

# Series 2600A System SourceMeter®

## Quick Start Guide

2600AS-903-01 Rev. A / September 2008



# WARRANTY

Keithley Instruments, Inc. warrants this product to be free from defects in material and workmanship for a period of one (1) year from date of shipment.

Keithley Instruments, Inc. warrants the following items for 90 days from the date of shipment: probes, cables, software, rechargeable batteries, diskettes, and documentation.

During the warranty period, Keithley Instruments will, at its option, either repair or replace any product that proves to be defective.

To exercise this warranty, write or call your local Keithley Instruments representative, or contact Keithley Instruments headquarters in Cleveland, Ohio. You will be given prompt assistance and return instructions. Send the product, transportation prepaid, to the indicated service facility. Repairs will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days.

## LIMITATION OF WARRANTY

This warranty does not apply to defects resulting from product modification without Keithley Instruments' express written consent, or misuse of any product or part. This warranty also does not apply to fuses, software, non-rechargeable batteries, damage from battery leakage, or problems arising from normal wear or failure to follow instructions.

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**KEITHLEY**

A G R E A T E R M E A S U R E O F C O N F I D E N C E

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The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance information carefully before using the product. Refer to the user documentation for complete product specifications.

If the product is used in a manner not specified, the protection provided by the product warranty may be impaired.

The types of product users are:

**Responsible body** is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

**Operators** use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

**Maintenance personnel** perform routine procedures on the product to keep it operating properly, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the user documentation. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

**Service personnel** are trained to work on live circuits, perform safe installations, and repair products. Only properly trained service personnel may perform installation and service procedures.

Keithley Instruments products are designed for use with electrical signals that are rated Measurement Category I and Measurement Category II, as described in the International Electrotechnical Commission (IEC) Standard IEC 60664. Most measurement, control, and data I/O signals are Measurement Category I and must not be directly connected to mains voltage or to voltage sources with high transient over-voltages. Measurement Category II connections require protection for high transient over-voltages often associated with local AC mains connections. Assume all measurement, control, and data I/O connections are for connection to Category I sources unless otherwise marked or described in the user documentation.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.

Operators of this product must be protected from electric shock at all times. The responsible body must ensure that operators are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product operators in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000V, no conductive part of the circuit may be exposed.

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance-limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, ensure that the line cord is connected to a properly-grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

When installing equipment where access to the main power cord is restricted, such as rack mounting, a separate main input power disconnect device must be provided in close proximity to the equipment and within easy reach of the operator.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.


The instrument and accessories must be used in accordance with its specifications and operating instructions, or the safety of the equipment may be impaired.


Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.


When fuses are used in a product, replace with the same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.


If a  screw is present, connect it to safety earth ground using the wire recommended in the user documentation.

The  symbol on an instrument indicates that the user should refer to the operating instructions located in the user documentation.

The  symbol on an instrument shows that it can source or measure 1000V or more, including the combined effect of normal and common mode voltages. Use standard safety precautions to avoid personal contact with these voltages.

The  symbol on an instrument shows that the surface may be hot. Avoid personal contact to prevent burns.

The  symbol indicates a connection terminal to the equipment frame.

If this  symbol is on a product, it indicates that mercury is present in the display lamp. Please note that the lamp must be properly disposed of according to federal, state, and local laws.

The **WARNING** heading in the user documentation explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading in the user documentation explains hazards that could damage the instrument. Such damage may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

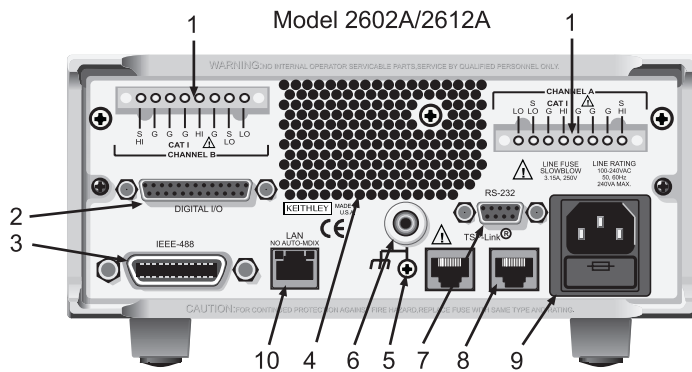
Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits - including the power transformer, test leads, and input jacks - must be purchased from Keithley Instruments. Standard fuses with applicable national safety approvals may be used if the rating and type are the same. Other components that are not safety-related may be purchased from other suppliers as long as they are equivalent to the original component (note that selected parts should be purchased only through Keithley Instruments to maintain accuracy and functionality of the product). If you are unsure about the applicability of a replacement component, call a Keithley Instruments office for information.

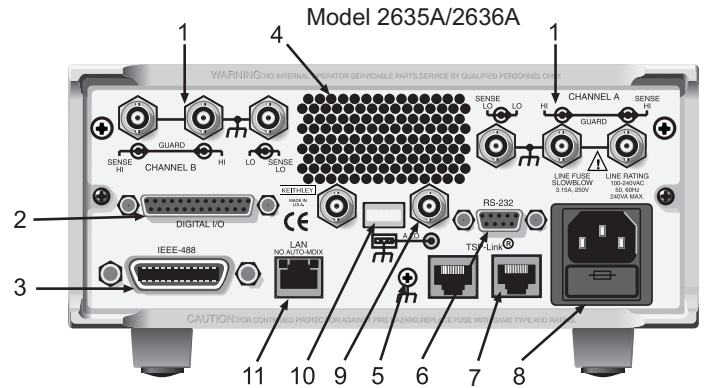
To clean an instrument, use a damp cloth or mild, water-based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument. Products that consist of a circuit board with no case or chassis (e.g., a data acquisition board for installation into a computer) should never require cleaning if handled according to instructions. If the board becomes contaminated and operation is affected, the board should be returned to the factory for proper cleaning/servicing.

## SMU Connectors

2601A/2611A/2602A/2612A (diagram shown for 2602A/2612A)



1 - CHANNEL A and CHANNEL B
2 - DIGITAL I/O
3 - IEEE-488
4 - Cooling exhaust vent
5 - Chassis ground
6 - Low noise chassis ground
7 - RS-232
8 - TSP-Link
9 - Power module
10 - LAN

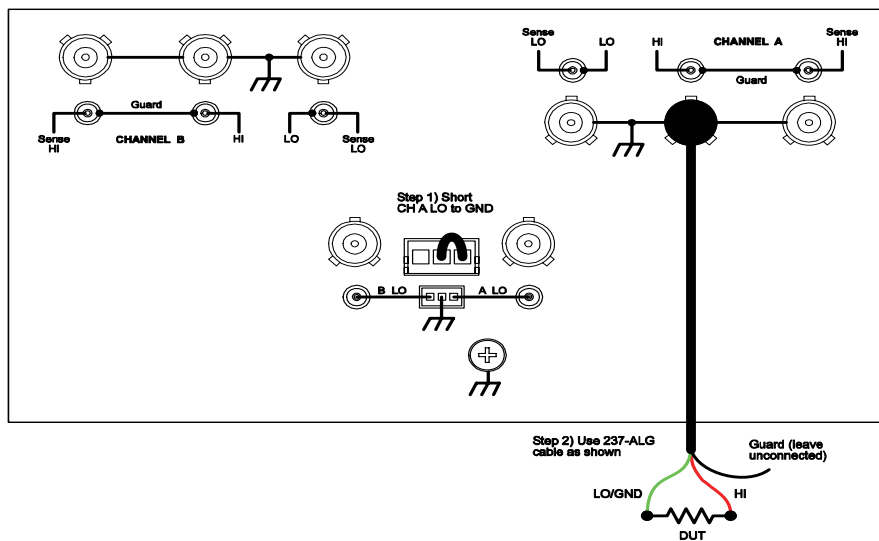


1 - CHANNEL A and CHANNEL B Triax connectors
2 - DIGITAL I/O
3 - IEEE-488
4 - Cooling exhaust vent
5 - Chassis ground
6 - RS-232
7 - TSP-Link
8 - Power module
9 - Triax connector
10 - Phoenix connector on ground module
11 - LAN

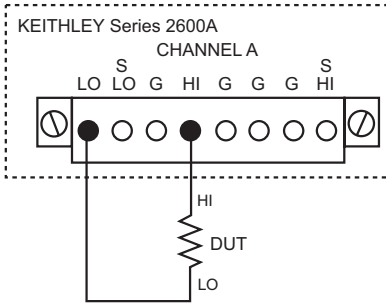
## DUT Connections

### Two-wire Connection

Model 2635A/2636A two-wire connections (local sensing, non-floating)

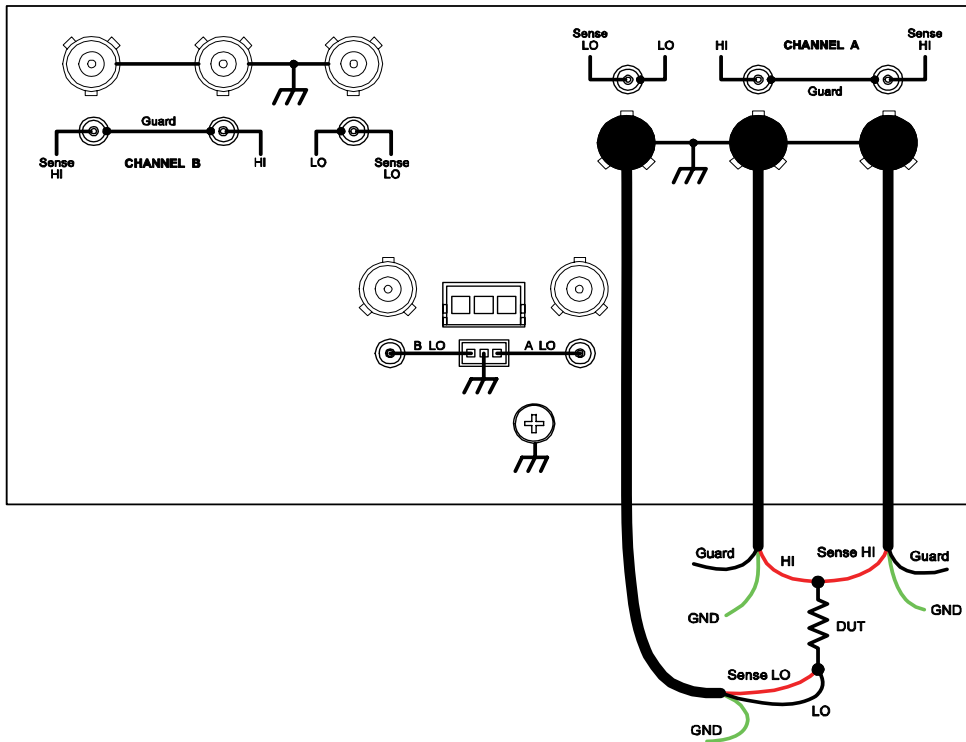


Model 2602A/2612A two-wire connections (local sensing)

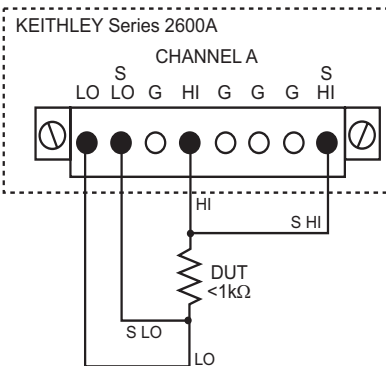


Four-wire Connections

Model 2636A four-wire connections (remote sensing)



Model 2602A/2612A four-wire connections (remote sensing)





## How do I make front panel measurements?

(this example assumes 10kOhm resistor as a DUT- but you may use any 2 terminal DUT with appropriate source values)

### Step 1: Connect the DUT

Connect a 10kO resistor to the SourceMeter Channel A HI and LO terminals.

### Step 2: Select source and set source level

Perform the following steps to select the voltage source and set the source value to 10V:

1. Press Channel A SRC to select the V-Source (indicated by the "V" units). The flashing cursor indicates which value is presently selected for editing.
2. Press the up RANGE key, and select the 20V source range. Use the lowest possible source range for best accuracy.
3. Use the CURSOR keys to move the cursor to the 10s digit, then press the Rotary Knob to enter the EDIT mode (EDIT annunciator on).
4. Using either the numeric keys or the Rotary Knob, set the source value to 10.0000V, then press ENTER or the Rotary Knob.

### Step 3: Set compliance limit

Perform the following steps to set the current compliance limit value to 10mA:

1. Put the Model 2600A in the single-channel display mode with the DISPLAY key. (Toggle the DISPLAY key to see different modes)
2. Press the LIMIT key, then press ENTER or the Rotary Knob.
3. Move the cursor to the 10s digit, then press the Rotary Knob to enter the EDIT mode.
4. Using the numeric keys or the Rotary Knob, set the limit value to 10.000mA, then press ENTER or the Rotary Knob.

### Step 4: Select measurement function and Range

1. Put the Model 2600A in the single-channel display mode with the DISPLAY key, then select the current measurement function by pressing MEAS or MODE.
2. Select the measurement range with the RANGE keys. For the purposes of this example, press AUTO RANGE, and note the AUTO annunciator turns on. The instrument will automatically select the best range based on the measured value. You can also use manual ranging by pressing the up or down RANGE.

### Step 5: Turn output on

Turn the output on by pressing the appropriate OUTPUT ON/OFF key. The ON/OFF indicator LED will light when the channel output is on. (NOTE: Safety Interlock line on digital IO connector must be pulled high in order to use 200V range. See Series 2600 Reference Manual - section 10 for more information.)

### Step 6: Make measurements

1. Observe the readings on the display (Press TRIG if necessary to trigger the unit to begin taking readings.). For the single-channel display mode, the readings will appear on the top line, while source and limit values are on the bottom line. For the 10kOhm resistor under test, typical display values are:  
1.00000mA  
SrcA: +10.0000 V LimA:010.0000mA
2. Use the DISPLAY key to cycle through the various display modes. 3. Press the MEAS key several times to display measured voltage, resistance and power. Typical values for the 10kO resistor are: 10.0000V, 10.0000kO, and 10.0000mW.

### Step 7: Turn output off

When finished making measurements, turn the output off by pressing the OUTPUT ON/OFF key. The OUTPUT indicator light will turn off.

## Establishing a point-to-point connection

There are multiple ways to accomplish remote operation. The following procedure is one way, using a one-to-one LAN connection to set up a static IP address between the PC and the instrument so that you can use the instrument's internal web page and TSP™ Express.

This method will configure the instrument's IP address based on the present IP address of your PC. Whenever there is an existing IP address configured for the network interface card network settings, the IP address for the Ethernet instruments should be configured.

**CAUTION:** Capture the network configuration before modifying the existing network configuration information on the network interface card. Once you update the network configuration settings, the older information is lost. This may cause a problem when you try to reconnect the PC to a corporate network if DHCP Enabled = NO (DHCP is disabled). If you have any problems, contact your system administrator.

### Identify and record the PC's existing IP configuration information

You are responsible to return ALL settings back to their original configuration PRIOR to reconnecting the PC to a corporate network; failure to do this could result in damage to your equipment or loss of data. These settings include, but are not limited to, the IP address, DHCP enabled mode, and the subnet mask.

1. Use the command prompt to see the existing IP configuration information.  
In Windows 2000/XP:
  - a. Click the Start button and select Run.
  - b. Type cmd in the Open field and click OK.In Windows Vista:
  - a. Click the Start button.
  - b. Select All Programs.
  - c. Select Accessories.
  - d. Select Command Prompt.

The command window is displayed.

- At the command prompt, type `ipconfig/all`. Enter.
- When the information is displayed, record the DHCP mode, IP address, subnet mask, default gateway, and DNS servers. Record the existing IP configuration information in the table below so that you can properly return all settings back to their original configuration before reconnecting your PC to a corporate network

DHCP Enabled	
IP Address	
Subnet Mask	
Default Gateway	
DNS Servers	

#### Screen capture of current computer configuration

```

Windows 2000 IP Configuration

Host Name . . . . . :
Primary DNS Suffix . . . . . :
Node Type . . . . . :
IP Routing Enabled. . . . . : No
WINS Proxy Enabled. . . . . : No

Ethernet adapter Instrument Network:

Connection-specific DNS Suffix . :
Description . . . . . :
Physical Address. . . . . : 00-04-76-EE-DD-3A
DHCP Enabled. . . . . : No
IP Address. . . . . : 192.168.1.1
Subnet Mask . . . . . : 255.255.255.0
Default Gateway . . . . . :
DNS Servers . . . . . :

Ethernet adapter Keithley:

Media State . . . . . : Cable Disconnected
Description . . . . . :
Physical Address . . . . . :
  
```

#### 2. Verify DHCP or Static IP status

Look at the DHCP Enabled setting in the IP configuration screen or in the settings you recorded to determine which step you should perform next.

- If DHCP Enabled = Yes, proceed to "Disable DHCP to use the computer's existing IP address" section.
- If DHCP Enabled = No, proceed to "Configure the instrument's LAN settings" section.

**NOTE:** When DHCP Enabled = Yes, the settings are assigned automatically upon power up. However, if DHCP Enabled = No, your corporate network will not recognize your PC if you change the original settings. Do not change the computer settings; in this case, proceed to "Configure the instrument's LAN settings" to configure the instrument settings. If at any time you are unsure how to proceed, contact your system administrator.

#### Disable DHCP to use the computer's existing IP address

Do NOT change your IP address at any time without talking to your system administrator first. Entering an incorrect IP address can prevent your PC from connecting to your corporate network.

##### 1. Open the Internet Protocol Properties dialog box

In Windows 2000:

- Click the Start button and open the Control Panel.
- Open Network and Dial-up Connections.
- Right-click Internet Connections and select Properties. The Local Area Connection Properties dialog box is displayed.
- Double-click Internet Protocol (TCP/IP) in the items list. The Internet Protocol (TCP/IP) Properties dialog box is displayed.

In Windows XP:

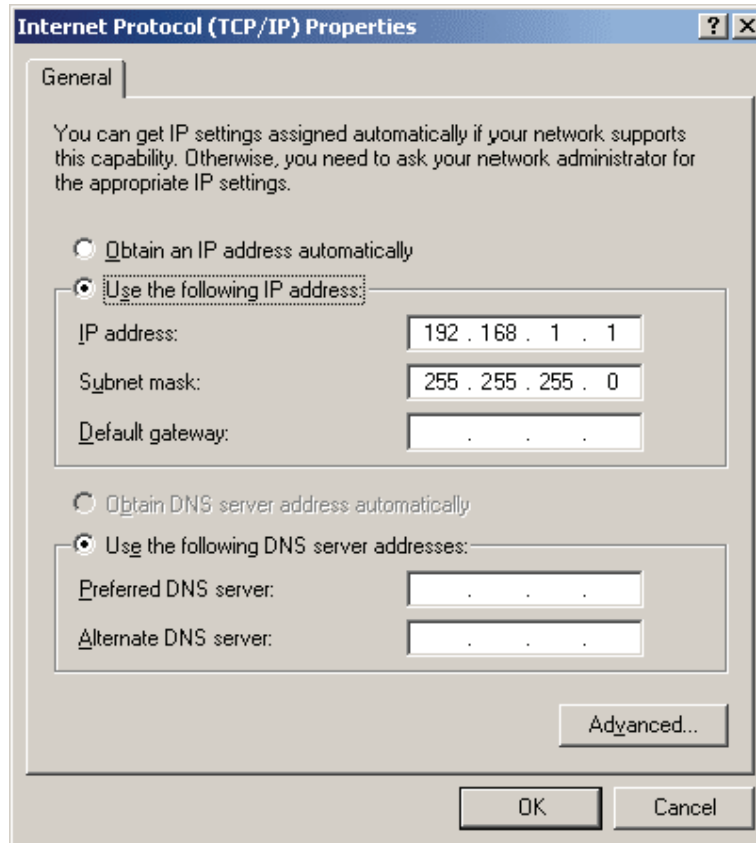
- Click the Start button and open the Control Panel.
- Open Network Connections.
- Right-click Internet Connections and select Properties. The Local Area Connection Properties dialog box is displayed.
- Double-click Internet Protocol (TCP/IP) in the items list. The Internet Protocol (TCP/IP) Properties dialog box is displayed.

In Windows Vista:

- Click the Start button and select Control Panel.
- Open Network & Sharing Center.
- In the list, click View Status next to Connection. The Wireless Network Connection Status dialog box is displayed.
- Click Properties. Windows displays a permissions message.
- If you are logged in as administrator, click Continue. If you are not logged in as administrator, enter the administrator's password to continue.
- The Wireless Network Connection Properties dialog box is displayed.
- Double-click Internet Protocol Version 6 (TCP/IPv6) in the items list. The Internet Protocol Version 6 (TCP/IPv6) Properties dialog box is displayed

##### 2. Select Use the following IP address. The option for Use the following DNS server addresses is automatically selected.

**The Internet Protocol (TCP/IP) Properties dialog box**



3. Set the IP Address
  - a. DECISION: Is the IP address and subnet mask field populated?
    - Yes: If populated, record this address and subnet mask to use in "Configure the instrument's LAN settings" section.
    - NO: blank, enter the IP address of 192.168.0.3 and subnet mask of 255.255.255.0 in the field to use in "Configure the instrument's LAN settings" section.
  - b. After selecting Use the following IP address and recording or entering the IP address, click OK.

**Configure the Instrument's LAN settings**

Use the following tasks to use the front panel to configure the instrument.

1. Press the MENU key. MAIN MENU will be displayed. Use the navigation wheel to select LAN. The LAN MENU will be displayed.
2. Change the method of how the instrument assigns its IP address.
  - a. Select CONFIG > METHOD > MANUAL, then Enter.
  - b. Press the EXIT key one time to return to the LAN MENU.
  - c. Select APPLY\_SETTINGS > YES, then Enter.

**NOTE:** You must apply changes before changes to the IP Address take place.

3. Enter the IP address from within the LAN MENU.
  - a. Select CONFIG > IP-ADDRESS.
  - b. Refer to the recorded computer's IP address. You will use a portion of the computer's address as a base for the instrument's unique ID. Only the last three numbers (after the last decimal point) will be different between the PC and instrument. The last three digits may be anything from 1-255 for a subnet mask of 255.255.255.0.  
For example: The picture of the Internet Protocol (TCP/IP) Properties dialog box shows that the computer's IP address is 192.168.1.1. A unique address for the instrument is 192.168.001.101.

**NOTE:** The instrument can have leading zeros, but the computer cannot.

- c. Use the navigation wheel to select and enter an appropriate IP-ADDRESS for the instrument.

**NOTE:** When changing a multiple-character value, such as an IP address or channel pattern name, push the navigation wheel to enter edit mode and rotate the navigation wheel to change the character's value as desired, but do not leave edit mode. Use the CURSOR keys to scroll to the other characters and use the navigation wheel to change their value as needed.

- d. Push the wheel or press the ENTER key when finished changing all the characters.
- e. Press the EXIT key to return to the LAN MENU.
- f. Select APPLY\_SETTINGS > YES, then Enter.

**NOTE:** You must apply changes before changes to the IP Address take place.

4. Change the subnet mask from within the LAN MENU.
  - a. Select CONFIG > SUBNETMASK, then ENTER (hint: SUBNETMASK is to the right of GATEWAY).
  - b. Modify the SUBNETMASK to be the same as PC settings recorded above or 255.255.255.000 if DHCP Enabled = yes.
  - c. Push the wheel or press the ENTER key when finished changing all the characters.
  - d. Press the EXIT key to return to the LAN MENU.
  - e. Select APPLY\_SETTINGS > YES, then Enter.

### Connect the crossover cable from the instrument to the PC network interface card

Connect the supplied crossover cable between the computer's NIC card and the instrument's Ethernet connector on the rear panel. There are multiple connectors on the instrument rear panel. Be sure to connect to the network Ethernet connector.

### Step 6. Series 3700 web page connection

Access instrument's internal web page

1. Open your browser.
2. Enter the instruments IP Address in the browser's address box.  
EXAMPLE If the instrument's IP address is 192.168.0.3, enter 192.168.0.3 in the browser's address box.

**NOTE:** For computers, do not enter any leading or trailing zeros.

3. Press ENTER on the PC keyboard to open the webpage.

**NOTE:** If the web page does not open in the browser, see LAN troubleshooting suggestions section.

### LAN troubleshooting Suggestions

If you are not able to connect to the instruments internal webpage, check the following items.

- Verify that the crossover cable is in the correct port on the instrument. Do not connect to one of the TSP-Link® ports
- Verify that the computers network card is enabled
- Verify the instrument IP address is compatible with the IP address on the computer
- Verify the instrument Subnet mask address is the same as the computer's subnet mask address
- Power cycle the instrument
- Reboot the computer
- Contact your system administrator for assistance.

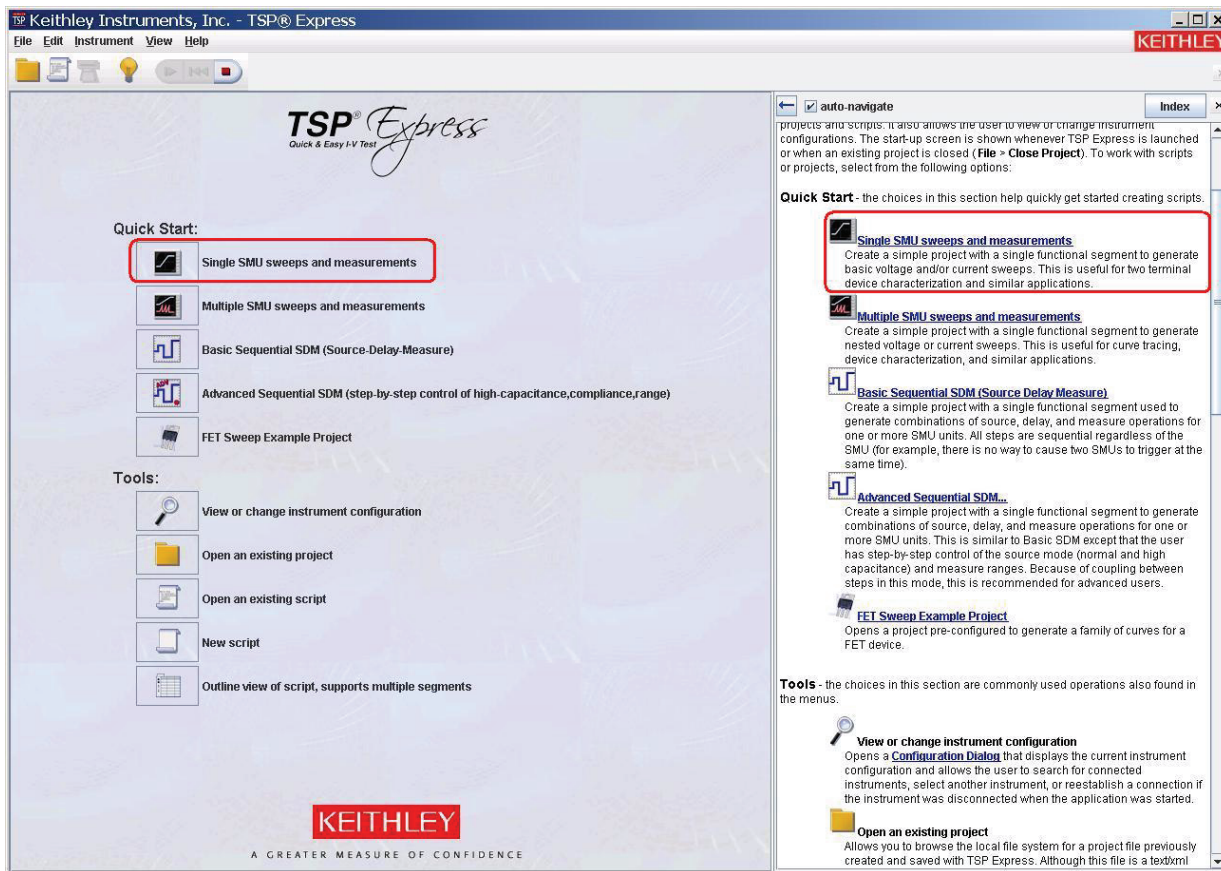
## Using TSP Express to make measurements

### Step 1. Launch TSP Express software

Series 2600A comes with TSP Express software that is designed to provide quick data captures for common I-V source measure tests. The software tool is embedded in the instrument and you can launch it from LXI web page.



**NOTE:** TSP Express requires Java runtime environment (version 6) to be installed. If you don't already have Java runtime environment on your PC, download and install it from <http://www.java.com/en/download/index.jsp> or from the product CD shipped with your 2600A.



Quick start menu of TSP Express includes pre-configured tests for common SMU functionality, such as sweeps, pulse and sequential source-measure (see help content on the right column for detail description of each). Tools section provides file management and other utilities (see help).

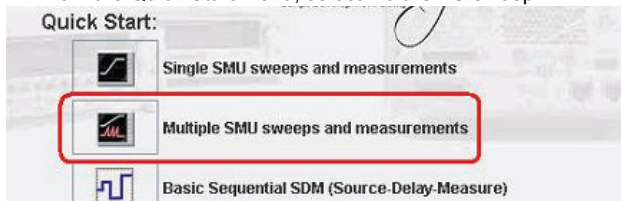
As an example, let's say you want to generate an idvd curves of a FET.

**Step 2. Connect the DUT**

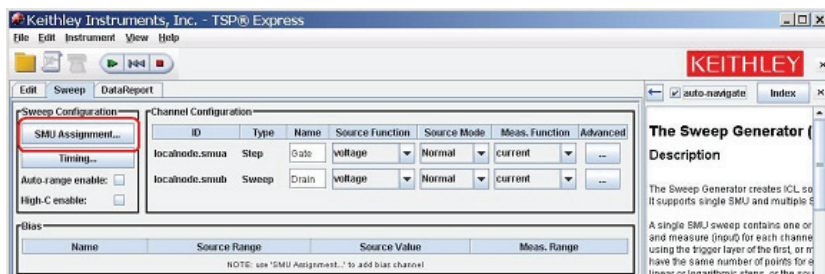
Here the device connection with a 2602A is shown.

**Step 3. Configure the project and Run**

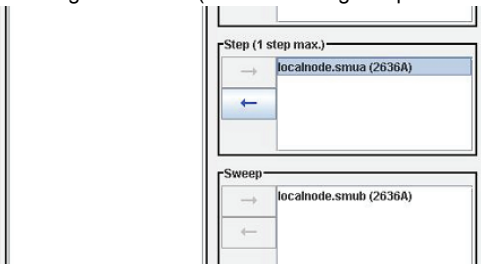
1. From the Quick Start Menu, select multi-SMU sweep



2. Click SMU assignment.



3. Assign the SMUs (smua for voltage step on Gate and smub for voltage sweep on Drain)



4. Set Step and Sweep Parameters



5. Click Run



Step 4. View the data

Data can be viewed in tabular format, plotted or exported to a .csv file.

**Data Collection Options (set prior to running script)**

Data source: Sweep (automatically determined by position of Data Report in script)

Buffers: AUTO

**Data Display (collected automatically when script is run)**

Status:   
 Display: Table   
 X Axis: Timestamp (localnode.smub.nvbuffer 1)   
 Y Axis: Reading (localnode.smub.nvbuffer 1)   
 LOG  Device Source   
 Start GMT Timestamp: 9/24/08 11:39 AM 0.223819 (GMT)

localnode.smua.nvbuffer1			localnode.smub.nvbuffer1		
Timestamp	Source Value	Reading	Timestamp	Source Value	Reading
0.0	0.0	4.708767E-5	0.0	0.0	2.408028E-5
0.451743	0.1111111	0.1111586	0.050001	0.1111111	0.1111127
0.903518	0.2222222	0.2223642	0.099999	0.2222222	0.2222433
1.355291	0.3333333	0.3335874	0.149997	0.3333333	0.3334674
1.807065	0.4444444	0.4448053	0.199996	0.4444444	0.4446934
2.25884	0.5555556	0.5560032	0.249996	0.5555556	0.5559143
2.710615	0.6666667	0.6672112	0.300001	0.6666667	0.667243
3.162393	0.7777778	0.7784196	0.350001	0.7777778	0.7784942
3.614163	0.8888889	0.8896509	0.399999	0.8888889	0.8896134
4.065985	1.0	1.000853	0.449997	1.0	1.000841
			0.451804	0.0	-3.457069E-6
			0.501771	0.1111111	0.1111309
			0.55177	0.2222222	0.2222447
			0.601768	0.3333333	0.3334627
			0.651768	0.4444444	0.4446973
			0.701768	0.5555556	0.5559162
			0.751772	0.6666667	0.6672506
			0.801771	0.7777778	0.7784952
			0.85177	0.8888889	0.8896115
			0.901768	1.0	1.000847
			0.903566	0.0	1.311302E-5
			0.953547	0.1111111	0.1111313
			1.003545	0.2222222	0.222248
			1.053543	0.3333333	0.3334697
			1.103543	0.4444444	0.4446996
			1.153542	0.5555556	0.5559157

Export...

**The Data Segment**

The Data Tab displays the data generated by another functional segment of script (such as Sweep, SDM, or custom) and makes it available as a table or graph. The Data Collection Options panel determines how and where the script gets the data and the Data Display panel shows the data. The previous segment (normally Sweep or SDM) is the source of data for the Data tab. In all cases except for the Data Display panel, the tabs/controls are input into the script generator and nothing happens until the script is run. The Data Display panel automatically collects data generated in the script (using `print()` statements) and aggregates it for the table and graph. No actions beyond running the generated script are required to populate the Data Display panel with measurement data.

The main options are:

- Data Collection Options:** Includes the controls that influence the created script (namely, the ICL statements that return the data from the instrument to this application).
- Buffers:** Selects the reading buffers.
  - AUTO:** The system will determine which reading buffers are used by the preceding segment and enables data collection from those. The table columns and graph axis controls will be populated when the script is run.
  - Custom:** Lists all factory-dedicated internal reading buffers for each device. Users may select a specific buffer.



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