Model 2182A Nanovoltmeter Quick Start Guide

KEITHLEY
A Tektronix Company

Safety precautions

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.

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

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.

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 precautions as of June 2018.

Safety

Power and environmental ratings

For indoor use only.

Power supply	100 V ac /120 V ac / 220 V ac / 240 V ac 50 Hz, 60 Hz, and 400 Hz, automatically sensed at power-up
Power consumption	22 VA
Operating environment	Specified for 0 °C to 50 °C; specified to 80% relative humidity at 35 °C
Storage temperature	−40 °C to 70 °C
Pollution degree	1 or 2

Introduction

The two-channel Model 2182A Nanovoltmeter is optimized for making stable, low noise voltage measurements and for characterizing low resistance materials and devices reliably and repeatably. It provides higher measurement speed and significantly better noise performance than alternative low voltage measurement solutions.

The 2182A offers a simplified delta mode for making resistance measurements when used in combination with a reversing current source, such as the Model 6220 or 6221.

Complete documentation for the 2182A instrument is available for download on the Keithley web page at tek.com/en/products/keithley.

The 2182A documentation includes:

- **Quick Start Guide:** This document. It provides unpacking instructions, describes basic connections, and reviews basic operation information.
- **User's Manual:** Includes installation, instrument description, operation, and maintenance information.
- **Service Manual:** Provides performance verification, calibration, routine maintenance, and troubleshooting information.
- Information on accessories.

Measurement capabilities

- Two voltage measurement channels.
- Measure voltage from 1 nV to 100 V (channel 1); 10 nV to 12 V (channel 2).
- Temperature measurements
- Ratio, delta, mx + b, and percent math operations.

Unpack and inspect the instrument

To unpack and inspect the instrument:

1. Inspect the box for damage.
2. Open the top of the box.
3. Remove the documentation and accessories.
4. Carefully lift the instrument out of the box.
5. Inspect the instrument for any obvious signs of physical damage. Report any damage to the shipping agent immediately.
6. There may be a protective film over the display lens, which can be removed.

You receive the 2182A with these accessories and documents:

- Power line cord
- DeoxIT® Contact Cleaner
- Model 2107-4 Low-thermal Input Cable Assembly
- Model 2182-KIT Low-thermal Connector with Strain Relief
- Four copper alligator clips that attach to the copper lugs of the cable assembly
- Software and documentation downloads information
- Safety precautions
- *Model 2182A Nanovoltmeter Quick Start Guide* (this document)

Connect the instrument

Important test system safety information

This product is sold as a stand-alone instrument that may become part of a system that could contain hazardous voltages and energy sources. It is the responsibility of the test system designer, integrator, installer, maintenance personnel, and service personnel to make sure the system is safe during use and is operating properly.

You must also realize that in many test systems a single fault, such as a software error, may output hazardous signal levels even when the system indicates that there is no hazard present.

It is important that you consider the following factors in your system design and use:

- The international safety standard IEC 61010-1 defines voltages as hazardous if they exceed 30 V_{RMS} and 42.4 V_{PEAK} or 60 V dc for equipment rated for dry locations. Keithley Instruments products are only rated for dry locations.
- Read and comply with the specifications of all instruments in the system. The overall allowed signal levels may be constrained by the lowest rated instrument in the system. For example, if you are using a 500 V power supply with a 300 V dc rated switch, the maximum allowed voltage in the system is 300 V dc.
- Cover the device under test (DUT) to protect the operator from flying debris in the event of a system or DUT failure.
- Make sure any test fixture connected to the system protects the operator from contact with hazardous voltages, hot surfaces, and sharp objects. Use shields, barriers, insulation, and safety interlocks to accomplish this.
- Double-insulate all electrical connections that an operator can touch. Double insulation ensures the operator is still protected even if one insulation layer fails. Refer to IEC 61010-1 for specific requirements.
- Make sure all connections are behind a locked cabinet door or other barrier. This protects the system operator from accidentally removing a connection by hand and exposing hazardous voltages. Use high-reliability fail-safe interlock switches to disconnect power sources when a test fixture cover is opened.
- Where possible, use automatic handlers so that operators are not required to access the DUT or other potentially hazardous areas.
- Provide training to all users of the system so that they understand all potential hazards and know how to protect themselves from injury.
- In many systems, during power up, the outputs may be in an unknown state until they are properly initialized. Make sure the design can tolerate this situation without causing operator injury or hardware damage.

NOTE

To keep users safe, always read and follow all safety warnings provided with each of the instruments in your system.

Install the instrument

You can use the 2182A on a bench or in a rack. See the instructions that came with your rack-mount kit if you are installing the 2182A in a rack.

To prevent damaging heat build-up and ensure specified performance, make sure there is adequate ventilation and airflow around the instrument to ensure proper cooling. Do not cover the ventilation holes on the top, sides, or bottom of the instrument.

Position the instrument so that it is easy to reach any disconnecting devices, such as the power cord and the power switch.

Connect line power

The 2182A operates from a line voltage of 100 V ac, 120 V ac, 220 V ac, or 240 V ac at line frequencies of 45 Hz to 66 Hz or 360 Hz to 440 Hz. It automatically senses line frequency. Make sure the operating voltage in your area is compatible.

⚠ WARNING

The power cord supplied with the 2182A contains a separate protective earth (safety ground) wire for use with grounded outlets. When proper connections are made, the instrument chassis is connected to power-line ground through the ground wire in the power cord. In the event of a failure, not using a properly grounded protective earth and grounded outlet may result in personal injury or death due to electric shock.

Do not replace detachable mains supply cords with inadequately rated cords. Failure to use properly rated cords may result in personal injury or death due to electric shock.

CAUTION

Operating the instrument on an incorrect line voltage may cause damage to the instrument, possibly voiding the warranty.

To connect line power:

1. Make sure the front-panel power switch is in the off (O) position.
2. Connect the socket of the supplied power cord to the power module on the rear panel.

3. Connect the plug of the power cord to a grounded ac outlet.

Turn on the instrument

1. Disconnect any devices under test (DUTs) from the 2182A.
2. Turn on the instrument by pressing the front-panel POWER switch to the on (|) position.

You must turn on the 2182A and allow it to warm up for at least 2½ hours to achieve rated accuracies.

Power-up sequence

On power up, the 2182A performs self-tests and momentarily lights all digit segments and annunciators. If a failure is detected, the instrument momentarily displays an error message and the ERR annunciator turns on.

When the instrument passes the self-tests, the firmware revision levels are displayed. For example:

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REV: A01 A02
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Where A01 is the main board ROM revision and A02 is the display board ROM revision.

After the power-up sequence, the instrument begins to display readings.

Connections for testing

WARNING

To prevent electric shock, test connections must be configured such that the user cannot come in contact with test leads or any device under test (DUT) that is in contact with the conductors. It is good practice to disconnect DUTs from the instrument before powering the instrument. Safe installation requires proper shields, barriers, and grounding to prevent contact with test leads.

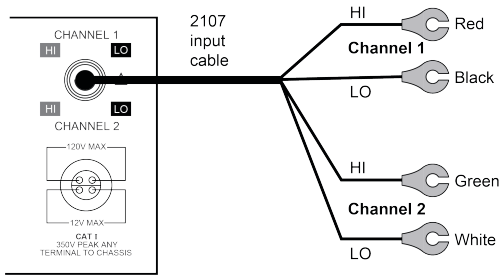
A hazardous voltage condition exists at or above 42 V_{PEAK}. To prevent electric shock that could result in personal injury or death, never make or break connections while hazardous voltage is present.

CAUTION

Exceeding the following limits may cause instrument damage that will void the warranty.
Channel 1 HI and LO inputs have a maximum measurement capability of 120 V_{PEAK}. These inputs are protected to 150 V_{PEAK} to any terminal or 350 V_{PEAK} to chassis.
Channel 2 HI and LO inputs have a maximum measurement capability of 12 V_{PEAK}. Channel 2 HI is protected to 150 V_{PEAK} to any terminal. Channel 2 LO is protected to 70 V_{PEAK} to Channel 1 LO. Both inputs are protected to 350 V_{PEAK} to chassis.

Model 2107 low-thermal input cable

The 2107, shown in the following figure, is terminated with a CHANNEL connector on one end and copper lugs on the other end. The cable is shielded to chassis ground when connected to the 2182A. You can use this cable to make voltage measurements and temperature measurements that use an external simulated reference junction.

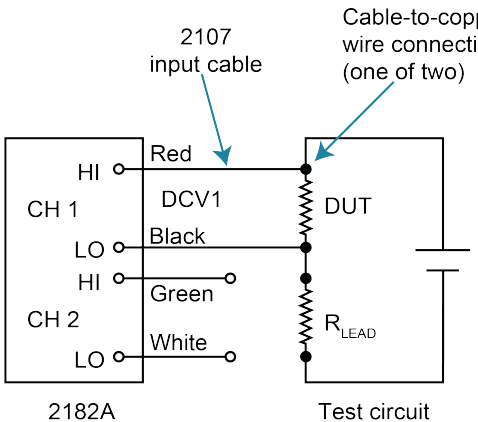


To make voltage connections, clamp the cleaned copper lugs of the cable to the cleaned copper connectors of the test circuit. For the test circuit, use clean #10 copper bus wire wherever possible. Clean copper-to-copper connections minimize thermal electromagnetic fields (EMFs). EMFs can corrupt a measurement.

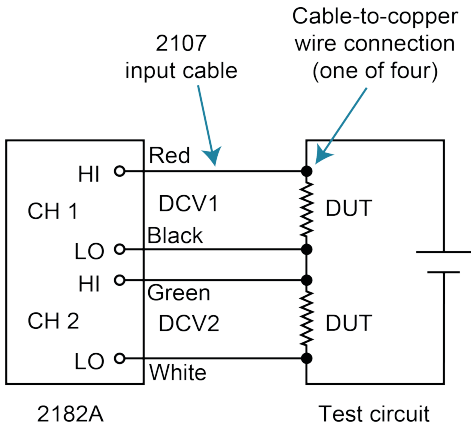
Voltage measurement connections

You can perform single or dual channel voltage measurements. The dual channel feature of the 2182A allows you to make comparison measurements in a test circuit.

The following figure shows typical connections to measure a DUT using a single channel.

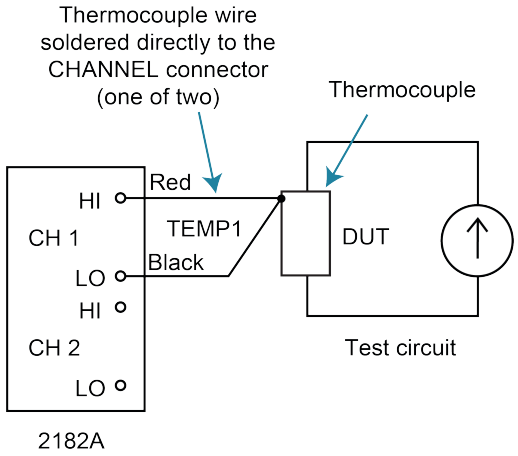


The following figure shows typical connections to make comparison measurements of two devices in a test circuit. For this measurement configuration, there is no voltage differential between the two measurement channels. Channel 2 HI is connected directly to Channel 1 LO.

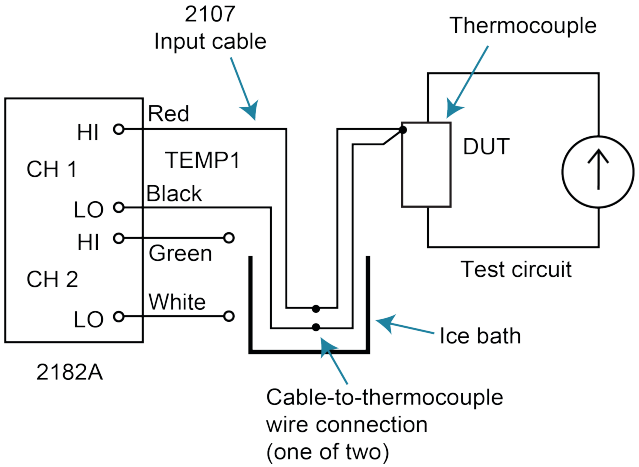


Temperature measurement connections

You can use Channel 1 of the 2182A to make temperature measurements. The following figure shows connections using the internal reference junction. The thermocouple wires must be soldered directly to the CHANNEL connector.



The following figure shows temperature-only connections using an ice bath as a simulated reference junction. The connection points for the input cable and the thermocouple wires are immersed in the ice bath.



Basic operation

Most front panel keys have two functions. The name on the key indicates its primary function. The name in blue above a key indicates its function when the **SHIFT** key is pressed.

For example, press **DCV1** to select the Channel 1 voltage measurement function. Press **SHIFT** then **MX+B** to choose the mx + b function.

Make a voltage measurement

The following test verifies basic operation of the 2182A. In this test, you use the front-panel controls to make a voltage measurement.

To measure voltage:

1. Make connections to the DUT as described in “Voltage measurement connections.”
2. Press **DCV1**, which measures voltage on channel 1.
3. Press **AUTO RANGE** to enable automatic range setting.
4. Observe the voltage reading on the front panel.

Make a temperature measurement

In this test, you use the front-panel controls to make a temperature measurement.

To measure voltage:

1. Make connections to the DUT as described in “Temperature measurement connections.”
2. Press **SHIFT** then **TCOUP**.
3. Select **UNITS** to set the temperature units (°C, °F, or K).
4. Select **SENS** and select **TCOUPLE**.
5. Select **TYPE** and select the thermocouple type that you are using to measure temperature.
6. Select **JUNC** and select the type of reference measurement:
   - To reference measurements to the internal reference junction: Select **INTRNL**.
   - To reference measurements to an external simulated reference: Select **SIM**. You are prompted to enter the simulated reference temperature. Use the arrow keys to display the value and press **ENTER**.
7. Select **TEMP 1** to measure temperature on channel 1.
8. Observe the temperature reading on the front panel.

NOTE

These steps confirm basic functionality of your instrument.

Measurement considerations

For sensitive measurements, follow these guidelines to maximize measurement accuracy:

- Use only clean, copper-to-copper connections to minimize thermal EMFs.
- Any solder connections should use silver solder to minimize thermal EMFs.
- Clean all connector terminals of oxidation using a small amount of DeoxIT.
- Use the relative offset (REL) to null out offsets:
  - Connect the circuit, but leave the source disconnected.
  - Select DCV1 or DCV2 as appropriate.
  - Press REL to null offsets.
  - Repeat for other channel if needed.
  - Connect the source, and make the measurement.
- Keep the 2182A and test circuit away from electrical noise sources, and shield if necessary.

Refer to the *Model 2182A Nanovoltmeter User's Guide* for additional information.

FAQs

Where can I find updated drivers or firmware?

For the latest drivers and additional support information, see the Keithley Instruments support website.

To find drivers that are available for your instrument:

1. Go to tek.com/en/support/product-support.
2. Enter **2182A** and select **GO**.
3. Select **Software**.

Next steps

For more information, refer to the Keithley Instruments website, tek.com/en/products/keithley.

You can find support and additional information about the instrument in the *Model 2182A Nanovoltmeter User's Manual*.

Contact information: 1-800-833-9200
For additional contacts, see **https://www.tek.com/en/contact-tek**

Find more valuable resources at TEK.COM.

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