KEITHLEY
A Tektronix Company

KPCI-488LPA GPIB Controller Interface Card

Quick Start Guide

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Welcome

Thank you for choosing a Keithley Instruments product. The KPCI-488LPA has the following features:

- Full compatibility with the IEEE488.2 standard
- Up to 1.5 MB per second data transfer rates
- Supports a 32-bit 3.3 V or 5 V PCI bus
- A built-in 1 KB first-in first-out (FIFO) for read/write operations
- Half-sized printed circuit board
- Supports up to 14 stand-alone instruments
- An interactive utility for testing and diagnostics
- Command-compatible driver API (application program interfaces) for Keithley Instruments, National Instruments NI^{TM}, and VISA (Virtual Instrument Software Architecture) libraries.

Contact and support information

This guide is designed to help you to install your KPCI-488LPA. For more detailed information, refer to the Models KPCI-488LPA and KUSB-488B *Reference Manual* (part number KI488-901-01), available from the Keithley Instruments website (tek.com/keithley).

From the website, you can also access updated drivers and information about related products.

Your local Field Applications Engineer can help you with product selection, configuration, and usage. Check the website for contact information.

Inspection for damage

The KPCI-488LPA was carefully inspected electrically and mechanically before shipment. After unpacking all items from the shipping carton, check for any obvious signs of physical damage that may have occurred during transit. Report any damage to the shipping agent immediately. Save the original packing carton for possible future shipment.

Repacking for return shipment

Should it become necessary to return the KPCI-488LPA for repair, carefully pack the entire instrument in its original packing carton or the equivalent, and follow these instructions:

- Call Keithley Instruments' repair department at 1-800-935-5595 for a Return Material Authorization (RMA) number.
- Let the repair department know the warranty status of the KPCI-488LPA.
- Write ATTENTION REPAIR DEPARTMENT and the RMA number on the shipping label.

Software and hardware installation

To download the latest software drivers, visit tek.com/keithley.

NOTE

You must install the software driver before you connect the KPCI-488LPA to your computer.

Driver installation

NOTE

Make sure that your user account has Administrator privileges, or log into your computer's Administrator account before installing the driver

To install the drivers:

1. Remove any existing GPIB interfaces and GPIB drivers from your computer.
2. Download the latest KPCI-488LPA software from the Product Support web page (tek.com/product-support). The software is available in a compressed (.zip) format.
3. Extract the files to your computer.
4. Launch setup.exe to begin the driver installation.

Figure 1: Selecting setup.exe from the extracted files

5. The driver installation dialog window opens, as shown in the following figure.

Figure 2: KUSB-488 driver installation screen
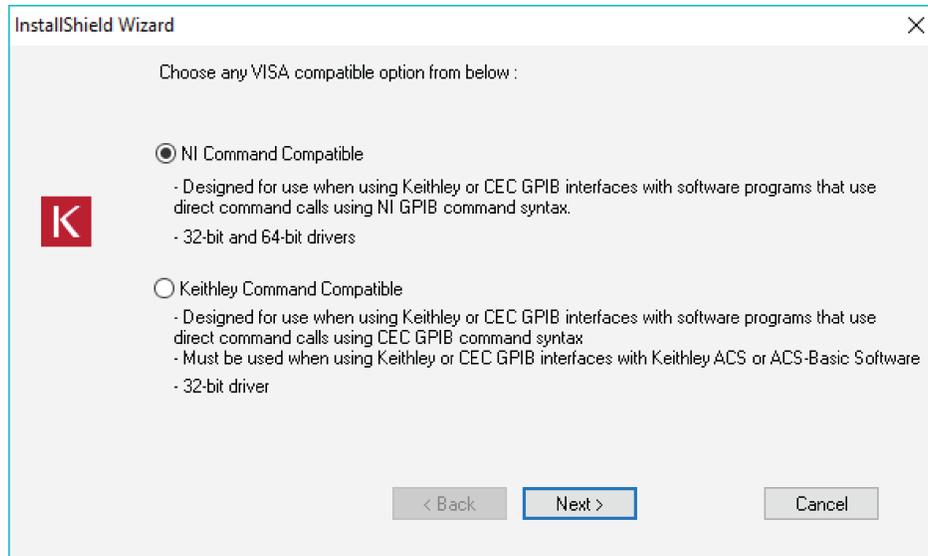
6. Install one of the following drivers. The InstallShield Wizard provides guidance on which driver to install.
    ▪ NI command-compatible driver (32- or 64-bit)
    ▪ Keithley command-compatible driver (32-bit)

NOTE

You can install either a Keithley command-compatible driver or an NI command-compatible driver. See the *Models KPCI-488LPA and KUSB-488B Reference Manual* (part number KI488-901-01) for the available functions of each driver.

For LabVIEW™ and LabWindows/CVI™ support, Keithley Instruments recommends that you install the NI command-compatible driver. For LabVIEW programming, you can also install the LabVIEW GPIB virtual instruments (VIs) that are optimized for use with the KPCI-488LPA.

For ACS and ACS Basic support, install the Keithley command-compatible driver.

To use VISA or an application that uses VISA (such as KickStart Instrument Control Software), install either driver.

7. Follow the prompts to complete the setup procedure.
8. When the installation finishes, select **Yes** to restart your system.

Hardware installation

CAUTION

The KPCI-488LPA contains sensitive components that can easily be damaged by static electricity. Handle the module on a grounded anti-static mat. The operator should be wearing an anti-static wristband, grounded at the same point as the anti-static mat.

NOTE

You must install the drivers before installing the hardware. See [Driver installation](#) (on page 2).

To install the KPCI-488LPA:

1. Turn off your computer and all accessories connected to your computer.
2. Disconnect the power cord from the power source.
3. Open your computer case.
4. Select a vacant PCI slot.
5. Discharge any static buildup on your body by touching the metal case of the computer before touching the KPCI-488LPA card.
6. Position the board into the PCI slot you selected.
7. Secure the card in place at the rear panel of the system.
8. Replace your computer's case.

In most Microsoft Windows® 10 configurations, the KPCI-488LPA hardware is automatically configured by the operating system when you power on your computer. However, previous versions of Windows may display the Found New Hardware Wizard.

You can initiate the wizard manually with older versions of Windows.

To manually initiate the Found New Hardware Wizard:

1. From the Control Panel on your computer, select **Add Hardware**. The Add Hardware Wizard dialog box displays.
2. Select **Next**. The wizard searches for any new hardware that has not yet been installed.
3. The Found New Hardware Wizard will display. Click **Next** and follow the prompts.

If the wizard does not find any new hardware, turn your computer off and turn it on again. Once it has rebooted, the Found New Hardware Wizard should launch.

Cabling

For optimal GPIB throughput, adhere to the following cabling guidelines:

- The longest distance between two devices cannot exceed 4 m.
- The average GPIB bus distance between all devices should be less than 2 m.
- The total GPIB bus distance should be less than 20 m.
- The total number of connected devices must be less than 15 (including your computer) with at least two-thirds of all devices powered on.

You can connect devices in a linear configuration, star configuration, or a combination of the two configurations. See the next figures.

Figure 3: Linear connection configuration
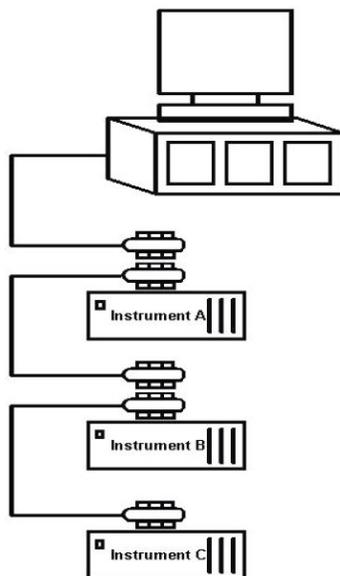
NOTE

To lower the total current load of the configuration, limit the number of cable connections on each individual instrument to three or less. For example, to lower the required current load when using the configuration shown in the next figure, move one of the cable connections from Instrument A to a different instrument. This makes the configuration a combination of linear and star configurations.

Figure 4: Star connection configuration
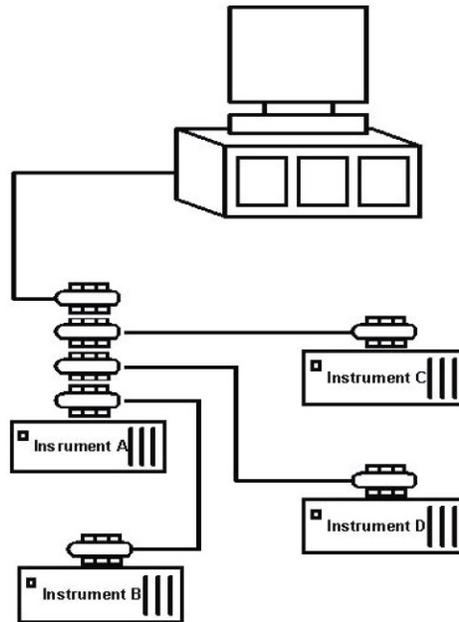
GPIB connection configuration

The GPIB has 24 lines. These lines consist of 16 signal lines and eight ground-return or shield-drain lines . The 16 signal lines can be divided into a set of eight parallel (8-bit) data transfer bus lines and a set of eight control lines. The eight control lines contain five system management lines and handshake lines.

Figure 5: Standard GPIB connector

SIGNAL GROUND	24	12	Shield
GND (TW PAIR W/ATN)	23	11	ATN
GND (TW PAIR W/SRQ)	22	10	SRQ
GND (TW PAIR W/IFC)	21	9	IFC
GND (TW PAIR W/NDAV)	20	8	NDAC
GND (TW PAIR W/NRFD)	19	7	NRFD
GND (TW PAIR W/DAV)	18	6	DAV
REN	17	5	EOI
DIO8	16	4	DIO4
DIO7	15	3	DIO3
DIO6	14	2	DIO2
DIO5	13	1	DIO1
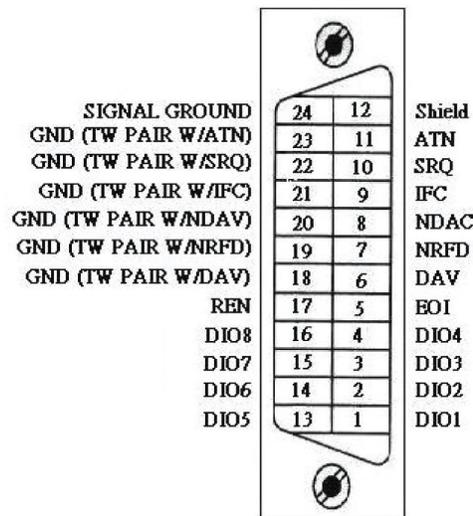
GPIB BUS	Type	Function		Pin	
				Number	**Description**
24 lines	16 signal lines	8 data lines		1	DIO1
				2	DIO2
				3	DIO3
				4	DIO4
				13	DIO5
				14	DIO6
				15	DIO7
				16	DIO8
		8 control lines	5 system management lines	5	EOI
				9	IFC
				10	SRQ
				11	ATN
				17	REN
			3 handshake lines	6	DAV
				7	NRFD
				8	NDAC
	8 ground lines	1 shield drain line		12	SHIELD
		7 ground return lines		18	GND
				19	GND
				20	GND
				21	GND
				22	GND
				23	GND
				24	SIGNAL GROUND

Data lines

DIO1 to DIO8 carry both data and command messages. All commands (and most data) use 7-bit ASCII code. The 8th bit (DIO8), is either unused or used for parity check.

Handshake lines

Three handshake lines control the transfer of data/messages between devices:

- **DAV (Data Valid)**:   Used to indicate the availability and validity of information on the DIO signal lines.
- **NRFD (Not Ready For Data)**:   Used to indicate readiness of devices to accept data.
- **NDAC (Not Data Accepted)**:   Used to indicate acceptance of data by device.

System management lines

The following five system management lines manage the flow of control and data bytes across the interface:

- **EOI (End or Identify)**:   Used (by a talker) to indicate the end of a multiple-byte transfer sequence or, in conjunction with **ATN** (by a controller), to execute a polling sequence.
- **IFC (Interface Clear)**:   Used (by a controller) to place the interface system, portions of which are contained in all interconnected devices, in a known quiescent state.
- **SRQ (Service Request)**:   Used by a device to indicate the need for attention and to request an interruption of the current sequence of events.
- **ATN (Attention)**:   Used (by a controller) to specify how data on the Digital I/O signal lines are to be interpreted, and which devices must respond to the data.
- **REN (Remote Enable)**:   Used (by a controller) in conjunction with other messages to enable or disable one or more local controls that have corresponding remote controls.

KPCI-488LPA block diagram

The KPCI-488LPA has a 1 KB on-board FIFO buffer (First In First Out) to maximize the data transfer rate. The CPLD (Complex Programmable Logical Device) coordinates the data flow between the PCI controller (Peripheral Component Interconnect), FIFO buffer, and GPIB bus.

Figure 6: KPCI-488LPA block diagram
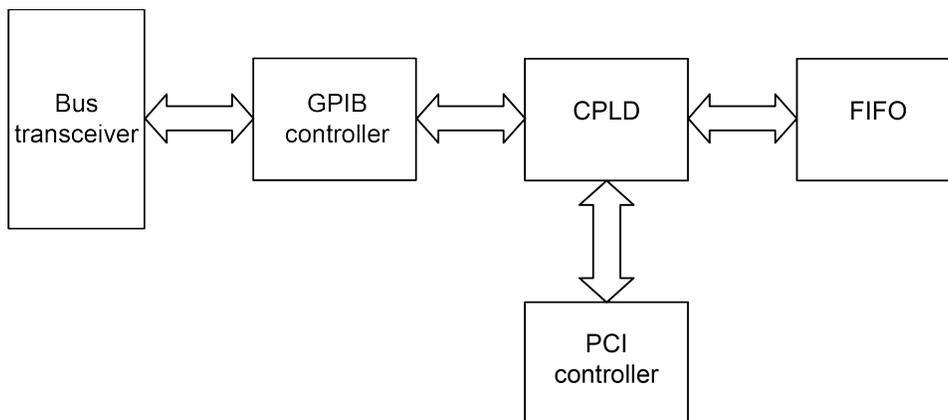
The FIFO can buffer data from the master (either from the KPCI-488LPA or external device) when the target is busy. Therefore, the efficiency will be significantly improved when transferring large blocks of data.

Using the Keithley GPIB Configuration Utility

The Keithley GPIB Configuration Utility allows you to configure the following settings:

- KPCI-488LPA bus address
- Bus timing
- I/O timeout
- Set the KPCI-488LPA to be a system controller
- Enable autopolling

To launch the configuration utility:

1. From Microsoft Windows, select **Start** > **All Programs**.
2. From the programs selection, select **Keithley Instruments > KI-488 > KI-488 Configuration Utility**. The Keithley GPIB Configuration Utility window will open. The utility queries the GPIB bus for instruments and displays the response to the identification query for any discovered instruments.

Figure 7: Keithley GPIB Configuration Utility

3. Double-click the interface icon to open the GPIB Interface & Bus Setting dialog box.

4. Make any changes to the configuration, then select **OK**.

Figure 8: GPIB interface and bus configuration
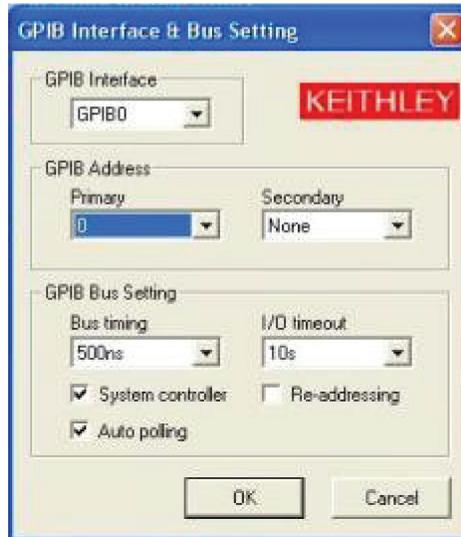
5. Save these configuration changes by selecting **Setting > Save Configuration** in the Keithley GPIB Configuration Utility window.

Using the Keithley Instruments KI-488 Diagnostic Tool

The KI-488 Diagnostic Tool lets you communicate with any GPIB instrument by writing command strings to your instrument and reading the results.

Before you launch the diagnostic tool, make sure that the KPCI-488LPA is connected to both your computer and your instrument, and verify that both are powered-on. Make sure that your instrument is set for remote GPIB communication, and verify the assigned GPIB address.

NOTE

The following example demonstrates how to send a single command and receive a response from a GPIB-connected instrument. For detailed information about using command strings with the KPCI-488LPA, refer to the *Models KPCI-488LPA and KUSB-488B Reference Manual* (part number KI488-901-01), available from the Keithley Instruments website (tek.com/keithley).

To use the diagnostic tool:

1. From Windows, select **Start** > **All Programs**.
2. From the programs selection, select **Keithley Instruments** > **KI-488 Diagnostic Tool**. The KI-488 Diagnostic Tool window will open.

Figure 9: KI-488 Diagnostic Tool
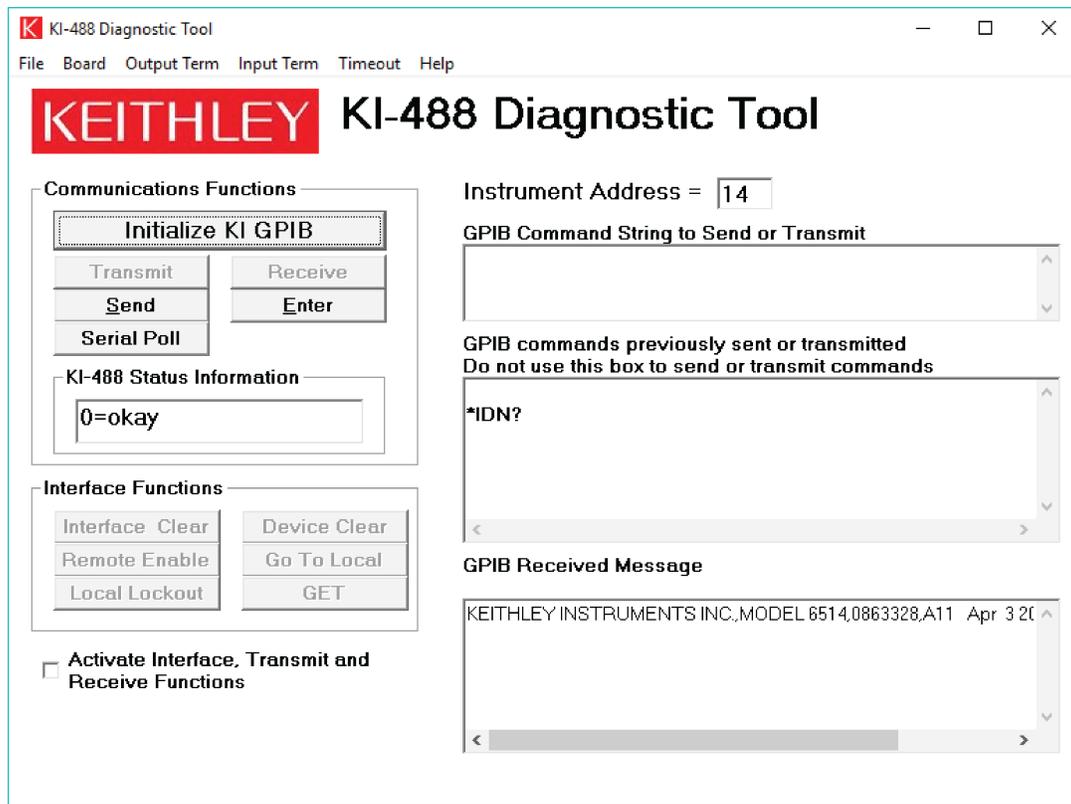
To initialize your GPIB interface accessory:

1. Select **Initialize KI GPIB**. The Initialize GPIB Interface Board dialog is displayed.

NOTE

You must select **Initialize KI GPIB** before communicating with your instrument using the KI-488 Diagnostic Tool. To initialize the communication interface, select a GPIB address that is not assigned to any instrument connected to your GPIB bus.

Figure 10: Specifying the GPIB board address
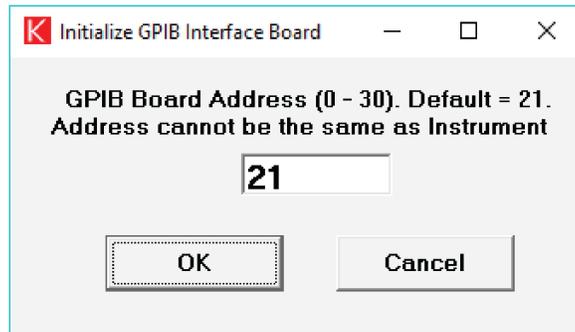
2. Enter the address to assign to your GPIB interface. The default is 21.

3. Select **OK**.

To communicate with a GPIB-connected instrument:

1. Enter the instrument GPIB address.

Figure 11: Specifying the instrument address

2. Type any commands to send to your instrument in the GPIB Command String to Send or Transmit field. For example, you can send `*IDN?` to query the identification of an instrument.

3. Under Communications Functions, select **Send**. The command string will appear in the GPIB Commands Previously Sent or Transmitted field.

To read the instrument response to a query:

Select **Enter** under Communications Functions. Any instrument responses are displayed in the GPIB Received Message field. In this example, sending the `*IDN?` command to the instrument returns the manufacturer, model number, and other information about the instrument.

Figure 12: GPIB Received Message field
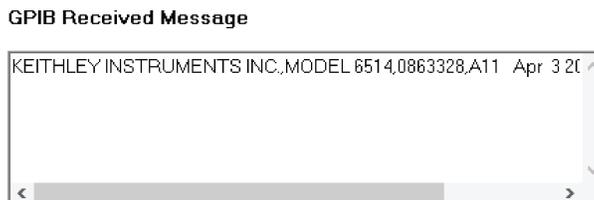
The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with nonhazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by 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 products are designed for use with electrical signals that are measurement, control, and data I/O connections, with low transient overvoltages, and must not be directly connected to mains voltage or to voltage sources with high transient overvoltages. Measurement Category II (as referenced in IEC 60664) connections require protection for high transient overvoltages often associated with local AC mains connections. Certain Keithley measuring instruments may be connected to mains. These instruments will be marked as category II or higher.

Unless explicitly allowed in the specifications, operating manual, and instrument labels, do not connect any instrument to mains.

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 30 V RMS, 42.4 V peak, or 60 VDC 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 1000 V, 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.

For safety, instruments and accessories must be used in accordance with the operating instructions. If the instruments or accessories are used in a manner not specified in the operating instructions, the protection provided by the equipment may be impaired.

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

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 protective earth (safety 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 protective earth (safety ground) using the wire recommended in the user documentation.

The ⚠ symbol on an instrument means caution, risk of hazard. The user must refer to the operating instructions located in the user documentation in all cases where the symbol is marked on the instrument.

The ⚡ symbol on an instrument means warning, risk of electric shock. 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 (Hg) 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 hazards 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.

The **CAUTION** heading with the ⚠ symbol in the user documentation explains hazards that could result in moderate or minor injury or damage the instrument. Always read the associated information very carefully before performing the indicated procedure. Damage to the instrument 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. Standard fuses with applicable national safety approvals may be used if the rating and type are the same. The detachable mains power cord provided with the instrument may only be replaced with a similarly rated power cord. 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 to maintain accuracy and functionality of the product). If you are unsure about the applicability of a replacement component, call a Keithley office for information.

Unless otherwise noted in product-specific literature, Keithley instruments are designed to operate indoors only, in the following environment: Altitude at or below 2,000 m (6,562 ft); temperature 0 °C to 50 °C (32 °F to 122 °F); and pollution degree 1 or 2.

To clean an instrument, use a cloth dampened with deionized water 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.

Safety precaution revision as of June 2017.