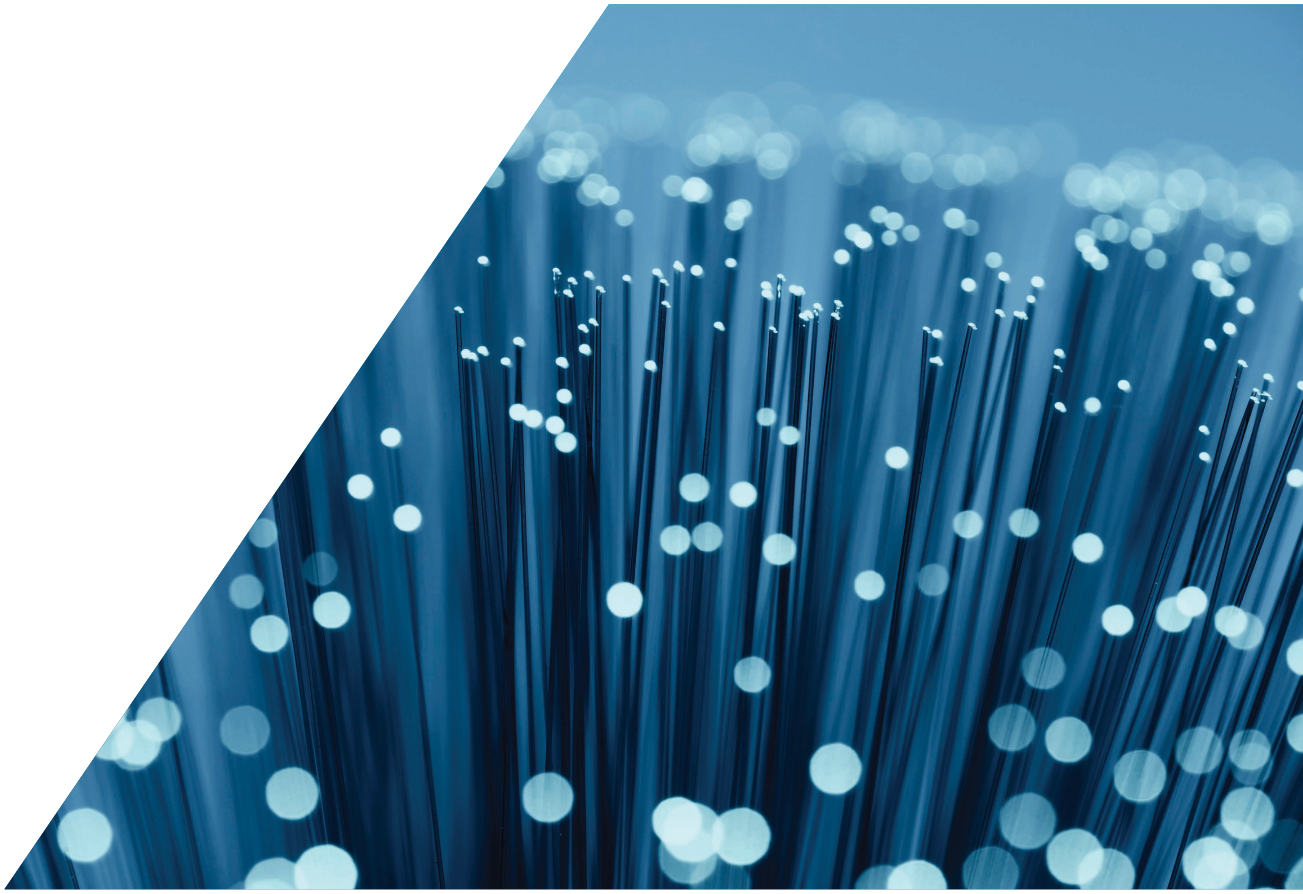
Tektronix®

MP5000 Series

Power Supply Module

REFERENCE MANUAL



077-1892-02 July 2026

Tektronix®

MP5000 Series
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Contacting Tektronix

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USA

For product information, sales, service, and technical support:

In North America, call 1-800-833-9200.

Worldwide, visit www.tek.com to find contacts in your area.

Contents

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.

Tektronix 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 Tektronix 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 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.

Production of this equipment required the extraction and use of natural resources. The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the product's end of life. To avoid release of such substances into the environment and to reduce the use of natural resources, we encourage you to recycle this product in an appropriate system that will ensure that most of the materials are reused or recycled appropriately.

The symbol indicates that this product complies with the applicable European Union requirements according to Directives 2012/19/EU and 2006/66/EC on waste electrical and electronic equipment (WEEE) and batteries. For information about recycling options, check the Tektronix Web site (www.tek.com/productrecycling).

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 Tektronix. 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 Tektronix to maintain accuracy and functionality of the product). If you are unsure about the applicability of a replacement component, call a Tektronix office for information.

Unless otherwise noted in product-specific literature, Tektronix instruments are designed to operate indoors only, in a non-residential location, 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.

This product may contain a small installed lithium metal button cell. Please properly dispose of or recycle the cell at its end of life according to local government regulations.

This product may contain one or more type CR lithium batteries. According to the state of California, CR lithium batteries are classified as perchlorate materials and require special handling. See http://www.dtsc.ca.gov/hazardouswaste/perchlorate for additional information.

If present, the small lithium primary button cell contained in this equipment does not exceed 1 gram of lithium metal content per cell, and the cell type has been shown by the manufacturer to comply with the applicable requirements of the UN Manual of Tests and Criteria Part III, Sub-section 38.3. Consult your carrier to determine which lithium battery transportation requirements are applicable to your configuration, including to its re-packaging and re-labeling, prior to reshipment of the product by any mode of transport.

Safety Precautions version April 2025

Introduction

Introduction

This manual describes the power-supply module for the MP5000 Series modular precision test system.

It includes information for the module MPSU50-2ST, which is a 50 W, 50 V 5 A dual-channel power supply.

Extended warranty

Additional years of warranty coverage are available on many products. These valuable contracts protect you from unbudgeted service expenses and provide additional years of protection at a fraction of the price of a repair. Extended warranties are available on new and existing products. Contact your local Tektronix office, sales partner, or distributor for details.

Contact information

If you have any questions after you review the information in this documentation, please contact your local Tektronix office, sales partner, or distributor. You can also call the Tektronix corporate headquarters (toll-free inside the U.S. and Canada only) at 1-800-833-9200. For worldwide contact numbers, visit tek.com/contact-tek.

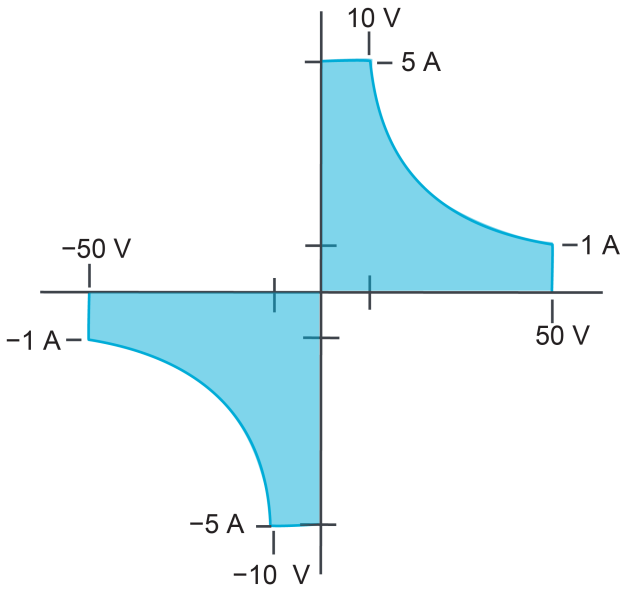
Test connections

Module overview

You can use the power-supply module for the following source and measure operations:

- Source voltage
- Measure current or draw
- Provide voltage source readback

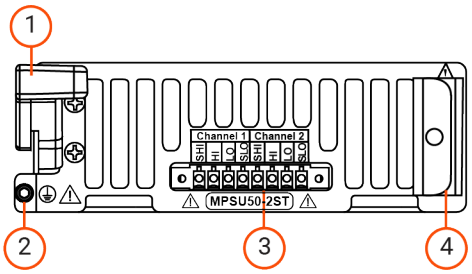
The power envelope of the power supply is shown in the following figure.



WARNING: Hazardous voltages may be present on the output terminals. To prevent electrical shock that could cause injury or death, NEVER make or break connections to the MP5000 series modules while the slot is powered on. Power down the slot before handling cables connected to the outputs. Verify that there is no voltage on the terminals of the module before you make connections between the module and the DUT. Placing the output in standby mode does not guarantee that the outputs are not powered if a hardware or software fault occurs. For the safest operation, power down the MP5000 mainframe before making or breaking connections to the MP5000 modules.

Module output panel

The output panel of the MPSU50-2ST is shown in the following figure.

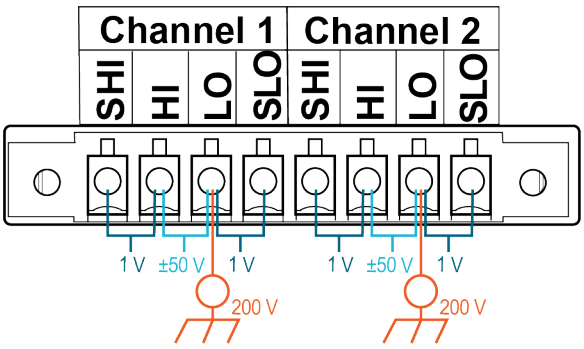


1	Release lever	The release lever at the top left of the output panel of the module assists with removing a module.
2	Retention screw	The module retention screw at the bottom-left of the output panel of the module must be tightened after inserting a module and loosened before removing a module.
3	MPSU50-2ST output terminals	The output terminals of the MPSU50-2ST provide connections for SENSE HI, SENSE LO, SOURCE HI, and SOURCE LO for each channel
4	Spring bracket	The spring bracket ensures that the module is fully seated and locked into the mainframe. It is also used to release a module when removing it from the mainframe.

PSU output terminal ratings

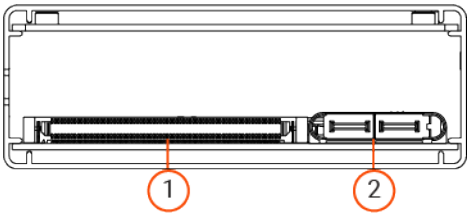
MPSU50-2ST

Terminal	Maximum voltage
LO to chassis ground	200 V
HI to LO	50 V
HI to S HI or LO to S LO	1 V



Module interface panel

The module has 140-pin differential signal connectors and 4-pin power connectors that interface with the MP5103.



1	140-pin signal connector
2	4-pin power connector

Interlock

The MP5000 provides an interlock circuit. You must assert this signal to turn on the output. When the signal is asserted, the front-panel INTERLOCK indicator is illuminated green.

If the interlock signal is not asserted, you cannot turn on the output and the front-panel INTERLOCK indicator is not illuminated.

To check the status of the interlock, send:

```
print(slot[X].status.measurement.INT)
```

Where *X* is the slot number of the SMU. A return of `2048` indicates that the interlock is asserted. `0` indicates that it is not asserted. If you try to turn the output on when the interlock is not engaged, message 802 “Output blocked by interlock” is generated.

If there is a fault in the interlock circuit and the interlock power supply circuit cannot provide the voltage needed to engage the interlock, the interlock LED is illuminated red. This can happen if the interlock power supply pin is shorted to ground.

For detail on setting up and using the interlock, refer to “Interlock installation” in the *MP5103 Reference Manual*.

WARNING: The MP5103 interlock circuit must be positively activated to enable the output of installed modules. The interlock helps facilitate safe operation of the equipment in a test system. Bypassing the interlock could expose the operator to hazardous voltages that could result in personal injury or death.

Related command:

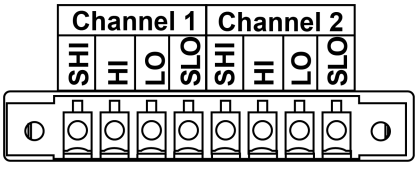
`slot[Z].status.measurement.*`

Output connections

The MP5000 Series PSU modules use screw-terminal connectors for output connections. They are supplied with mating screw terminal accessories.

The module has sense HI (SHI), HI, LO, and sense LO (SLO) output connectors for each of the two channels. The output terminals accept wire sizes from AWG 22 to AWG 16.

The MPSU50-2ST connections are shown in the following figure.



Basic connection sequence:

1. Remove power from the mainframe or slot and wait for power to dissipate. If you are powering down a slot, use a voltmeter to verify that there is no voltage on the output terminals of the module.
2. Connect cables from the test fixture, prober, or device-under-test (DUT) to the screw-terminal block.
3. Tighten the screws of the screw-terminal block. Do not overtighten.
4. Cover the screw terminal block with optional housing. This provides additional strain relief to cables to prevent accidental disconnection or shorting.
5. Connect the screw-terminal block to the rear panel of the PSU module.
6. Tighten the two captive screws to ensure full contact to the module.

WARNING: The input/output connectors of the MP5000 Series PSU modules are rated for connection to circuits rated Measurement Category O only, with transients rated less than 1500 V_{PEAK}. Do not connect the MP5000 Series terminals to CAT II, CAT III, or CAT IV circuits. Connections of the input/output terminals to circuits higher than CAT O can cause damage to the equipment or expose the operator to hazardous voltages.

When you make or break connections, follow these guidelines:

- Make sure power is removed from the modules. To remove power from the modules, you can either power off the MP5000 Series mainframe, which removes power from all modules, or use `slot.stop()` to power down a specific module.
- Disconnect any devices that may deliver energy.
- Make connections to the device under test through a test fixture or other safe enclosure.
- Make sure the MPSU50-2ST is properly connected to protective earth (safety ground).
- If the test fixture is conductive, make sure the test fixture is properly connected to protective earth (safety ground).
- Make sure the test fixture provides proper protection.
- Properly make interlock connections between the MP5000 Series mainframe, the test fixture, and any other instruments.
- Make sure to follow all warnings and cautions and to take adequate safety precautions for each set of connections.
- Properly terminate any cables. All unterminated cable ends must be in a safe enclosure.

Sense terminal configuration

To ensure accurate voltage output, the PSU always uses sense leads. The PSU relies on the voltage detected with the sense lines to provide the proper closed-loop control of its output voltage and to properly limit the voltage across the device under test. This ensures accurate voltage levels at the device terminals.

You can connect to the power supply in a local sense (2-wire) or remote sense (4-wire) configuration depending on where you connect the sense leads. In any configuration, sense HI must always be connected to HI and sense LO must always be connected to LO.

Use 4-wire measurement techniques to prevent voltage drops because of lead or contact resistance that could affect source and measurement accuracy.

Use local sense in the following situations:

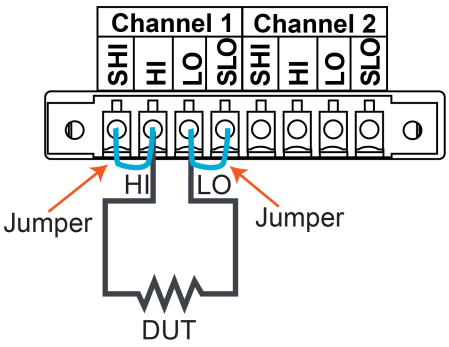
- Test configurations with short leads
- Test configurations with minimal lead resistance
- Devices that do not require exact voltage sourcing

Remote sense should be used in the following situations:

- Test configurations with long leads
- Test configurations with significant lead resistance
- Devices that require precise voltage sourcing

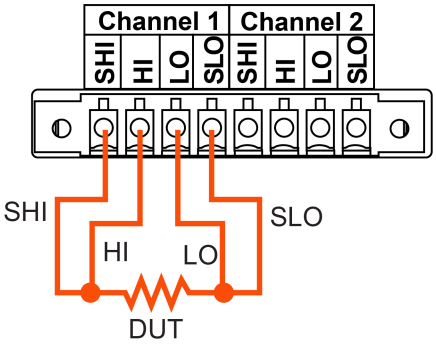
2-wire connection

A local sense or 2-wire connection connects the sense leads to the output terminals at the screw-terminal connector. The voltage output measurement is made at the screw-terminal connector. You must connect a jumper or short wire between the sense HI and HI terminals and a second jumper or wire between the sense LO and LO terminals. The following figure shows the 2-wire connection for channel 1. Channel 2 is similar.



4-wire connection

Remote sense or 4-wire connection is similar to 2-wire except that the sense leads connect at the device under test (DUT). The measurement on the sense leads measures the voltage present at the DUT so the PSU can ensure the correct output value at the point where the sense leads are connected. The following figure shows the 4-wire connections for channel 1. Channel 2 is similar.



To reduce the environmental noise, twist the load and sense wires.

CAUTION: Make sure you make the connections correctly. Incorrect connections between output and sense terminals result in a serious error and may damage the device under test (DUT). In addition, the voltage across the device may exceed the programmed source limit voltage, possibly causing damage to the device or test fixture.

Test fixtures

A test fixture can be used to house a device or test circuit. The test fixture can be a metal or nonconductive enclosure and is typically equipped with a lid. When the test fixture is correctly connected using the interlock, the outputs of any installed modules turn off when the lid of the test fixture is opened.

You mount the test circuit inside the test fixture.

WARNING: To provide protection from shock hazards, an enclosure should be provided that surrounds all live parts.

Nonconductive enclosures must be constructed of materials that are suitably rated for flammability and the voltage and temperature requirements of the test circuit. Connect the enclosure of all metal test fixtures to protective earth (safety ground). See your specific test fixture for information. Nonconductive test fixtures must be rated to double the maximum capability of the test equipment in the system.

For metallic enclosures, the test fixture chassis must be properly connected to protective earth (safety ground). A grounding wire (16 AWG or larger) must be attached securely to the test fixture at a screw terminal designed for safety grounding. The other end of the ground wire must be attached to a known protective earth (safety ground).

When hazardous voltages (>30 V_{RMS}, 42 V_{PEAK}) will be present, the test fixture must meet the following safety requirements:

- **Construction material**: A metal test fixture must be connected to a known protective earth (safety ground) as described in the above warning. A nonconductive test fixture must be constructed of materials that are suitable for flammability, voltage, and temperature conditions that may exist in the test circuit. The construction requirements for a nonconductive enclosure are also described in the warning above.
- **Test circuit isolation**: With the lid closed, the test fixture must completely surround the test circuit. A metal test fixture must be electrically isolated from the test circuit. Internally, Teflon standoffs are typically used to insulate the internal printed circuit board or guard plate for the test circuit from a metal test fixture.

The test fixture must also have a normally-open interlock switch. The interlock switch must be installed so that when the lid of the test fixture opens, the switch opens, and when the lid closes, the switch closes. The MP5000 includes an interlock connector on the rear panel of the instrument. When properly connected to a test fixture, the outputs of the PSU module turn off when the lid of the test fixture is open.

General operation

Front-panel PSU operation

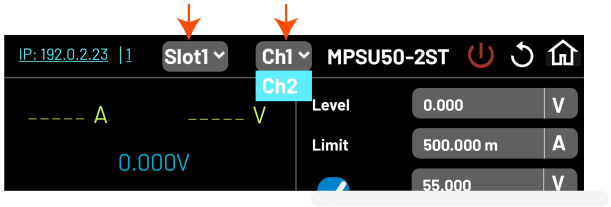
Most of the procedures in this manual assume you are using remote commands to set up and control the PSU. However, you can perform some operations using the PSU from the MP5103 front panel. You can:

- Turn the output on or off
- View the current and voltage readings
- View and set the PSU output level
- Set overvoltage and overcurrent protection levels
- Set the slew rate mode and value
- Reset the module

NOTE: The front-panel display turns off after 10 minutes of inactivity to prevent screen burn-in. Touch the display or turn the navigation wheel to return the display to normal brightness.

To access the front-panel settings:

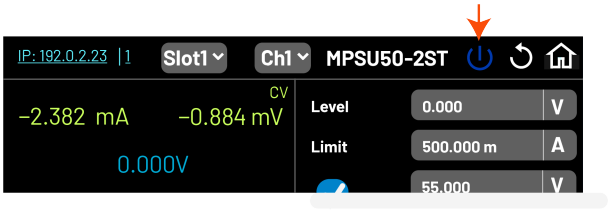
1. From the Home screen, select **Channels**. Information for channel 1 (**Ch1**) of the module installed in slot 1 (**SLOT1**) is displayed.
2. Select the slot and channel from the lists.



3. Use the touch screen and knobs to access the options on the screen.

Turn the output on or off

Select the output status indicator, shown in the following figure, to turn on the output. The indicator turns blue. The Module Status light on the front panel of the mainframe also changes from green to blue. When the output is on, the current and voltage measurements are shown on the left side of the screen. The source level is shown below the measurements.



This sets the `slot[Z].psu[Y].source.output` command.

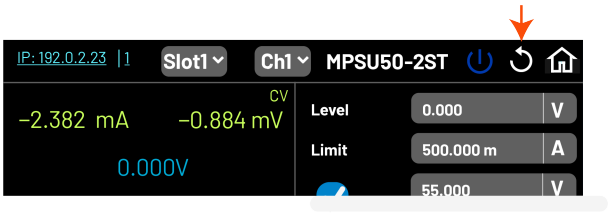
Adjust measure and source settings

Measure and source settings are presented on the right side of the display. Use the touchscreen and the knob to make selections. Use the knob to scroll down to view additional settings. You can make the following settings.

Front-panel setting	Brief description	Equivalent command
Level	The output level of the source.	`slot[Z].psu[X].source.levelv`
Limit	The source limit value.	`slot[Z].psu[X].source.limiti`
OVP	Select the checkbox to enable output overvoltage protection. Set the OVP level.	`slot[Z].psu[X].source.protect.enablev` `slot[Z].psu[X].source.protect.levelv`
OCP	Select the checkbox to enable output overcurrent protection. Set the OCP level.	`slot[Z].psu[X].source.protect.enablev` `slot[Z].psu[X].source.protect.levelv`
Slew Rate	Select a slew rate mode and value.	`slot[Z].psu[X].source.slewrate.v`

Reset the channels

Select reset, shown in the following figure.



Set the source voltage and current limit

The output is affected by the source level and source limit. The power supply is always a voltage source, and therefore sources voltage and limits current.

The level sets the voltage that is output. If the output is on, the new voltage level is sourced immediately. If the output is off, the new voltage level is sourced when the output is turned on. The sign of the source level dictates the polarity of the source. Positive values generate positive voltage or current from the high terminal of the source relative to the low terminal. Negative values generate negative voltage or current from the high terminal of the source relative to the low terminal. The MPSU50-2ST has a fixed source range.

The current limit restricts the current that is output. If the current exceeds the limit, the voltage level is limited so that the current remains below the set limit. For example, assume you set a current limit of 1 A and connect a 5 ohm resistor to the power supply output. If you set the voltage level to 2 V, 2 V/ 5 Ω = 400 mA. Since this is less than 1 A, the power supply outputs 2 V as requested. If you change the voltage level to 6 V, 6 V/5 Ω = 1.2 A. Since this is more than 1 A, the current limit takes effect and limits the output to 1 A. In this example, the output voltage is 5 V even though the level was set to 6 V.

Related commands:

`slot[Z].psu[X].source.levelv`
`slot[Z].psu[X].source.limiti`
`slot[Z].psu[X].source.output`
`slot[Z].psu[X].source.rangev`

Maximum output and power envelope

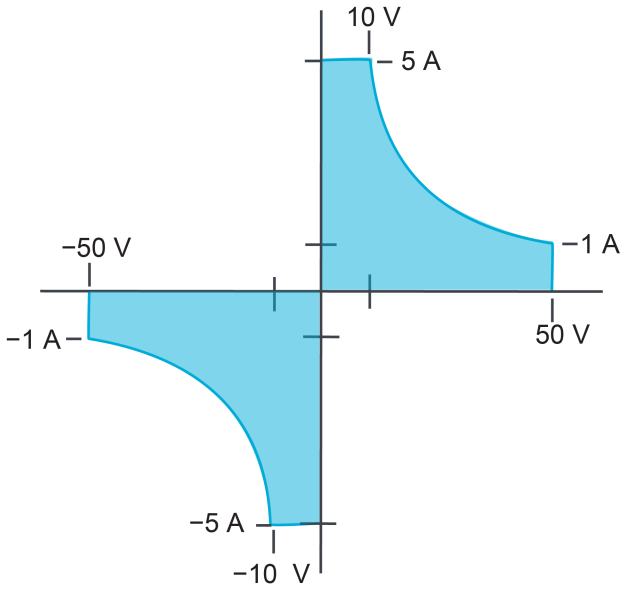
The power supply module has a curved power envelope. The maximum current and voltage output that can be drawn follows the curve, which is equal to the maximum power available from the power supply channel. Depending on the set voltage, the load can draw more or less current.

You can calculate the maximum current that can be drawn from the maximum power and the set voltage level:

$I_{MAX} = P_{MAX}/V_{SET}$

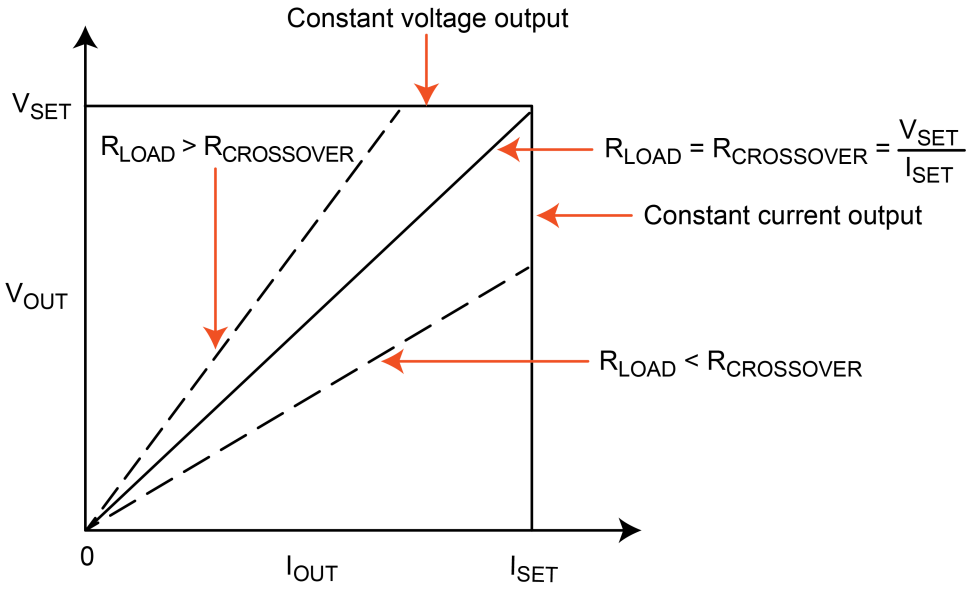
For example, if the set voltage is 15 V, the maximum current drawn on an MPSU50-2ST is the maximum power of 50 W divided by 15, or 3.33 A.

The actual current drawn depends on the load and the current limit setting. The power supply cannot exceed overall maximum voltage output and current draw specifications. The power envelope of the power supply is shown in the following figure.



Constant voltage and current states

The power supply modules feature a constant voltage and constant current automatic crossover. This feature permits continuous operation in the transition from a constant-voltage state to a constant-current state as the load changes. The intersection of the current limit setting (I_{SET}) and the voltage setting (V_{SET}) is the crossover point, as shown in the following figure.



For example, if the resistive load is such that the power supply is operating in a constant-voltage state, the power supply provides a regulated output voltage. As the load increases, the output voltage remains constant until the preset current limit is reached. Then the crossover occurs.

Once the crossover occurs, the voltage drops in proportion to further load increases as the output current becomes constant.

Crossover from the constant-voltage state to the constant-current state also occurs automatically in response to an increase in load.

To check the present state, use the `slot[Z].psu[X].source.constantcurrent` command.

Overcurrent and overvoltage protection

You can set the power supply to ensure that the source remains within specified current and voltage values. This helps to protect the device under test (DUT) from damage from high voltage or current levels. Overvoltage and overcurrent protections restrict the maximum voltage and current levels that the instrument can source.

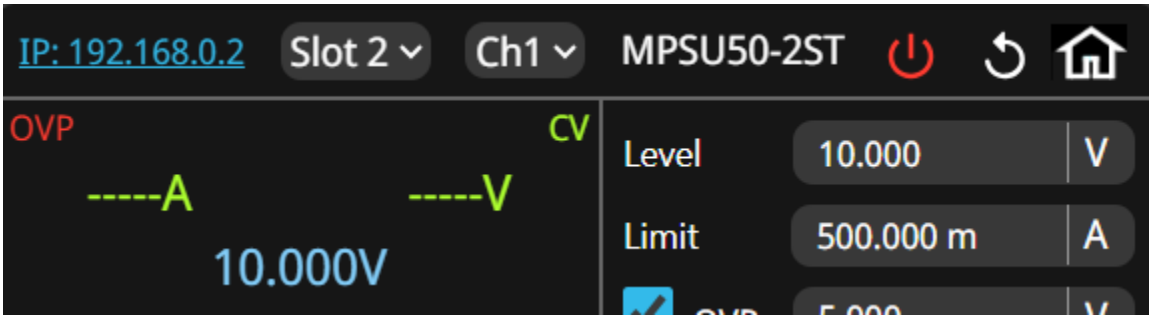
For example, if a sense lead is disconnected or broken during a 4-wire sense measurement, the instrument can interpret the missing sense lead as a decrease in voltage and respond by increasing the source output. If overvoltage protection is set, the sourced output is not allowed to exceed the overvoltage protection limit. If overcurrent protection is set, the sourced output is not allowed to exceed the overcurrent protection limit.

In addition to the user-set value for overvoltage protection, the instrument maintains a fixed overvoltage protection limit that prevents the power supply from exceeding an output of 75 W if there is an excessive voltage drop on the source leads. This level is determined by the current limit using the following equation:

$V_{LIM} = 75/I_{LIM}$

For example, if the current limit is set to 5 A, the fixed overvoltage limit is set to 15 V. Protection is tripped based on which limit is lower, the user set limit or the fixed limit. The user set overvoltage limit can be disabled, but the fixed limit is always active.

When overvoltage or overcurrent protection is enabled and the source exceeds the setting, the output is turned off by immediately opening the output disconnect relays. This turns off the output in less than 50 µs. Note that inductive elements in cables may discharge after disconnection; however, the power supply is isolated from the device. In addition, an error is generated and `OVP` or `OCP` is displayed on the front panel and web interface, as shown in the following figure.



In the status model, a protection bit is set and you can query the protection trip status using commands. To clear the error from the status model, you need to clear the Measurement Event PSU protection bit. For more information on registers, refer to “Measurement Event Registers” in the *MP5000 Series Programmer Manual*.

WARNING: Even with the overcurrent and overvoltage protection set to the lowest value, never touch anything connected to the terminals of the power supply when the output is on. Always assume that a hazardous voltage (greater than 30 V_{RMS}) is present when the output is on. To prevent damage to the DUT or external circuitry, do not set the current source to levels that exceed the value that is set for overcurrent or overvoltage protection.

To set the protection levels, use the `slot[Z].psu[X].source.protect.leveli` and `slot[Z].psu[X].source.protect.levelv` commands. To enable or disable protection, use the `slot[Z].psu[X].source.protect.enablei` and `slot[Z].psu[X].source.protect.enablev` commands.

To check if protection was tripped, use the `slot[Z].psu[X].source.protect.trippedi` and `slot[Z].psu[X].source.protect.trippedv` commands.

Related commands:

```
slot[Z].psu[X].source.protect.enablei
slot[Z].psu[X].source.protect.enablev
slot[Z].psu[X].source.protect.leveli
slot[Z].psu[X].source.protect.levelv
slot[Z].psu[X].source.protect.trippedi
slot[Z].psu[X].source.protect.trippedv
```

Overtemperature protection

To prevent damaging heat build-up and ensure specified performance, make sure there is adequate ventilation and airflow around the mainframe to ensure proper cooling. Do not cover the ventilation holes on the sides of the instrument. For additional detail, refer to “Airflow” in the *MP5103 User Manual*.

Even with proper ventilation, the modules can overheat in the following situations:

- If the ambient temperature is too high.
- If you use a module as a power sink for long periods.

If a power supply module overheats, the output of the module is turned off and an event message is generated. If the temperature continues to climb and exceeds another threshold, the mainframe is powered down.

CAUTION: If an overtemperature condition occurs, turn off the module and allow it to cool for 30 minutes. You cannot turn the output on until the module cools down. Verify that there is adequate ventilation. When you return power to the module, verify that the cooling fan is running. If not, contact Tektronix. Leaving the instrument turned on with an inoperative cooling fan may result in damage to the instrument.

Slew rate

The slew rate determines the maximum rate at which the voltage changes to a new programmed setting. You can specify the rate for the voltage changes to be between 1 V/s and 10,000 V/s. The slew rate is specified from 10% to 90% of the transition from the previous voltage level to the new set voltage level.

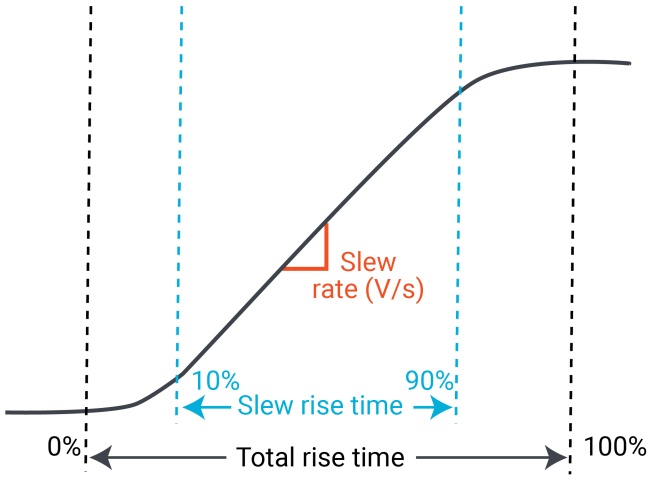
The set and achieved slew rate may differ due to the slew rate being limited by a few different factors. The factors that limit the slew rate are the following:

- The voltage difference between the present programmed voltage level and the new programmed voltage level. The maximum slew rate can only be achieved with voltage differences ≥50 V.
- The set current limit. The current limit must be >500 mA to achieve the best slew rate performance.
- The load current in relation to the current limit. If the current drawn by the load is near the current limit, the slew rate is reduced to prevent current limit overshoot.

The slew rate will not exceed the set value.

The maximum slew rate is achieved when stepping from 0 V to ± full scale with a current limit that is greater than 500 mA and a load that is greater than 65 ohms.

Actual slew rate is limited by current limit, load, and voltage level. If the current drawn by the load is near the current limit, the slew rate is reduced to prevent overshoot. Increase the current limit to improve slew rate performance. Maximum slew rate performance is achieved with current limits greater than 500 mA.



Related command:

`slot[Z].psu[X].source.slewrate.v`

Make a measurement

You can make voltage, current, resistance, or power measurements. The units of measure are volts, amperes, ohms, and watts. You can measure current and voltage at the same time. Measured voltage is a readback value of the source and the measured current is the sourced current. Resistance and power measurements are based on calculations of the measured voltage and current. The power supply cannot measure external signals.

Measurements can be stored in a reading buffer. Existing data in a reading buffer is deleted before new measurements are made unless the reading buffer is set up to append data.

The MPSU50-2ST has only one voltage range and one current range, so there are no range settings to make.

The TSP commands that set up the measurement functions begin with `slot[Z].psu[X].measure`. Command descriptions are provided in the TSP command reference.

Related commands:

```
slot[Z].psu[X].defbufferY
slot[Z].psu[X].makebuffer()
slot[Z].psu[X].measure.rangeY
slot[Z].psu[X].measure.tempcomp
slot[Z].psu[X].measure.Y()
```

Measurement rate

The measure rate can be set to normal or fast. This selection changes the measurement aperture of the analog-to-digital converter. The measurement aperture is the amount of time that the input signal is measured. The fast reading rate increases reading noise. The normal reading rate takes longer but has the least amount of reading noise.

This setting changes the reported NPLC and aperture attributes to match the predefined rate. The amount of time is specified in parameters that are based on the number of power line cycles (NPLCs). Each power line cycle for 60 Hz is 16.67 ms (1/60); for 50 Hz, it is 20 ms (1/50).

Related commands:

```
slot[Z].psu[X].measure.aperture
slot[Z].psu[X].measure.nplc
slot[Z].psu[X].measure.rate
```

Count

The count is the number of measurements made when a measurement is requested. If you use a reading buffer with a measure command, the count also controls the number of readings that are stored. If a measurement count makes more new measurements than the buffer can hold, the measurement command returns an error and no measurements are made.

Related command:

```
slot[Z].psu[X].measure.count
```

Overlapped operations

In normal operation, each action is conducted sequentially and must complete before the next action begins. Some operations take additional time to execute in the hardware. When overlapped mode is enabled, commands return as soon as they are able, even if the action is not fully complete in the hardware.

This mode is most useful when you perform operations on multiple channels. It allows operations to perform in parallel and thus execute more quickly than sequential operation in normal mode. Overlapping only applies to commands that specify settings. If you retrieve a setting, such as when you use a print command, command execution pauses and waits for other commands to complete before the setting is retrieved. Overlapped operations are most applicable to making measurements, as measurements can continue in the background while other actions occur. Not all actions can be overlapped. In particular, overlapped measure commands cannot be used with the trigger model.

If actions on the channel are aborted, all overlapped operations are also aborted.

Related commands:

```
slot[Z].psu[X].abort()
slot[Z].psu[X].measure.overlappedY()
slot[Z].psu[X].overlapped
waitcomplete()
```

Abort overlapped operations

To terminate all overlapped operations on a channel, send the `slot[Z].psu[X].abort()` command, where *Z* is the module slot number and *X* is the channel number. This does not turn off the output or change other settings.

Related command:

`slot[Z].psu[X].abort()`

Measurement timing

The timing of measurements including implementing measure delays is dependent on the configuration of the trigger model. For more information on constructing a trigger mode, see “Triggering” in the *MP5000 Series Programmer Manual*.

Relative offset

When making measurements, you may need to subtract an offset value from a measurement.

The relative offset feature subtracts a set value or a baseline reading from measurement readings. When you enable relative offset, all measurements are recorded as the difference between the actual measured value and the relative offset value. The formula to calculate the offset value is:

Reading with offset applied = Actual measured value − Relative offset value

Related commands:

`slot[Z].psu[X].measure.rel.enableY`
`slot[Z].psu[X].measure.rel.levelY`

Temperature compensation

Temperature compensation improves accuracy for current measurements by accounting for the temperature coefficient of the current measure circuitry. When temperature compensation is enabled, the measure rate for current measurements is reduced because the analog-to-digital converter performs an additional temperature measurement. This attribute does not affect voltage measurements.

Related command:

`slot[Z].psu[X].measure.tempcomp`

Reset the module

You can reset individual channels to the default settings. Reset also turns the output off.

Related commands:

`slot[Z].psu[X].reset()`

Sink operation

When the power supply is operating as a sink, voltage and current have opposite polarities and the instrument is dissipating power rather than sourcing it. The instrument can be forced into sink operation by an external source, such as a battery, or an energy storage device, such as a capacitor. The sink current is nonprogrammable and the maximum sink current is 0.1 A ±10%.

For example, if a 12 V battery is connected to the voltage source (HI to battery high) that is programmed for +10 V, sink operation occurs in the second quadrant (source +V and measure −I).

CAUTION: Carefully consider and configure the source and limits before connecting the power supply to a device that can deliver energy. Devices that can deliver energy include voltage sources, batteries, capacitors, and solar cells. Configure power supply settings before making connections to the device. Failure to consider the source and limits may result in damage to the instrument or to the device under test (DUT).

Battery test considerations

WARNING: To prevent personal injury or damage to the MP5000 Series, do not attempt to charge nonrechargeable batteries. Some of the batteries that can be charged with an MP5000 Series are nickel cadmium (Ni-Cd), nickel metal hydride (Ni-MH), lithium ion (Li-ion), rechargeable alkaline, and lead acid. If you are working with a battery type that is not listed here, please contact your local Tektronix office, sales partner, or distributor, or call one of our Applications Engineers to get technical assistance.

Always follow the requirements of the battery manufacturer for charging or discharging batteries using a MPSU50-2ST. Failure to properly charge or discharge batteries may cause them to leak or explode, resulting in personal injury and property damage. Overvoltage and current protection should be provided in the charge circuit, external to the instrument, when charging batteries without built-in protection.

A battery is usually charged using a constant current. To do this, use a PSU as a voltage source set to the voltage rating of the battery, with the target charging current set as the current limit. At the start of the test, the battery voltage is less than the voltage output setting of the PSU. As a result, this voltage difference drives a current that is immediately limited to the user-defined current limit. When in current limit, the PSU acts as a constant current source until it reaches the programmed voltage level. As the battery becomes fully charged, the current decreases until it reaches zero or near zero. To prevent safety hazards or damage to the battery, be careful not to overcharge the battery.

When discharging a battery, the PSU operates as a sink because it is dissipating power instead of sourcing it. The voltage source of the PSU is set to a lower level than the battery voltage. The current limit sets the discharge rate. When the output is enabled, the current from the battery flows into the HI terminal of the PSU. As a result, the current readings are negative. The discharge current should stay constant until the battery voltage decreases to the voltage source setting of the PSU. The discharging current must be within the maximum specification for sinking current.

Sweep operation

Sweeps allow you to configure the source to step through a specific sequence of values. The PSU modules can generate DC and pulsed linear, logarithmic, and list voltage sweeps. Sweeps are stored in tables that are generated by the following commands:

- `slot[Z].psu[X].trigger.source.linearY()`
- `slot[Z].psu[X].trigger.sourcelogY()`
- `slot[Z].psu[X].trigger.source.listY()`

Sweeps are created for each channel and are executed using the trigger model source action blocks. For more information on configuring and executing sweeps, refer to the *MP5000 Series Programmer Manual*.

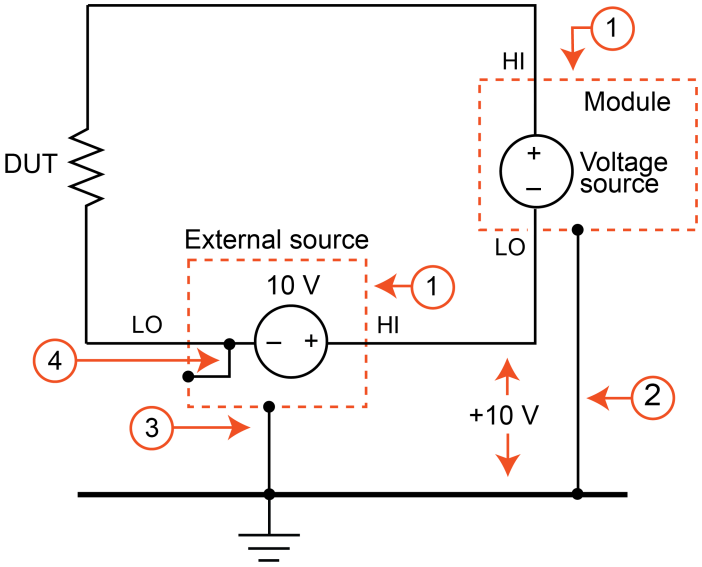
Float a PSU module

WARNING: SENSE LO and LO are not internally connected to the chassis. Do not allow them to float above chassis ground more than 200 V for the MPSU50-2ST. Failure to adhere to these guidelines can result in personal injury or death due to electric shock.

If you use an external source in the test system, you may need the PSU to float off chassis ground. An example is shown in the following figure, which includes an external voltage source. Notice that output LO of the external voltage source is connected to chassis ground.

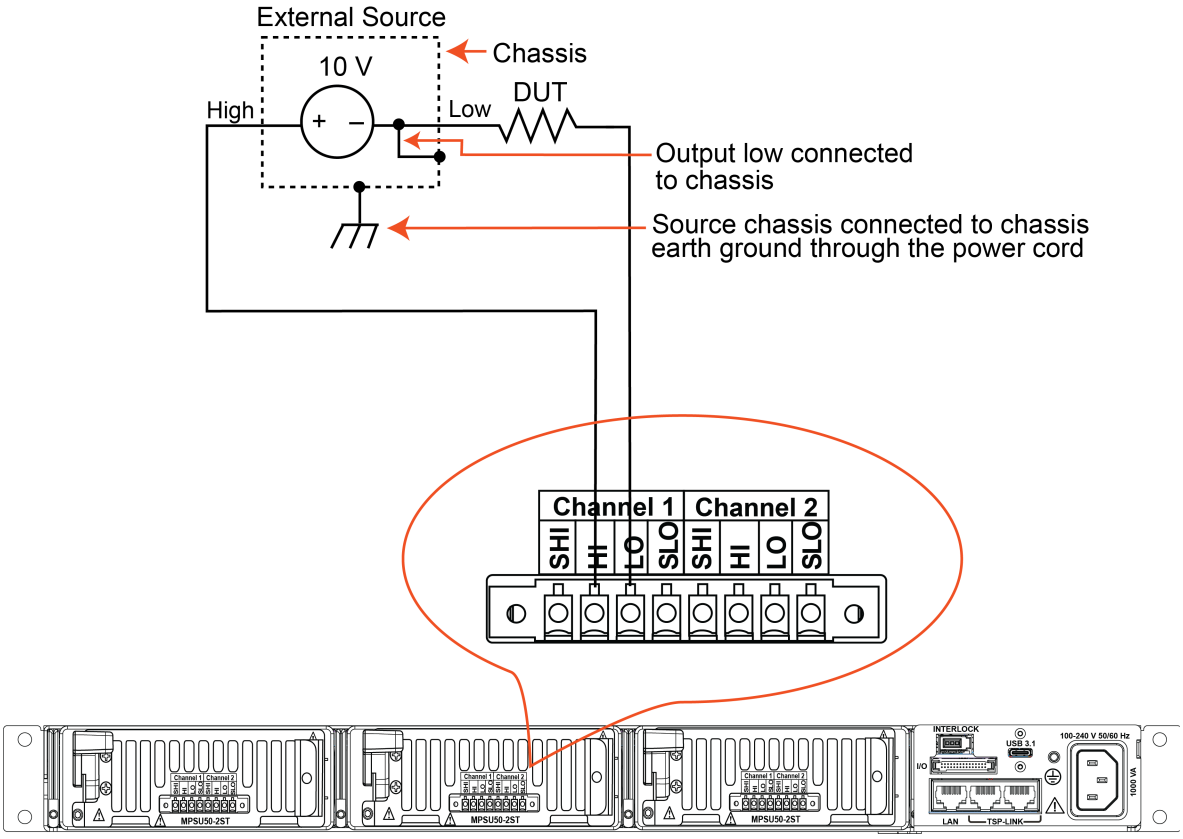
For the test circuit shown in this figure, the PSU must float off chassis ground. As shown, LO of the PSU is floating +10 V above chassis ground. If LO of the PSU was instead connected to chassis ground, the external voltage source would be shorted to the chassis ground.

The external voltage source can be another PSU or other instrument. If the combined outputs of the sources exceed ±42 V, a safety shield is required for the device under test (DUT).



1	Chassis
2	Instrument chassis connected to chassis ground through the power cord
3	Source chassis connected to earth ground through the power cord
4	Output Lo connected to chassis

The connections for the floating configuration are shown in the following figure. To float the PSU, LO and SENSE LO must be isolated from chassis ground. To do this, do not connect LO and SENSE LO to chassis ground.



WARNING: All measurement connections should be considered to be hazardous.

The maximum floating (common mode) voltage for a MPSU50-2 is 200 V. Exceeding this level may cause damage to the instrument and create a shock hazard.

Using an external source to float a PSU could create a shock hazard in the test circuit. A shock hazard exists whenever >42 V_{PEAK} is present in the test circuit. Appropriately rated cables or insulators must be provided for all connections to prevent access to live parts.

When >42 V is present, the test circuit must be insulated for the voltage used or surrounded by a metal safety shield that is connected to a known protective earth (safety ground) and chassis ground; refer to Test fixtures (on page 13).

Combine PSU outputs

The following information provides cautions and important considerations that must be observed if you combine PSU output channels.

Use care when combining PSU channels. When PSU channels are combined, it is best to use instruments with identical current and voltage envelopes and ranges.

If you combine two PSUs in series, there can be up to 100 V (50 V per channel). If you combine two MPSU50-2ST in parallel, there can be up to 10 A (5 A per channel).

CAUTION: Carefully consider and configure the appropriate source, limit, overcurrent, and overvoltage values before connecting the PSU to a device that can deliver energy (for example, other voltage sources, batteries, capacitors, solar cells, or other MPSU50-2ST instruments). Configure recommended instrument settings before making connections to the device. Failure to consider the source and limit values may result in damage to the instrument or to the device under test (DUT).

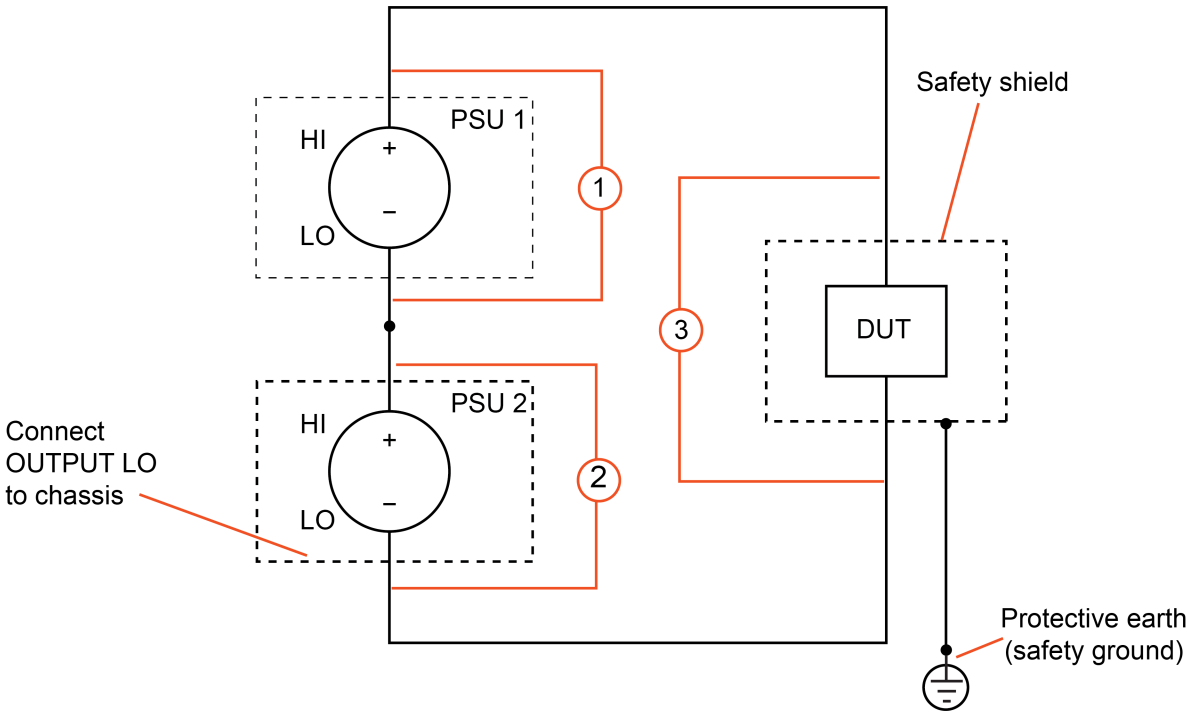
Combine channels in series to output higher voltage

WARNING: Channels in series cause hazardous voltage (>30 V_{RMS}, 42 V_{PEAK}) to be present and accessible at the PSU output connector. A safety shield must be used whenever hazardous voltages will be present in the test circuit. To prevent electrical shock that could cause injury or death, never use the PSU in a test circuit that may contain hazardous voltages without a properly installed and configured test fixture.

To output a higher pulse voltage, connect up to four PSU channels in series. Never connect more than four PSU modules. When combining the channels from two PSU modules, make sure that the common mode voltage of one PSU supports the maximum output voltage of the second PSU.

The following figure illustrates two PSU channels on the same module connected in series to output up to 100 V (50 V per channel).

Whenever hazardous voltage (>30 V_{RMS}, 42 V_{PEAK}) will be output, a safety shield must completely surround the device under test (DUT) test circuit. When using a metal safety shield, it must be connected to a known safety earth ground and chassis ground.



1	PSU 1: +50 V
2	PSU 2: +50 V
3	Series: +100 V

Since the PSU modules are bipolar, you can also connect the lows for extended differential voltages. For example, connect one power supply at 25 V to another that sources −25 V to provide a differential voltage of 50 V spanning −25 V to 25 V on the device.

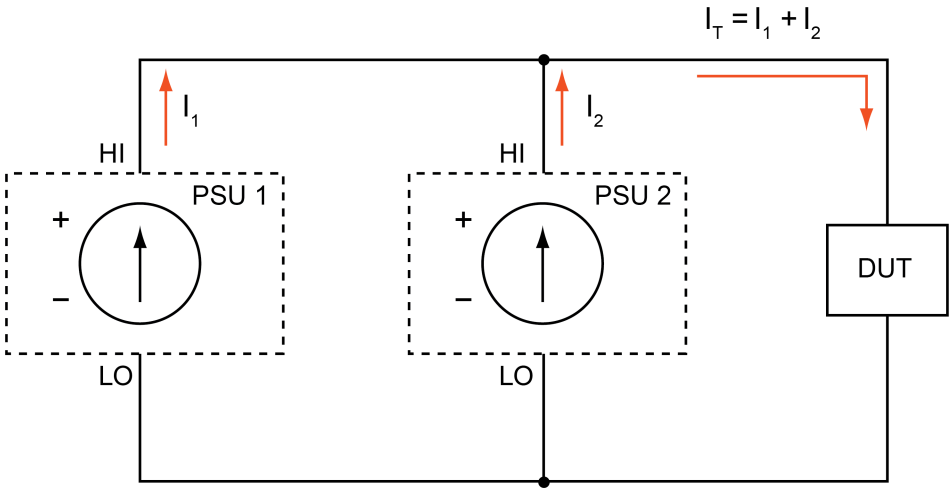
Combine channels in parallel to output higher current

To output higher current, connect two PSU modules in parallel. Never connect more than two PSU channels in parallel. When you combine two PSU channels, make sure both PSUs have the same model number.

The following figure shows the connections of two PSU channels on the same module connected in parallel. Two MPSU50-2ST channels can output up to 10 A at 10 V. The current delivered to the device under test (DUT) is the sum of currents output by the PSU channels (I_T). When you combine two MPSU50-2ST channels, you expand the power envelope.

When combining PSU outputs in parallel, the channels must have different settings to prevent one channel from sinking into the other. Set one channel to a voltage that is higher than needed with a current limit that is half of the combined current output. Set the other channel to the needed voltage with the current limit set above half of the combined current. This channel sets the voltage for the pair, and the channel with the higher voltage operates in constant current mode and the voltage is reduced to match. The second channel operates in constant voltage and outputs the rest of the current draw to the device. The headroom on this current should be equal to the excess current the device can handle.

For example, to output 6 A from two MPSU50-2ST channels at 5 V, one channel should be set to 6 V with a 3 A limit and the other channel should be set to 5 V with a 3.5 A limit. The combined output is 6 A at 5 V, with an overall current limit of 6.5 A.



I_1	Single PSU maximum DC current: 3 A
I_2	Single PSU maximum DC voltage: 3 A
I_T	Parallel PSU channels maximum DC voltage (as shown): 6 A

Maintenance and troubleshooting

Introduction

This section describes routine maintenance of the instrument that an operator can perform.

Identify the module

The module serial number is on a label on the top of the module. The serial number for a specific module can be accessed through the virtual front panel or by using the `localnode.serialno` command over a remote interface.

You can use the following commands to identify the module:

- `slot[Z].manufacturer`: Returns `TEKTRONIX`.
- `slot[Z].model`: Returns the model number of the module in the specified slot.
- `slot[Z].serialno`: Returns the serial number of the module in the specified slot.
- `slot[Z].revision`: Returns the firmware version number of the module in the specified slot.

Update the firmware

You can load a newer or older version of firmware to the mainframe or modules. The process takes about ten minutes. You can use the front panel, TSP commands, TSP Toolkit, or the web interface to update.

The mainframe and modules are updated separately, but the process is similar for both. You can update modules without upgrading the mainframe. Check the release notes for compatibility of mainframe and module firmware.

During the mainframe update, the front panel displays an update message. During a module update, the front panel is blank and the Module Status indicator for the slot blinks red and green.

Prepare to update

If you are using TSP commands or the front panel to update, you need to copy the firmware files to a USB flash drive. Verify that the flash drive is formatted with FAT32 or exFAT. In Microsoft™ Windows™, you can check the file system by checking the properties of the USB flash drive.

CAUTION: Do not remove the USB drive, turn off the instrument power, or otherwise interrupt the firmware update process. Your instrument may become unresponsive and require factory service.

To download firmware for your instrument:

1. To get the update file, go to Datasheets, Manuals, and Software Downloads.
2. Enter the model number of your instrument.
3. Select **Software** from the filter list.
4. Select **Firmware** from the filter list.
5. Download the firmware.
6. Unzip the files. The firmware file has the extension `.x`.
7. Review the release notes.

Update the firmware from the front panel

You can use a USB flash drive to update the firmware from the front panel for the mainframe and modules. The latest firmware is available from tek.com.

Make sure that the firmware is loaded onto your USB flash drive, then insert it into the USB port on the front of the mainframe.

The update process is the same for the mainframe as it is for the modules. The following example demonstrates the firmware update for a module.

CAUTION: Do not remove the USB drive, turn off the instrument power, or otherwise interrupt the firmware update process. Your instrument may become unresponsive and require factory service.

The following procedure updates a module with mainframe firmware V1.0.1 or newer installed. If you need to update using an older mainframe version, replace the first two steps in the following procedure by selecting General info from the home screen and then selecting the firmware download icon.

To update the module firmware (mainframe V1.0.1 and newer):

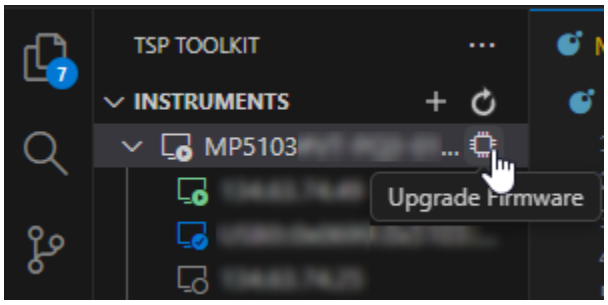
1. Select **Settings** from the mainframe home screen.
2. Select **Firmware Update**.
3. Select **Slot1**, **Slot2**, or **Slot3**.
4. Select **Browse** to locate the new firmware file on your USB flash drive, then select it.
5. Select **Update**. The firmware may take several minutes to load. The slot indicator on the front panel blinks red and green while the update is in process, and a message is displayed when the update is complete.
6. To confirm that the update was successful, select the information icon from the Home screen, then scroll to the information section for the slot to verify the module firmware version.

Update the firmware with TSP Toolkit

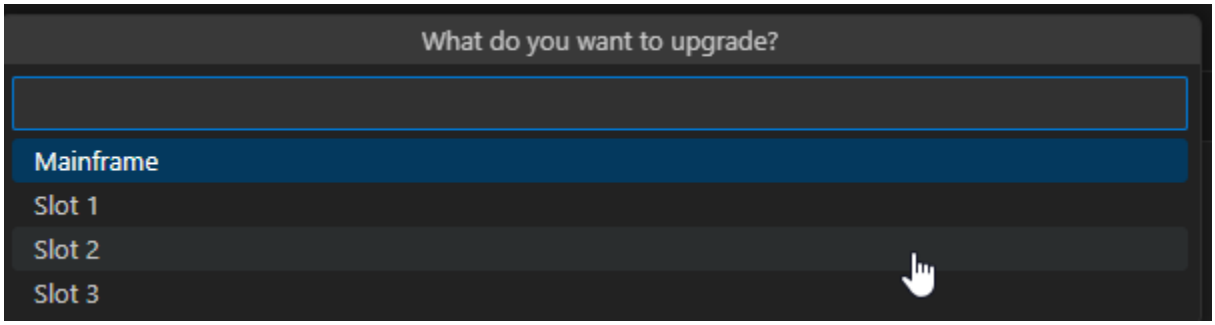
To update the firmware with TSP Toolkit:

1. Place the update file in a location that can be accessed by TSP Toolkit.
2. Open Visual Studio Code with TSP Toolkit extension installed.
3. Connect to the mainframe.
4. Select the **TSP Toolkit** icon. The mainframe is displayed in the Primary Sidebar.

5. Select the **Upgrade Firmware** icon to the right of the mainframe name.



6. Select the mainframe or slot number from the list. The Select Firmware File dialog is displayed.



7. Select the update file.
8. Select **Upgrade**.
9. Wait until the update process is complete:
   - **Mainframe:** Monitor the front panel for update status. TSP Toolkit is disconnected during the update process.
   - **Module:** The message "Module upgrade complete" is displayed in the TSP Toolkit terminal.

Update the firmware using TSP

To update firmware using TSP, you need to load the firmware file to the mainframe and then run the file.

NOTE: You can check the current firmware version of a mainframe with `print(localnode.revision)` and `print(slot[Z].revision)` for a module.

To update the firmware using TSP commands over a remote interface:

1. Copy the firmware file to a USB flash drive.
2. Insert the flash drive into the USB port on the front panel of the instrument.
3. Load the firmware. Send
   `firmware.image.load("/usb1/filename")`
   Where *filename* is the directory and file name for the firmware.
4. Start the firmware update.

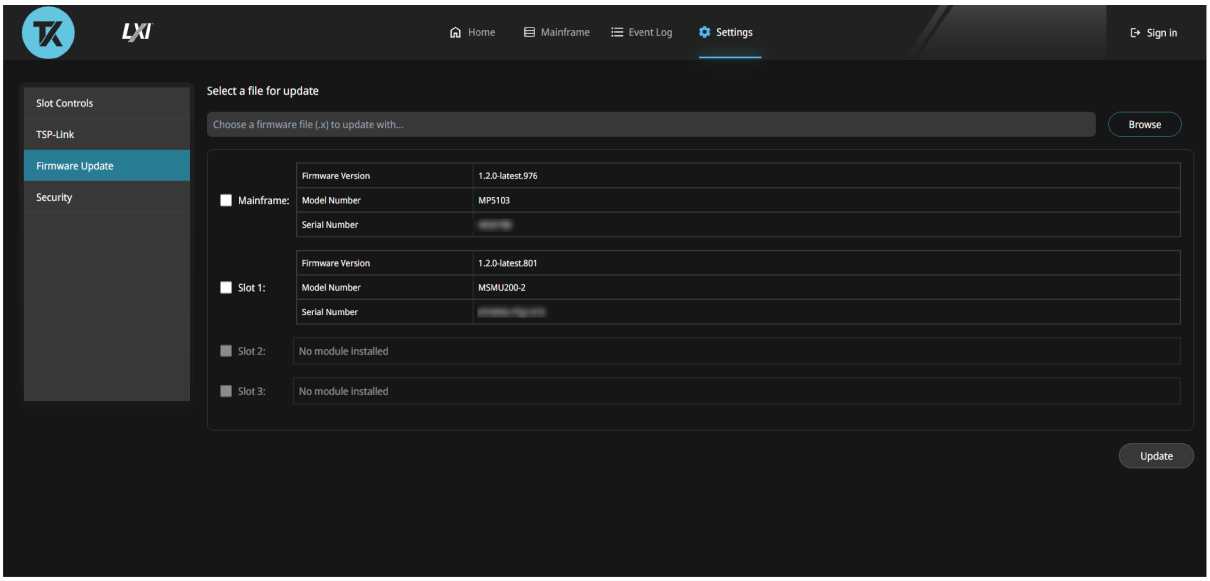
   For the mainframe, send
   `firmware.update()`

   For a module, send
   `slot[Z].firmware.update()`
   Where *Z* is the slot number.
5. Wait for the update to complete.

During a mainframe update, the front panel and module lights go dark for a few seconds, then the front panel displays an update message. The mainframe is restarted. During the module update, the Module Status light blinks red and green.

Update the firmware using the web interface

To update the firmware using the web interface:



1. Make sure that you are connected to the mainframe and logged in. See Log in to the MP5103.
2. Place the upgrade file in a location that can be accessed by the web browser.
3. Select **Settings**.
4. Select **Firmware Update**.
5. Select the mainframe or a module slot to be updated. You can only update one instrument at a time.
6. Select **Browse**.
7. Select the firmware update file.
8. Select **Update**.
9. Wait until the update process is complete:
   - **Mainframe:** Monitor the web page for update status. The connection will be interrupted during the update. Refresh the web page after several minutes to verify that the update has been installed. If your instrument is set to use automatic IP address assignment, check the mainframe front panel display to verify the IP address, then connect to the mainframe again.
   - **Module:** Monitor the web page for update status.

License information

To review the license information for the module, send the command:

```
slot[Z].license
```

Where `Z` is the slot number that contains the module.

Event log

The event log records errors, warnings, and information reported by the instrument. Events are logged in a first-in, first-out queue. Event messages include the event code, event message, severity, TSP-Link node, and the time of the event.

Events are assigned to one of the following levels.

Number	Event level	Description
0	NO_SEVERITY	The message is information only. This level is used when the event queue is empty.
10	INFORMATIONAL	The message is information only. This level is used to indicate status changes.
15	WARNING	This message indicates that a change occurred that could affect operation.
20	RECOVERABLE	The event was caused by improper use of the instrument or by conditions that can be corrected. This message indicates that an error occurred. The instrument is still operating normally.
30	SERIOUS	There is a condition that prevents the instrument from functioning properly. The message indicates that the instrument is presently operating in an error condition. If the condition is corrected, the instrument returns to normal operation.
40	FATAL	There is a condition that cannot be corrected that prevents the instrument from functioning properly. Disconnect the DUT and turn the power off and then on again. If the error is a hardware fault that persists after cycling the power, the instrument must be repaired.

Most events do not abort a running script. The only time a script is aborted is when a Lua runtime error (event code −286, "TSP runtime error") is detected. Runtime errors are caused by actions such as trying to index into a variable that is not a table.

Execution of scripts or commands is prevented if there is a syntax error (event code −285, "Program syntax") in the script or command.

You can retrieve events from the event log by using the commands in the following table.

Command	Description
`eventlog.clear()`	Clear event log of all errors
`print(eventlog.count)`	Number of messages in the event log
`print(eventlog.next())`	Read and return the oldest unread event message from the log and remove the event message from the log

For example, the following command requests an event log message:

```
print(eventlog.next())
```

If there are no events in the event log, the return is similar to:

```
0.00000e+00 Queue Is Empty 0.00000e+00 1.00000e+00 0.00000e+00 0.00000e+00
```