 mA              | 1 nA                                    | <1 mV                       | 0.02% + 200 nA                                   |
| 10 mA             | 10 nA                                   | <1 mV                       | 0.02% + 2.5 μA                                   |
| 100 mA            | 100 nA                                  | <1 mV                       | 0.02% + 20 μA                                    |
| 1 A               | 1 μA                                    | <1 mV                       | 0.03% + 1.5 mA                                   |
| 1.5 A             | 1 μA                                    | <1 mV                       | 0.05% + 3.5 mA                                   |
| 10 A <sup>8</sup> | 10 μA                                   | <1 mV                       | 0.4% + 25 mA (typical)                           |

### Current Measure Settling Time (time for measurement to settle after a $V_{step}$ )<sup>9</sup>

Time required to reach within 0.1% of final value after source level command is processed on a fixed range. Values for  $V_{out} = 1$  V unless noted.

Current Range 1 mA.

Settling Time <100 μs (typical).

### Temperature Coefficient (0°–18°C and 28°–50°C)<sup>10</sup>

±(0.15 × accuracy specification)/°C. Applicable for normal mode only. Not applicable for high capacitance mode.

### Additional Meter Specifications

Maximum Load Impedance **Normal Mode:** 10 nF (typical). **High Capacitance Mode:** 50 μF (typical).

Common Mode Voltage 250 VDC.

Common Mode Isolation >1 GΩ, <4500 pF.

Overrange 101% of source range, 102% of measure range.

Maximum Sense Lead Resistance 1 kΩ for rated accuracy.

Sense Input Impedance >10 GΩ.

**Contact Check <sup>11</sup> (not available on 2614B)**

| Speed  | Maximum Measurement Time to Memory For 60 Hz (50 Hz) | Accuracy (1 Year), 23°C ±5°C<br>±(%rdg. + ohms) |
|--------|--|---|
| FAST   | 1 (1.2) ms   | 5% + 10 Ω                                       |
| MEDIUM | 4 (5) ms   | 5% + 1 Ω  |
| SLOW   | 36 (42) ms   | 5% + 0.3 Ω                                      |

**NOTES**

1. Add 50 μV to source accuracy specifications per volt of HI lead drop.
2. Derate accuracy specifications for NPLC setting <1 by increasing error term. Add appropriate % of range term using table below.

| NPLC Setting | 200 mV Range | 2 V–200 V Ranges | 100 nA Range | 1 μA–100 mA Ranges | 1 A–1.5 A Ranges |
|--------------|--------------|------------------|--------------|--------------------|------------------|
| 0.1          | 0.01%        | 0.01%            | 0.01%        | 0.01%              | 0.01%            |
| 0.01         | 0.08%        | 0.07%            | 0.1%         | 0.05%              | 0.05%            |
| 0.001        | 0.8%         | 0.6%             | 1%           | 0.5%               | 1.1%             |

3. Applies when in single channel display mode.
4. High Capacitance Mode accuracy is applicable for 23°C ±5°C only.
5. Accuracy specifications do not include connector leakage. De-rate accuracy by  $V_{out}/2E11$  per °C when operating between 18°–28°C. Derate accuracy by  $V_{out}/2E11 + (0.15 \cdot V_{out}/2E11)$  per °C when operating <18° and >28°C
6. Applies when in single channel display mode.
7. Four-wire remote sense only with current meter mode selected. Voltage measure set to 200 mV or 2 V range only.
8. 10 A range accessible only in pulse mode.
9. Compliance equal to 100 mA.
10. High Capacitance Mode accuracy is applicable for 23°C ±5°C only.
11. Includes measurement of SENSE HI to HI and SENSE LO to LO contact resistances.

**High Capacitance Mode <sup>1, 2, 3</sup>****Voltage Source Output Settling Time**

Time required to reach 0.1% of final value after source level command is processed on a fixed range. Current limit = 1 A.

| Voltage Source Range | Settling Time with $C_{load} = 4.7 \mu\text{F}$ |
|----------------------|---|
| 200 mV               | 600 μs (typical)                                |
| 2 V                  | 600 μs (typical)                                |
| 20 V                 | 1.5 μs (typical)                                |
| 200 V                | 20 ms (typical)                                 |

**Current Measure Settling Time**

Time required to reach 0.1% of final value after voltage source is stabilized on a fixed range. Values below for  $V_{out} = 2 \text{ V}$  unless noted.

| Current Measure Range | Settling Time                               |
|-----------------------|---|
| 1.5 A – 1 A           | <120 μs (typical) ( $R_{load} > 6 \Omega$ ) |
| 100 mA – 10 mA        | <100 μs (typical)                           |
| 1 mA                  | < 3 ms (typical)                            |
| 100 μA                | < 3 ms (typical)                            |
| 10 μA                 | < 230 ms (typical)                          |
| 1 μA                  | < 230 ms (typical)                          |

**Capacitor Leakage Performance Using HIGH-C Scripts <sup>4</sup>**

Load = 5 μF/10 MΩ. Test: 5 V step and measure. 200 ms (typical) @ 50 nA.

**NOTES**

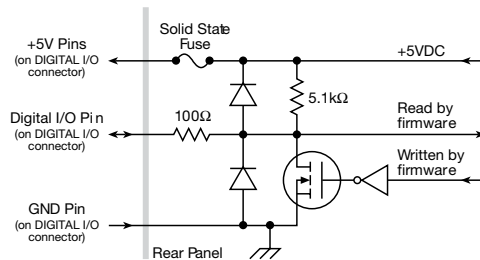
1. High Capacitance Mode specifications are for DC measurements only.
2. 100 nA range is not available in High Capacitance Mode.
3. High Capacitance Mode utilizes locked ranges. Auto Range is disabled.
4. Part of KI Factory scripts. See reference manual for details.

**Mode Change Delay**

|   |  |
|---|--|
| <b>100 <math>\mu</math>A Current Range and Above</b>                    | Delay into High Capacitance Mode: 10 ms.<br>Delay out of High Capacitance Mode: 10 ms.     |
| <b>1 <math>\mu</math>A and 10 <math>\mu</math>A Current Ranges</b>      | Delay into High Capacitance Mode: 230 ms.<br>Delay out of High Capacitance Mode: 10 ms.    |
| <b>Voltmeter Input Impedance</b>  | 30 G $\Omega$ in parallel with 3300 pF.  |
| <b>Noise, 10 Hz–20 MHz (20 V Range)</b>                                 | <30 mV peak-peak (typical).  |
| <b>Voltage Source Range Change Overshoot (for 20 V range and below)</b> | <400 mV + 0.1% of larger range (typical). Overshoot into a 200 k $\Omega$ load, 20 MHz BW. |

**General (2611B, 2612B, 2614B)**

|                              |  |
|------------------------------|--|
| <b>IEEE-488</b>              | IEEE-488.1 compliant. Supports IEEE-488.2 common commands and status model topology.   |
| <b>USB Control (rear)</b>    | USB 2.0 device, TMC488 protocol.   |
| <b>RS-232</b>                | Baud rates from 300 bps to 115200 bps.   |
| <b>Ethernet</b>              | RJ-45 connector, LXI Class C, 10/100BT, no auto MDIX.  |
| <b>Expansion Interface</b>   | The TSP-Link expansion interface allows TSP enabled instruments to trigger and communicate with each other. (Not available on 2614B.)  |
| <b>Cable Type</b>            | Category 5e or higher LAN crossover cable.   |
| <b>Length</b>                | 3 meters maximum between each TSP enabled instrument.  |
| <b>LXI Compliance</b>        | LXI Class C 1.4.   |
| <b>LXI Timing</b>            | <b>Total Output Trigger Response Time:</b> 245 $\mu$ s min., 280 $\mu$ s typ., (not specified) max.<br><b>Receive LAN[0-7] Event Delay:</b> Unknown.<br><b>Generate LAN[0-7] Event Delay:</b> Unknown. |
| <b>Digital I/O Interface</b> | (Not available on Model 2614B)   |



|  |                          |
|--|--------------------------|
| <b>Connector</b>   | 25-pin female D.         |
| <b>Input/Output Pins</b>                                       | 14 open drain I/O bits.  |
| <b>Absolute Maximum Input Voltage</b>                          | 5.25 V.                  |
| <b>Absolute Minimum Input Voltage</b>                          | -0.25 V.                 |
| <b>Maximum Logic Low Input Voltage</b>                         | 0.7 V, +850 $\mu$ A max. |
| <b>Minimum Logic High Input Voltage</b>                        | 2.1 V, +570 $\mu$ A.     |
| <b>Maximum Source Current (flowing out of Digital I/O bit)</b> | +960 $\mu$ A.            |
| <b>Maximum Sink Current @ Maximum Logic Low Voltage (0.7V)</b> | -5.0 mA.                 |

**Absolute Maximum Sink Current (flowing into Digital I/O pin)**

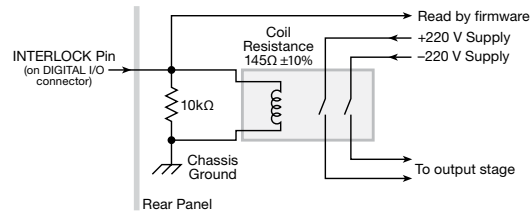
-11 mA.

**5 V Power Supply Pins**

Limited to 250 mA total for all three pins, solid state fuse protected.

**Safety Interlock Pin**

Active high input. >3.4 V @ 24 mA (absolute maximum of 6 V) must be externally applied to this pin to ensure 200 V operation. This signal is pulled down to chassis ground with a 10 k $\Omega$  resistor. 200 V operation will be blocked when the INTERLOCK signal is <0.4 V (absolute minimum -0.4 V). See figure below:

**USB File System (Front)****USB 2.0 Host:** Mass storage class device.**Power Supply**

100 V to 250 VAC, 50–60 Hz (auto sensing), 240 VA max.

**Cooling**

Forced air. Side intake and rear exhaust. One side must be unobstructed when rack mounted.

**EMC**

Conforms to European Union Directive 2004/108/EEC, EN 61326-1.

**Safety**

Conforms to European Union Directive 73/23/EEC, EN 61010-1, and UL 61010-1.

**Dimensions**89 mm high  $\times$  213 mm wide  $\times$  460 mm deep (3½ in  $\times$  8⅜ in  $\times$  17½ in).

**Bench Configuration (with handle and feet):** 104mm high  $\times$  238mm wide  $\times$  460mm deep (4⅛ in  $\times$  9⅜ in  $\times$  17½ in).

**Weight****2611B:** 4.75 kg (10.4 lbs). **2612B, 2614B:** 5.50 kg (12.0 lbs).**Environment**

For indoor use only.

**Altitude**

Maximum 2000 meters above sea level.

**Operating**

0°–50°C, 70% R.H. up to 35°C. Derate 3% R.H./°C, 35°–50°C.

**Storage**

-25°C to 65°C.

See pages 30 and 31 for measurement speeds and other specifications.

## Specification Conditions (2634B, 2635B, 2636B)

This document contains specifications and supplemental information for the 2634B, 2635B, and 2636B System SourceMeter® SMU instruments. Specifications are the standards against which the 2634B, 2635B, and 2636B are tested. Upon leaving the factory, the 2634B, 2635B, and 2636B meet these specifications. Supplemental and typical values are non-warranted, apply at 23°C, and are provided solely as useful information.

Accuracy specifications are applicable for both normal and high capacitance modes.

The source and measurement accuracies are specified at the SourceMeter CHANNEL A (2634B, 2635B, and 2636B) or SourceMeter CHANNEL B (2634B, 2636B) terminals under the following conditions:

1. 23°C ± 5°C, <70% relative humidity
2. After 2 hour warm-up
3. Speed normal (1 NPLC)
4. A/D auto-zero enabled
5. Remote sense operation or properly zeroed local operation
6. Calibration period = 1 year

## Source Specifications (2634B, 2635B, 2636B)

### Voltage Source Specifications

#### Voltage Programming Accuracy<sup>1</sup>

| Range  | Programming Resolution | Accuracy (1 Year), 23°C ±5°C<br>±(% rdg. + volts) | Typical Noise (peak-peak)<br>0.1Hz–10Hz |
|--------|------------------------|---|---|
| 200 mV | 5 µV                   | 0.02% + 375 µV                                    | 20 µV                                   |
| 2 V    | 50 µV                  | 0.02% + 600 µV                                    | 50 µV                                   |
| 20 V   | 500 µV                 | 0.02% + 5 mV                                      | 300 µV                                  |
| 200 V  | 5 mV                   | 0.02% + 50 mV                                     | 2 mV                                    |

#### Temperature Coefficient (0°–18°C and 28°–50°C)<sup>2</sup>

±(0.15 × accuracy specification)/°C. Applicable for normal mode only. Not applicable for high capacitance mode.

#### Maximum Output Power and Source/Sink Limits<sup>3</sup>

30.3W per channel maximum. ±20.2 V @ ±1.5 A, ±202 V @ ±100 mA, four quadrant source or sink operation.

#### Voltage Regulation

**Line:** 0.01% of range. **Load:** ±(0.01% of range + 100 µV).

#### Noise 10 Hz–20 MHz

<20 mV peak-peak (typical), <3 mV RMS (typical), 20 V range.

#### Current Limit/Compliance<sup>4</sup>

Bipolar current limit (compliance) set with single value. Minimum value is 100 pA. Accuracy is the same as current source.

#### Overshoot

<±(0.1% + 10 mV) typical. Step size = 10% to 90% of range, resistive load, maximum current limit/compliance.

#### Guard Offset Voltage

<4 mV typical. Current <10 mA.

### NOTES

1. Add 50 µV to source accuracy specifications per volt of HI lead drop.
2. High Capacitance Mode accuracy is applicable at 23°C ±5°C only.
3. Full power source operation regardless of load to 30°C ambient. Above 30°C and/or power sink operation, refer to "Operating Boundaries" in the Series 2600B Reference Manual for additional power derating information.
4. For sink mode operation (quadrants II and IV), add 0.06% of limit range to the corresponding current limit accuracy specifications. Specifications apply with sink mode operation enabled.

## Current Source Specifications

### Current Programming Accuracy

| Range               | Programming Resolution | Accuracy (1 Year), 23°C ±5°C<br>±(% rdg. + amps) | Typical Noise (peak-peak)<br>0.1Hz–10Hz |
|---------------------|------------------------|--|---|
| 1 nA                | 20 fA                  | 0.15% + 2 pA                                     | 800 fA                                  |
| 10 nA               | 200 fA                 | 0.15% + 5 pA                                     | 2 pA                                    |
| 100 nA              | 2 pA                   | 0.06% + 50 pA                                    | 5 pA                                    |
| 1 µA                | 20 pA                  | 0.03% + 700 pA                                   | 25 pA                                   |
| 10 µA               | 200 pA                 | 0.03% + 5 nA                                     | 60 pA                                   |
| 100 µA              | 2 nA                   | 0.03% + 60 nA                                    | 3 nA                                    |
| 1 mA                | 20 nA                  | 0.03% + 300 nA                                   | 6 nA                                    |
| 10 mA               | 200 nA                 | 0.03% + 6 µA                                     | 200 nA                                  |
| 100 mA              | 2 µA                   | 0.03% + 30 µA                                    | 600 nA                                  |
| 1 A <sup>1</sup>    | 20 µA                  | 0.05% + 1.8 mA                                   | 70 µA                                   |
| 1.5 A <sup>1</sup>  | 50 µA                  | 0.06% + 4 mA                                     | 150 µA                                  |
| 10 A <sup>1,2</sup> | 200 µA                 | 0.5 % + 40 mA (typical)                          |   |

### Temperature Coefficient (0°–18°C and 28°–50°C)<sup>3</sup>

±(0.15 × accuracy specification)/°C. Applicable for normal mode only. Not applicable for high capacitance mode.

### Maximum Output Power and Source/Sink Limits<sup>4</sup>

30.3 W per channel maximum. ±1.515 A @ ±20 V, ±101 mA @ ±200 V, four quadrant source or sink operation.

### Current Regulation

**Line:** 0.01% of range. **Load:** ±(0.01% of range + 100 pA).

### Voltage Limit/Compliance<sup>5</sup>

Bipolar voltage limit (compliance) set with a single value. Minimum value is 20 mV. Accuracy is the same as voltage source.

### Overshoot

<±0.1% typical. Step size = 10% to 90% of range, resistive load; see Current Source Output Settling Time for additional test conditions).

## Additional Source Specifications

### Transient Response Time

<70 µs for the output to recover to within 0.1% for a 10% to 90% step change in load.

### Voltage Source Output Settling Time

Time required to reach within 0.1% of final value after source level command is processed on a fixed range.

| Range  | Settling Time     |
|--------|-------------------|
| 200 mV | <50 µs (typical)  |
| 2 V    | <50 µs (typical)  |
| 20 V   | <110 µs (typical) |
| 200 V  | <700 µs (typical) |

## NOTES

1. Full power source operation regardless of load to 30°C ambient. Above 30°C and/or power sink operation, refer to "Operating Boundaries" in the Series 2600B Reference Manual for additional power derating information.
2. 10 A range accessible only in pulse mode.
3. High Capacitance Mode accuracy is applicable at 23°C ±5°C only.
4. Full power source operation regardless of load to 30°C ambient. Above 30°C and/or power sink operation, refer to "Operating Boundaries" in the Series 2600B Reference Manual for additional power derating information.
5. For sink mode operation (quadrants II and IV), add 10% of compliance range and ±0.02% of limit setting to corresponding voltage source specification. For 200 mV range add an additional 120 mV of uncertainty.

**Current Source Output Settling Time**

Time required to reach within 0.1% of final value after source level command is processed on a fixed range. Values below for  $I_{out} \times R_{load} = 1\text{ V}$  unless noted.

| Range             | Settling Time   |
|-------------------|---|
| 1.5 A – 1 A       | <120 $\mu\text{s}$ (typical) ( $R_{load} > 6\Omega$ ) |
| 100 mA – 10 mA    | <80 $\mu\text{s}$ (typical)                           |
| 1 mA              | <100 $\mu\text{s}$ (typical)                          |
| 100 $\mu\text{A}$ | <150 $\mu\text{s}$ (typical)                          |
| 10 $\mu\text{A}$  | <500 $\mu\text{s}$ (typical)                          |
| 1 $\mu\text{A}$   | <2 ms (typical)                                       |
| 100 nA            | <20 ms (typical)                                      |
| 10 nA             | <40 ms (typical)                                      |
| 1 nA              | <150 ms (typical)                                     |

**DC Floating Voltage**

Output can be floated up to  $\pm 250\text{ VDC}$  from chassis ground.

**Remote Sense Operating Range<sup>1</sup>**

Maximum voltage between HI and SENSE HI = 3 V.  
Maximum voltage between LO and SENSE LO = 3 V.

**Voltage Output Headroom**

**200 V Range**

Max. output voltage = 202.3 V – total voltage drop across source leads (maximum 1  $\Omega$  per source lead).

**20 V Range**

Max. output voltage = 23.3 V – total voltage drop across source leads (maximum 1  $\Omega$  per source lead).

**Over Temperature Protection**

Internally sensed temperature overload puts unit in standby mode.

**Voltage Source Range Change Overshoot**

<300 mV + 0.1% of larger range (typical). Overshoot into a 200 k $\Omega$  load, 20 MHz BW.

**Current Source Range Change Overshoot**

<5% of larger range + 300 mV/ $R_{load}$  (typical with source settling set to SETTLE\_SMOOTH\_100NA). See Current Source Output Settling Time for additional test conditions.

**NOTES**

1. Add 50  $\mu\text{V}$  to source accuracy specifications per volt of HI lead drop.

**Pulse Specifications**

| Region         | Maximum Current Limit | Maximum Pulse Width <sup>1</sup> | Maximum Duty Cycle <sup>2</sup> |
|----------------|-----------------------|----------------------------------|---------------------------------|
| 1              | 100 mA @ 200 V        | DC, no limit                     | 100%                            |
| 1              | 1.5 A @ 20 V          | DC, no limit                     | 100%                            |
| 2              | 1 A @ 180 V           | 8.5 ms                           | 1%                              |
| 3 <sup>3</sup> | 1 A @ 200 V           | 2.2 ms                           | 1%                              |
| 4              | 10 A @ 5 V            | 1 ms                             | 2.2%                            |

**Minimum Programmable Pulse Width<sup>4,5</sup>**

100  $\mu\text{s}$ .  
**Note:** Minimum pulse width for settled source at a given I/V output and load can be longer than 100  $\mu\text{s}$ .

**Pulse Width Programming Resolution**

1  $\mu\text{s}$ .

**Pulse Width Programming Accuracy<sup>5</sup>**

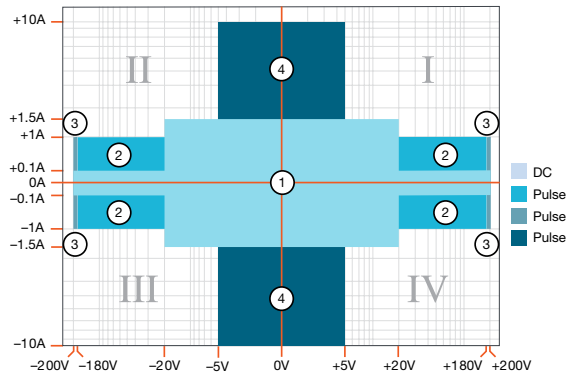
$\pm 5\ \mu\text{s}$ .

**Pulse Width Jitter**

50  $\mu\text{s}$  (typical).

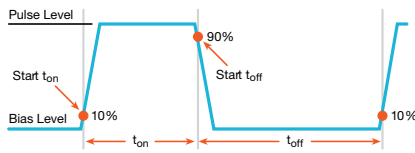


Quadrant Diagram



NOTES

1. Times measured from the start of pulse to the start off-time; see figure below.

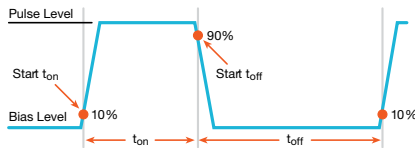


2. Thermally limited in sink mode (quadrants II and IV) and ambient temperatures above 30°C. See power equations in the reference manual for more information.
3. Voltage source operation with 1.5 A current limit.
4. Typical performance for minimum settled pulse widths:

| Source Value        | Load  | Source Settling (% of range) | Min. Pulse Width |
|---------------------|-------|------------------------------|------------------|
| 5 V                 | 0.5 Ω | 1%                           | 300 μs           |
| 20 V                | 200 Ω | 0.2%                         | 200 μs           |
| 180 V               | 180 Ω | 0.2%                         | 5 ms             |
| 200 V (1.5 A Limit) | 200 Ω | 0.2%                         | 1.5 ms           |
| 100 mA              | 200 Ω | 1%                           | 200 μs           |
| 1 A                 | 200 Ω | 1%                           | 500 μs           |
| 1 A                 | 180 Ω | 0.2%                         | 5 ms             |
| 10 A                | 0.5 Ω | 0.5%                         | 300 μs           |

Typical tests were performed using remote operation, 4W sense, and best, fixed measurement range. For more information on pulse scripts, see the Series 2600B Reference Manual.

5. Times measured from the start of pulse to the start off-time; see figure below.



## Meter Specifications (2634B, 2635B, 2636B)

### Voltage Measurement Accuracy <sup>1, 2</sup>

| Range  | Default Display Resolution <sup>3</sup> | Input Resistance    | Accuracy (1 Year), 23°C ±5°C ±(% rdg. + volts) |
|--------|---|---------------------|--|
| 200 mV | 100 nV                                  | >10 <sup>14</sup> Ω | 0.015% + 225 μV                                |
| 2 V    | 1 μV                                    | >10 <sup>14</sup> Ω | 0.02% + 350 μV                                 |
| 20 V   | 10 μV                                   | >10 <sup>14</sup> Ω | 0.015% + 5 mV                                  |
| 200 V  | 100 μV                                  | >10 <sup>14</sup> Ω | 0.015% + 50 mV                                 |

### Temperature Coefficient (0°–18°C and 28°–50°C) <sup>4</sup>

±(0.15 × accuracy specification)/°C. Applicable for normal mode only. Not applicable for high capacitance mode.

### Current Measurement Accuracy <sup>2</sup>

| Range                   | Default Display Resolution <sup>5</sup> | Voltage Burden <sup>6</sup> | Accuracy (1 Year), 23°C ±5°C ±(% rdg. + amps) |
|-------------------------|---|-----------------------------|---|
| *100 pA <sup>7, 8</sup> | 0.1 fA                                  | <1 mV                       | 0.15% + 120 fA                                |
| 1 nA <sup>7, 9</sup>    | 1 fA                                    | <1 mV                       | 0.15% + 240 fA                                |
| 10 nA                   | 10 fA                                   | <1 mV                       | 0.15% + 3 pA                                  |
| 100 nA                  | 100 fA                                  | <1 mV                       | 0.06% + 40 pA                                 |
| 1 μA                    | 1 pA                                    | <1 mV                       | 0.025% + 400 pA                               |
| 10 μA                   | 10 pA                                   | <1 mV                       | 0.025% + 1.5 nA                               |
| 100 μA                  | 100 pA                                  | <1 mV                       | 0.02% + 25 nA                                 |
| 1 mA                    | 1 nA                                    | <1 mV                       | 0.02% + 200 nA                                |
| 10 mA                   | 10 nA                                   | <1 mV                       | 0.02% + 2.5 μA                                |
| 100 mA                  | 100 nA                                  | <1 mV                       | 0.02% + 20 μA                                 |
| 1 A                     | 1 μA                                    | <1 mV                       | 0.03% + 1.5 mA                                |
| 1.5 A                   | 1 μA                                    | <1 mV                       | 0.05% + 3.5 mA                                |
| 10 A <sup>10</sup>      | 10 μA                                   | <1 mV                       | 0.4% + 25 mA                                  |

\*100 pA range not available on Model 2634B.

### Current Measure Settling Time (time for measurement to settle after a $V_{step}$ ) <sup>11</sup>

Time required to reach within 0.1% of final value after source level command is processed on a fixed range. Values for  $V_{out} = 2$  V unless noted.

**Current Range** 1 mA.

**Settling Time** <100 μs (typical).

### Temperature Coefficient (0°–18°C and 28°–50°C) <sup>12</sup>

±(0.15 × accuracy specification)/°C. Applicable for normal mode only. Not applicable for high capacitance mode.

### NOTES

1. Add 50 μV to source accuracy specifications per volt of HI lead drop.
2. Derate accuracy specifications for NPLC setting <1 by increasing error term. Add appropriate % of range term using table below.

| NPLC Setting | 200 mV Range | 2 V–200 V Ranges | 100 nA Range | 1 μA–100 mA Ranges | 1 A–1.5 A Ranges |
|--------------|--------------|------------------|--------------|--------------------|------------------|
| 0.1          | 0.01%        | 0.01%            | 0.01%        | 0.01%              | 0.01%            |
| 0.01         | 0.08%        | 0.07%            | 0.1%         | 0.05%              | 0.05%            |
| 0.001        | 0.8%         | 0.6%             | 1%           | 0.5%               | 1.1%             |

3. Applies when in single channel display mode.
4. High Capacitance Mode accuracy is applicable for 23°C ±5°C only.
5. Applies when in single channel display mode.
6. Four-wire remote sense only with current meter mode selected. Voltage measure set to 200 mV or 2 V range only.
7. 10-NPLC, 11-Point Median Filter, <200 V range, measurements made within 1 hour after zeroing. 23°C ± 1°C
8. Under default specification conditions: ±(0.15% + 750 fA).
9. Under default specification conditions: ±(0.15% + 1 pA).
10. 10 A range accessible only in pulse mode.
11. Delay factor set to 1. Compliance equal to 100 mA.
12. High Capacitance Mode accuracy is applicable for 23°C ±5°C only.

## Additional Meter Specifications

|                               |  |
|-------------------------------|--|
| Maximum Load Impedance        | <b>Normal Mode:</b> 10 nF (typical). <b>High Capacitance Mode:</b> 50 $\mu$ F (typical). |
| Common Mode Voltage           | 250 VDC.   |
| Common Mode Isolation         | >1 G $\Omega$ , <4500 pF.  |
| Overrange                     | 101% of source range, 102% of measure range.   |
| Maximum Sense Lead Resistance | 1 k $\Omega$ for rated accuracy.   |
| Sense Input Impedance         | >10 <sup>14</sup> $\Omega$ .   |

## Contact Check <sup>1</sup> (not available on 2634B)

| Speed  | Maximum Measurement Time to Memory For 60 Hz (50 Hz) | Accuracy (1 Year), 23°C $\pm$ 5°C<br>$\pm$ (%rdg. + ohms) |
|--------|--|---|
| FAST   | 1 (1.2) ms   | 5% + 10 $\Omega$  |
| MEDIUM | 4 (5) ms   | 5% + 1 $\Omega$   |
| SLOW   | 36 (42) ms   | 5% + 0.3 $\Omega$   |

## High Capacitance Mode <sup>2, 3, 4</sup>

**Voltage Source Output Settling Time** Time required to reach 0.1% of final value after source level command is processed on a fixed range. Current limit = 1 A.

| Voltage Source Range | Settling Time with C <sub>load</sub> = 4.7 $\mu$ F |
|----------------------|--|
| 200 mV               | 600 $\mu$ s (typical)                              |
| 2 V                  | 600 $\mu$ s (typical)                              |
| 20 V                 | 1.5 $\mu$ s (typical)                              |
| 200 V                | 20 ms (typical)                                    |

**Current Measure Settling Time** Time required to reach 0.1% of final value after voltage source is stabilized on a fixed range. Values below for V<sub>out</sub> = 2 V unless noted.

| Current Measure Range | Settling Time  |
|-----------------------|--|
| 1.5 A – 1 A           | <120 $\mu$ s (typical) (R <sub>load</sub> > 6 $\Omega$ ) |
| 100 mA – 10 mA        | <100 $\mu$ s (typical)                                   |
| 1 mA                  | < 3 ms (typical)   |
| 100 $\mu$ A           | < 3 ms (typical)   |
| 10 $\mu$ A            | < 230 ms (typical)                                       |
| 1 $\mu$ A             | < 230 ms (typical)                                       |

## Capacitor Leakage Performance Using HIGH-C Scripts <sup>5</sup>

Load = 5  $\mu$ F/10 M $\Omega$ . **Test:** 5 V step and measure. 200 ms (typical) @ 50 nA.

## NOTES

- Includes measurement of SENSE HI to HI and SENSE LO to LO contact resistances.
- High Capacitance Mode specifications are for DC measurements only.
- 100 nA range is not available in High Capacitance Mode.
- High Capacitance Mode utilizes locked ranges. Auto Range is disabled.
- Part of KI Factory scripts. See reference manual for details.

## Mode Change Delay

|  |   |
|--|---|
| <b>100 <math>\mu</math>A Current Range and Above</b>               | Delay into High Capacitance Mode: 10 ms.<br>Delay out of High Capacitance Mode: 10 ms.  |
| <b>1 <math>\mu</math>A and 10 <math>\mu</math>A Current Ranges</b> | Delay into High Capacitance Mode: 230 ms.<br>Delay out of High Capacitance Mode: 10 ms. |

**Voltmeter Input Impedance** 30 G $\Omega$  in parallel with 3300 pF.

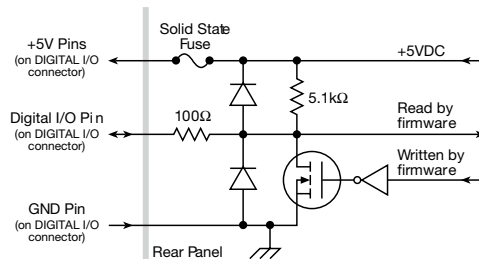
**Noise, 10 Hz–20 MHz (20 V Range)** <30 mV peak-peak (typical).

## Voltage Source Range Change Overshoot (for 20 V range and below)

<400 mV + 0.1% of larger range (typical). Overshoot into a 200 k $\Omega$  load, 20 MHz BW.

## General (2634B, 2635B, 2636B)

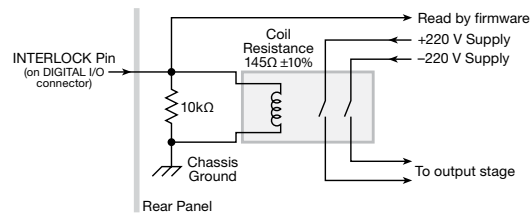
|                       |  |
|-----------------------|--|
| IEEE-488              | IEEE-488.1 compliant. Supports IEEE-488.2 common commands and status model topology.   |
| USB Control (rear)    | USB 2.0 device, TMC488 protocol.   |
| RS-232                | Baud rates from 300bps to 115200bps. Programmable number of data bits, parity type, and flow control (RTS/CTS hardware or none).   |
| Ethernet              | RJ-45 connector, LXI Class C, 10/100BT, no auto MDIX.  |
| Expansion Interface   | The TSP-Link expansion interface allows TSP enabled instruments to trigger and communicate with each other. (Not available on 2634B.)  |
| Cable Type            | Category 5e or higher LAN crossover cable.   |
| Length                | 3 meters maximum between each TSP enabled instrument.  |
| LXI Compliance        | LXI Class C 1.4.   |
| LXI Timing            | <b>Total Output Trigger Response Time:</b> 245 $\mu$ s min., 280 $\mu$ s typ., (not specified) max.<br><b>Receive LAN[0-7] Event Delay:</b> Unknown.<br><b>Generate LAN[0-7] Event Delay:</b> Unknown. |
| Digital I/O Interface | (Not available on Model 2634B)   |



|  |   |
|--|---|
| Connector  | 25-pin female D.  |
| Input/Output Pins  | 14 open drain I/O bits.   |
| Absolute Maximum Input Voltage                               | 5.25 V.   |
| Absolute Minimum Input Voltage                               | -0.25 V.  |
| Maximum Logic Low Input Voltage                              | 0.7 V, +850 $\mu$ A max.  |
| Minimum Logic High Input Voltage                             | 2.1 V, +570 $\mu$ A.  |
| Maximum Source Current (flowing out of Digital I/O bit)      | +960 $\mu$ A.   |
| Maximum Sink Current @ Maximum Logic Low Voltage (0.7V)      | -5.0 mA.  |
| Absolute Maximum Sink Current (flowing into Digital I/O pin) | -11 mA.   |
| 5 V Power Supply Pins  | Limited to 250 mA total for all three pins, solid state fuse protected. |

**Safety Interlock Pin**

Active high input.  $>3.4\text{ V}$  @  $24\text{ mA}$  (absolute maximum of  $6\text{ V}$ ) must be externally applied to this pin to ensure  $200\text{ V}$  operation. This signal is pulled down to chassis ground with a  $10\text{ k}\Omega$  resistor.  $200\text{ V}$  operation will be blocked when the INTERLOCK signal is  $<0.4\text{ V}$  (absolute minimum  $-0.4\text{ V}$ ). See figure below:



|                                |  |
|--------------------------------|--|
| <b>USB File System (Front)</b> | <b>USB 2.0 Host:</b> Mass storage class device.  |
| <b>Power Supply</b>            | $100\text{ V}$ to $250\text{ VAC}$ , $50\text{--}60\text{ Hz}$ (auto sensing), $240\text{ VA}$ max.  |
| <b>Cooling</b>                 | Forced air. Side intake and rear exhaust. One side must be unobstructed when rack mounted.   |
| <b>EMC</b>                     | Conforms to European Union Directive 2004/108/EEC, EN 61326-1.   |
| <b>Safety</b>                  | Conforms to European Union Directive 73/23/EEC, EN 61010-1, and UL 61010-1.  |
| <b>Dimensions</b>              | $89\text{ mm}$ high $\times$ $213\text{ mm}$ wide $\times$ $460\text{ mm}$ deep ( $3\frac{1}{2}\text{ in}$ $\times$ $8\frac{3}{8}\text{ in}$ $\times$ $17\frac{1}{2}\text{ in}$ ).<br><b>Bench Configuration (with handle and feet):</b> $104\text{ mm}$ high $\times$ $238\text{ mm}$ wide $\times$ $460\text{ mm}$ deep ( $4\frac{1}{8}\text{ in}$ $\times$ $9\frac{3}{8}\text{ in}$ $\times$ $17\frac{1}{2}\text{ in}$ ). |
| <b>Weight</b>                  | <b>2635B:</b> $4.75\text{ kg}$ ( $10.4\text{ lbs}$ ). <b>2634B, 2636B:</b> $5.50\text{ kg}$ ( $12.0\text{ lbs}$ ).   |
| <b>Environment</b>             | For indoor use only.   |
| <b>Altitude</b>                | Maximum $2000\text{ meters}$ above sea level.  |
| <b>Operating</b>               | $0^{\circ}\text{--}50^{\circ}\text{C}$ , $70\%$ R.H. up to $35^{\circ}\text{C}$ . Derate $3\%$ R.H./ $^{\circ}\text{C}$ , $35^{\circ}\text{--}50^{\circ}\text{C}$ .  |
| <b>Storage</b>                 | $-25^{\circ}\text{C}$ to $65^{\circ}\text{C}$ .  |

See pages 30 and 31 for measurement speeds and other specifications.

## Measurement Speed Specifications <sup>1, 2, 3</sup> (All Instruments)

### Maximum Sweep Operation Rates (operations per second) for 60Hz (50Hz):

| A/D Converter Speed | Trigger Origin | Measure To Memory Using User Scripts | Measure To GPIB Using User Scripts | Source Measure To Memory Using User Scripts | Source Measure To GPIB Using User Scripts | Source Measure To Memory Using Sweep API | Source Measure To GPIB Using Sweep API |
|---------------------|----------------|--------------------------------------|------------------------------------|---|---|--|--|
| 0.001 NPLC          | Internal       | 20000 (20000)                        | 10500 (10500)                      | 7000 (7000)                                 | 6200 (6200)                               | 12000 (12000)                            | 5900 (5900)                            |
| 0.001 NPLC          | Digital I/O    | 8100 (8100)                          | 7100 (7100)                        | 5500 (5500)                                 | 5100 (5100)                               | 11200 (11200)                            | 5700 (5700)                            |
| 0.01 NPLC           | Internal       | 5000 (4000)                          | 4000 (3500)                        | 3400 (3000)                                 | 3200 (2900)                               | 4200 (3700)                              | 3100 (2800)                            |
| 0.01 NPLC           | Digital I/O    | 3650 (3200)                          | 3400 (3000)                        | 3000 (2700)                                 | 2900 (2600)                               | 4150 (3650)                              | 3050 (2775)                            |
| 0.1 NPLC            | Internal       | 580 (490)                            | 560 (475)                          | 550 (465)                                   | 550 (460)                                 | 575 (480)                                | 545 (460)                              |
| 0.1 NPLC            | Digital I/O    | 560 (470)                            | 450 (460)                          | 545 (460)                                   | 540 (450)                                 | 570 (480)                                | 545 (460)                              |
| 1.0 NPLC            | Internal       | 59 (49)                              | 59 (49)                            | 59 (49)                                     | 59 (49)                                   | 59 (49)                                  | 59 (49)                                |
| 1.0 NPLC            | Digital I/O    | 58 (48)                              | 58 (49)                            | 59 (49)                                     | 59 (49)                                   | 59 (49)                                  | 59 (49)                                |

### Maximum Single Operation Rates (operations per second) for 60Hz (50Hz):

| A/D Converter Speed | Trigger Origin | Measure To GPIB | Source Measure To GPIB | Source Measure Pass/Fail To GPIB |
|---------------------|----------------|-----------------|------------------------|----------------------------------|
| 0.001 NPLC          | Internal       | 1900 (1800)     | 1400 (1400)            | 1400 (1400)                      |
| 0.01 NPLC           | Internal       | 1450 (1400)     | 1200 (1100)            | 1100 (1100)                      |
| 0.1 NPLC            | Internal       | 450 (390)       | 425 (370)              | 425 (375)                        |
| 1.0 NPLC            | Internal       | 58 (48)         | 57 (48)                | 57 (48)                          |

#### Maximum Measurement Range Change Rate

<150  $\mu$ s for ranges >10  $\mu$ A, typical. When changing to or from a range  $\geq$ 1 A, maximum rate is <450  $\mu$ s, typical.

#### Maximum Source Range Change Rate

<2.5 ms for ranges >10  $\mu$ A, typical. When changing to or from a range  $\geq$ 1 A, maximum rate is <5.2 ms, typical.

#### Maximum Source Function Change Rate

<1 ms, typical.

#### Command Processing Time

Maximum time required for the output to begin to change following the receipt of the smux.source.levelv or smux.source.leveli command. <1 ms typical.

#### NOTES

1. Tests performed with a 2602B, 2612B, or 2636B on Channel A using the following equipment: PC Hardware (Pentium® 4 2.4 GHz, 512 MB RAM, National Instruments PCI-GPIB). Driver (NI-486.2 Version 2.2 PCI-GPIB). Software (Microsoft® Windows® 2000, Microsoft Visual Studio 2005, VISA version 4.1).
2. Exclude current measurement ranges less than 1 mA.
3. 2635B/2636B with default measurement delays and filters disabled.

## Triggering and Synchronization Specifications <sup>1</sup>

### Triggering

Trigger in to Trigger Out 0.5  $\mu$ s, typical.

Trigger in to Source Change<sup>2</sup> 10  $\mu$ s, typical.

Trigger Timer Accuracy  $\pm$ 2  $\mu$ s, typical.

Source Change<sup>2</sup> After LXI Trigger  
280  $\mu$ s, typical.

### Synchronization

Single-Node Synchronized Source Change<sup>2</sup>: <0.5  $\mu$ s, typical.

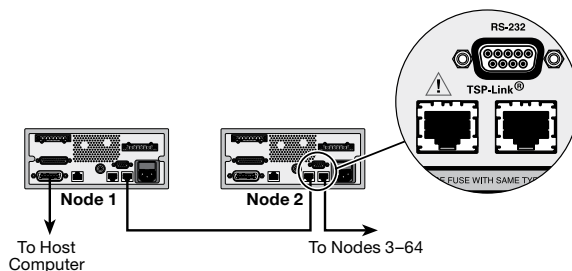
Multi-Node Synchronized Source Change<sup>2</sup>: <0.5  $\mu$ s, typical.

#### NOTES

1. TSP-Link not available on 2604B, 2614B, and 2634B.
2. Fixed source range, with no polarity change.

## Supplemental Information (All Instruments)

|                                 |  |
|---------------------------------|--|
| <b>Front Panel Interface</b>    | Two-line vacuum fluorescent display (VFD) with keypad and rotary knob.   |
| <b>Display</b>                  | Show error messages and user defined messages.<br>Display source and limit settings.<br>Show current and voltage measurements.<br>View measurements stored in dedicated reading buffers.   |
| <b>Keypad Operations</b>        | Change host interface settings.<br>Save and restore instrument setups.<br>Load and run factory and user defined test scripts (i.e. sequences) that prompt for input and send results to the display.<br>Store measurements into dedicated reading buffers.   |
| <b>Programming</b>              | Embedded Test Script Processor (TSP) accessible from any host interface. Responds to individual instrument control commands. Responds to high speed test scripts comprised of instrument control commands and Test Script Language (TSL) statements (e.g. branching, looping, math, etc.). Able to execute high speed test scripts stored in memory without host intervention.   |
| <b>Minimum Memory Available</b> | 16 MB (approximately 250,000 lines of TSL code).   |
| <b>Test Script Builder</b>      | Integrated development environment for building, running, and managing TSP scripts. Includes an instrument console for communicating with any TSP enabled instrument in an interactive manner.<br>Requires:<br>VISA (NI-VISA included on CD)<br>Pentium III 800MHz or faster personal computer<br>Microsoft .NET Framework (included on CD)<br>Microsoft Windows 98, NT, 2000, or XP<br>Keithley I/O Layer (included on CD)  |
| <b>Software Interface</b>       | TSP Express (embedded), Direct GPIB/VISA, READ/WRITE for VB, VC/C++, LabVIEW, LabWindows/CVI, etc.   |
| <b>Reading Buffers</b>          | Dedicated storage area(s) reserved for measurement data. Reading buffers are arrays of measurement elements. Each element can hold the following items:<br>Measurement<br>Source setting (at the time the measurement was taken)<br>Measurement Status<br>Range information<br>Timestamp<br><br>Two reading buffers are reserved for each SourceMeter channel. Reading buffers can be filled using the front panel STORE key and retrieved using the RECALL key or host interface.<br><b>Buffer Size, with timestamp and source setting:</b> >60,000 samples.<br><b>Buffer Size, without timestamp and source setting:</b> >140,000 samples. |
| <b>System Expansion</b>         | The TSP-Link expansion interface allows TSP enabled instruments to trigger and communicate with each other. Not applicable for 2604B, 2614B, and 2634B. See figure below:  |



Each SourceMeter SMU instrument has two TSP-Link connectors to facilitate chaining instruments together.

Once SourceMeter SMU instruments are interconnected via TSP-Link, a computer can access all of the resources of each SourceMeter SMU instrument via the host interface of any SourceMeter SMU instrument.

A maximum of 32 TSP-Link nodes can be interconnected. Each SourceMeter SMU instrument consumes one TSP-Link node.

|                   |   |
|-------------------|---|
| <b>TIMER</b>      | Free running 47-bit counter with 1 MHz clock input. Reset each time instrument powers up. Rolls over every 4 years. |
| <b>Timestamp</b>  | TIMER value automatically saved when each measurement is triggered.   |
| <b>Resolution</b> | 1 $\mu$ s.  |
| <b>Accuracy</b>   | $\pm$ 100 ppm.  |

## Supplied Accessories (All Instruments)

### Operators and Programming Manuals

|                                     |  |
|-------------------------------------|--|
| <b>2600-ALG-2</b>                   | Low Noise Triax Cable with Alligator Clips, 2m (6.6 ft.) (two supplied with 2634B and 2636B, one with 2635B) |
| <b>2600-Kit</b>                     | Screw Terminal Connector Kit (2601B, 2602B, 2604B, 2611B, 2612B, 2614B)                                      |
| <b>2600B-800A</b>                   | Series 2400 Emulation Script for Series 2600B (supplied on USB memory stick)                                 |
| <b>7709-308A</b>                    | Digital I/O Connector  |
| <b>CA-180-3A</b>                    | TSP-Link/Ethernet Cable (two per unit)   |
| <b>TSP Express Software Tool</b>    | (embedded)   |
| <b>Test Script Builder Software</b> | (supplied on CD)   |
| <b>LabVIEW Driver</b>               | (supplied on CD)   |
| <b>ACS Basic Edition Software</b>   | (optional)   |

## Available Accessories (All Instruments)

### Software

|                  |                                     |
|------------------|-------------------------------------|
| <b>ACS-BASIC</b> | Component Characterization Software |
|------------------|-------------------------------------|

### Rack Mount Kits

|               |   |
|---------------|---|
| <b>4299-1</b> | Single Rack Mount Kit with front and rear support |
| <b>4299-2</b> | Dual Rack Mount Kit with front and rear support   |
| <b>4299-5</b> | 1U Vent Panel                                     |

### Cables and Connectors

|                       |  |
|-----------------------|--|
| <b>2600-BAN</b>       | Banana Test Leads/Adapter Cable. For a single 2601B/2602B/2604B/2611B/2612B/2614B SMU instrument channel   |
| <b>2600-KIT</b>       | Extra screw terminal connector, strain relief, and cover for a single SourceMeter channel (one supplied with 2601B and 2611B, two with 2602B, 2604B, 2612B, 2614B) |
| <b>2600-FIX-TRIAX</b> | Phoenix-to-Triax Adapter for 2 wire sensing  |
| <b>2600-TRIAX</b>     | Phoenix-to-Triax Adapter for 4 wire sensing  |
| <b>7078-TRX-*</b>     | 3-Slot, Low Noise Triax Cable, 0.3m–6.1m. For use with 2600-TRIAX Adapter  |
| <b>7078-TRX-GND</b>   | 3-Slot male triax to BNC adapter (guard removed)   |
| <b>7709-308A</b>      | Digital I/O Connector (model specific)   |
| <b>8606</b>           | High Performance Modular Probe Kit. For use with 2600B-BAN   |



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## GPIO Interfaces and Cables

|             |   |
|-------------|---|
| 7007-1      | Double Shielded GPIB Cable, 1 m (3.3 ft.)     |
| 7007-2      | Double Shielded GPIB Cable, 2 m (6.6 ft.)     |
| KPCI-488LPA | IEEE-488 Interface/Controller for the PCI Bus |

---

## Digital I/O, Trigger Link, and TSP-Link

|            |   |
|------------|---|
| 2600-TLINK | Digital I/O to TLINK Adapter Cable, 1 m   |
| CA-126-1A  | Digital I/O and Trigger Cable, 1.5 m  |
| CA-180-3A  | CAT5 Crossover Cable for TSP-Link and direct Ethernet connection (two supplied) |

---

## Test Fixtures

|           |  |
|-----------|--|
| 8101-PIV  | DC, Pulse I-V and C-V Component Test Fixture                             |
| 8101-4TRX | 4 Pin Transistor Fixture   |
| LR8028    | Component Test Fixture – Optimized for device testing at up to 200 V/1 A |

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## Switching

|              |  |
|--------------|--|
| Series 3700A | DMM/Switch Systems                       |
| 707B         | Semiconductor Switching Matrix Mainframe |

---

## Calibration and Verification

|              |  |
|--------------|--|
| 2600-STD-RES | Calibration Standard 1 G $\Omega$ Resistor for 2634B, 2635B, and 2636B |
|--------------|--|

## Available Services (All Instruments)

---

### Extended Warranties

|             |   |
|-------------|---|
| 26xxB-EW    | 1 Year Factory Warranty extended to 2 years |
| 26xxB-3Y-EW | 1 Year Factory Warranty extended to 3 years |
| 26xxB-5Y-EW | 1 Year Factory Warranty extended to 5 years |

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### Calibration Contracts

|                  |   |
|------------------|---|
| C/26xxB-3Y-STD   | 3 Calibrations within 3 years   |
| C/26xxB-5Y-STD   | 5 Calibrations within 5 years   |
| C/26xxB-3Y-DATA  | 3 Calibrations within 3 years and includes calibration data before and after adjustment |
| C/26xxB-5Y-DATA  | 5 Calibrations within 5 years and includes calibration data before and after adjustment |
| C/26xxB-3Y-17025 | 3 ISO-17025 accredited calibrations within 3 years                                      |
| C/26xxB-5Y-17025 | 5 ISO-17025 accredited calibrations within 5 years                                      |

## Ordering Information (All Instruments)

|              |   |
|--------------|---|
| <b>2601B</b> | Single-channel System SourceMeter SMU Instrument (3 A DC, 10 A Pulse)                 |
| <b>2602B</b> | Dual-channel System SourceMeter SMU Instrument (3 A DC, 10 A Pulse)                   |
| <b>2604B</b> | Dual-channel System SourceMeter SMU Instrument (3 A DC, 10 A Pulse, Benchtop Version) |
| <b>2611B</b> | Single-channel System SourceMeter SMU Instrument (200 V, 10 A Pulse)                  |
| <b>2612B</b> | Dual-channel System SourceMeter SMU Instrument (200 V, 10 A Pulse)                    |
| <b>2614B</b> | Dual-channel System SourceMeter SMU Instrument (200 V, 10 A Pulse, Benchtop Version)  |
| <b>2634B</b> | Dual-channel System SourceMeter SMU Instrument (1 fA, 10 A Pulse, Benchtop Version)   |
| <b>2635B</b> | Single-channel System SourceMeter SMU Instrument (0.1 fA, 10 A Pulse)                 |
| <b>2636B</b> | Dual-channel System SourceMeter SMU Instrument (0.1 fA, 10 A Pulse)                   |

## Warranty Information

|                          |  |
|--------------------------|--|
| <b>Warranty Summary</b>  | This section summarizes the warranties of the Series 2600B. For complete warranty information, refer to the Series 2600B 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.  |
| <b>Hardware Warranty</b> | 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.   |
| <b>Software Warranty</b> | 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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