

S540 Power Semiconductor Test System

Administrative Guide

S540-924-01 Rev. D / January 2019



S540-924-01D

S540

Power Semiconductor Test System
Administrative Guide

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The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with 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.

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.

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.

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S540 system

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Introduction

If you have any questions after reviewing this information, please contact your local Keithley Instruments office, sales partner, or distributor. You can also call the corporate headquarters of Keithley Instruments (toll-free inside the U.S. and Canada only) at 1-800-935-5595, or from outside the U.S. at +1-440-248-0400. For worldwide contact numbers, visit the [Keithley Instruments website \(tek.com/keithley\)](http://tek.com/keithley).

Systems documentation

Documentation for your system is available at tek.com/keithley. Following is a list of documentation for your system, including the document part numbers.

- S540 Power Semiconductor Test System Administrative Guide (S540-924-01)
- S540 Power Semiconductor Test System Reference Manual (S540-901-01)
- Keithley Test Environment (KTE) Programmer's Manual (S500-904-01)

System description

The Keithley Instruments S540 Power Semiconductor Test System is a configurable, instrument-based system for power semiconductor parametric characterization and testing. There are two different S540 systems available:

- S540 3000 V high-voltage parametric test system with a 3-kV switching matrix (12 pins)
- S540 3000 V high-voltage, low-current parametric test system with a 3-kV switching matrix (12 pins) and a low-current switching matrix (12, 24, or 36 pins)

The S540 systems have flexible hardware configurations that allow you to customize them to your specific needs. See the following table for a description of the main system configuration options, and see the following figure for an example of a typical system configuration.

S540 3000 V high-voltage system configuration options

DC source-measure units (SMU)	<ul style="list-style-type: none"> ■ Maximum number of SMUs depends on other items in the system rack ■ Model 2636B System SourceMeter® instrument (quantity: 0 to 4) ■ Model 2657A High-Power System SourceMeter® instrument (quantity: 2)
Switching matrices	One Model HVM1212A 12 × 12 high-voltage switch matrix
Optional capacitance/voltage (C-V)	One channel of C-V (using one Model 4200A-SCS with one Model 4210-CVU card)
Optional instruments	<ul style="list-style-type: none"> ■ Model 4220-PGU dual-channel pulse cards (quantity: 0 to 3) ■ RSA306B USB Spectrum Analyzer (quantity: 0 to 1) for frequency and ring oscillator measurements
Included with each system	<ul style="list-style-type: none"> ■ Computer inside cabinet ■ External 24-inch flat-panel monitor and keyboard tray mounted on exterior of cabinet ■ Keithley Test Environment (KTE) or Automated Characterization Suite (ACS) system software ■ LO patch panel ■ Safety interlock system ■ Adjustable cable support arm
Other options	Advanced seismic securement kit for additional resistance to seismic forces

S540 3000 V high-voltage, low-current system configuration options

DC source-measure units (SMU)	<ul style="list-style-type: none"> ■ Maximum number of units depends on other items in the system rack ■ 2636B System SourceMeter® instrument (quantity: 1 to 4) ■ 2657A High-Power System SourceMeter® instrument (quantity: 2)
6-slot switching matrix	<p>One Model HVM1212A 12 × 12 high-voltage switch matrix and one Model 707B system switch mainframe with:</p> <ul style="list-style-type: none"> ■ Model 7531 switch cards (quantity: 2 to 6, depending on instruments and number of low-voltage pins in the system); one card is used as an interconnect card
Optional capacitance/voltage (C-V)	Two channels of C-V (using one Model 4200A-SCS with two Model 4210-CVU cards)
Optional instruments	<ul style="list-style-type: none"> ■ Model DMM7510 7-1/2 Digit Graphical Sampling Multimeter (quantity: 0 to 1) ■ Model 4220-PGU dual-channel pulse cards (quantity: 0 to 3) ■ Frequency measurement option
Included with each system	<ul style="list-style-type: none"> ■ Computer inside cabinet ■ External 24-inch flat-panel monitor and keyboard tray mounted on exterior of cabinet ■ Keithley Test Environment (KTE) or Automated Characterization Suite (ACS) system software ■ LO patch panel ■ Interlock system ■ Adjustable cable support arm
Other options	Advanced seismic securement kit for additional resistance to seismic forces

Optional accessories

Optional items and accessories that may accompany the S540 system:

- Cables to connect to the test fixture or the probe card adapter
- 9140A-PCA probe card adapter (12 3-kV pins to 36 200-V pins) or Celadon Systems VersaCore™ VC20 probe card adapter (12 3-kV pins to 32 200-V pins)
- RSA306B USB Spectrum Analyzer
- Advanced seismic securement kit

S540 site preparation and installation

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Site preparation checklist

NOTE

The following site preparation checklist will help you prepare your site for the S540 system in your facility. If you find that an item listed is not valid for your site, you can indicate it with "N/A."

S540 system preparation checklist

Site	Item
	Is it necessary to have lifting equipment?
	Is the flooring adequate and able to support the weight of the system while moving from receiving to the final destination (see Floor plan (on page 2-24) for specifications)?
	Are all of the corridors and hallways large enough to allow clearance for the system?
	Are stairways adequate for moving the system through?
	Are elevators needed to move the system? Can they support the size and weight of the system?
	Are the doorways wide enough for the system?
	If you are using a Keithley probe card adapter, you must supply a vacuum connection (50.80 cm Hg / 20 in.).
Floor plan	Item
	Did you complete the system layout (see Floor plan (on page 2-24) for specifications)?
	Does your layout show all of the locations for all of the equipment?
	Does your system layout show the locations of all doors and aisles?
	Does your layout allow for the proper clearance of the system for the front, rear, and the keyboard/monitor arm?
	Is there enough space for personnel safety, comfort, and freedom of movement?

S540 system preparation checklist (continued)	
Floor plan	Did you take future expansions into consideration?
Electrical power	Item
	Is there sufficient space for any supplies or manuals?
	Is adequate and proper electrical power available (see Line power requirements (on page 2-19) for specifications)?
	Is anything connected to the same power source that generates noise?
	Is anything that requires substantial amounts of current connected to the same power source?
	Did you prepare power outlets for service, testing, or maintenance?

Unpacking the S540 system

The Keithley field service engineer (FSE) is responsible for unpacking the S540 system cabinet and the accessories. However, we recommend that you move the crate and the accessories box to the area where the system is going to be used.

Here is a list of tools needed for unpacking:

- Safety glasses
- Gloves
- Standard screwdriver
- Socket wrench
- Socket head: 19 mm (3/4 in.)

The following information will help the FSE unpack the system. Series 500 systems are shipped in a wooden crate (see the following figure).

Figure 1: S540 system cabinet in shipping crate



Unpacking system components

Inspect the shock sensor on the outside of the shipping crate (see the following figure). If the shock sensor indicates a shock condition, do a thorough inspection of all components in the system cabinet.

Figure 2: S540 crate shock sensor



Also, check the "TIP N TELL" indicator to ensure that the crate has not been tipped over (see the following figure).

Figure 3: S540 crate tipping indicator



Carefully remove all system components from the crate. While unpacking, make sure there is no component damage. Report any damage to the shipping agent immediately. Please reuse or recycle packaging materials in accordance with your local requirements.

NOTE

You need at least two people to unpack and move the S540 system cabinet.

To unpack the system components:

1. Remove the crate clamps from the crate using a standard screwdriver.

Figure 4: Removing the crate clamps

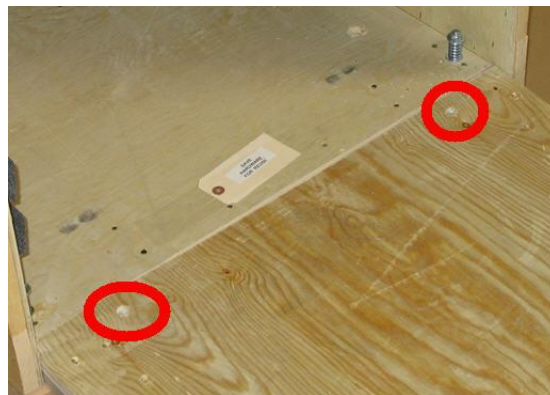
2. Open the front of the crate. The front is identified by the wooden ramp support attached across the panel (see the following figure).
3. Make sure the ramp support is pulled away from the crate. It is held in place with hook and loop fasteners (such as Velcro®).

Figure 5: Opening the front of the crate



4. Attach the ramp using the two bolts that are attached to the bottom front of the crate.

Figure 6: Front of the crate with ramp down



5. Remove the padding from the front of the S540 system cabinet.

Figure 7: Removing the padding



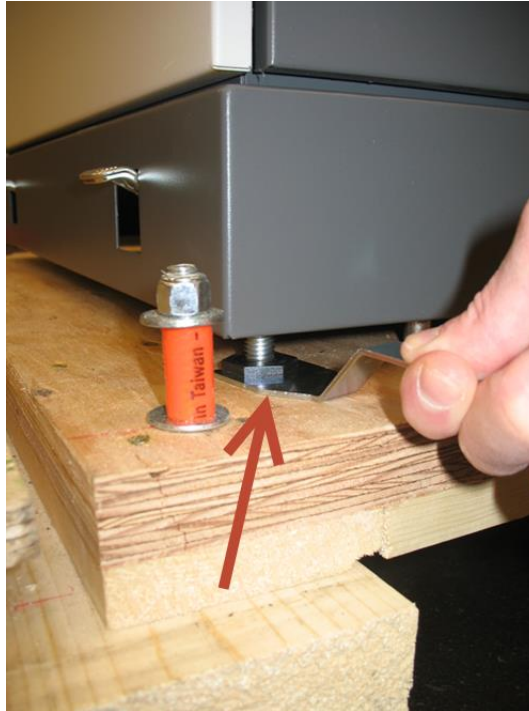
6. Remove the crate clamps and slide the outer box cover off the crate.

Figure 8: Sliding the outer box off the crate



7. Make sure that you retract the leveling feet on the bottom of the system (next to the casters) to put weight on the casters and prepare the system to be rolled down the ramp.

Figure 9: Leveling feet



8. Remove the four bolts from the bottom of the crate that are attached to the bottom of the S540 system cabinet using a 19 mm socket head on a socket wrench.

Figure 10: System bolted to the crate

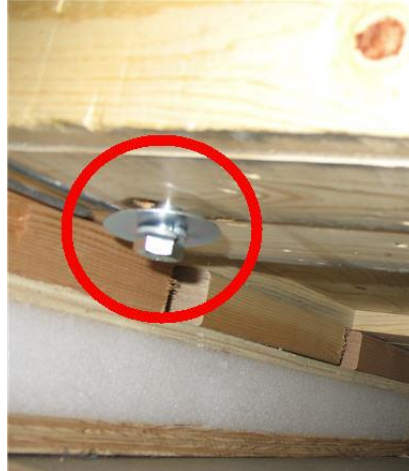


Figure 11: Removing the bolts from the crate



9. Save the hardware (the four bolts and washers) that you remove from the bottom of the crate.

Figure 12: System crate hardware



10. Unlock the two casters that are on the front of the S540 system cabinet by moving the locks up.

Figure 13: System caster brakes



11. With two people, slide the S540 system cabinet down the ramp.

Figure 14: Rolling the system down the ramp



12. Remove the tape from the packing material using scissors, taking care not to scratch the S540 system cabinet.

Figure 15: Cutting the wrap off the system



13. Move the S540 system cabinet to its final destination.

The system cabinet is shipped from the factory with all of the instruments installed. Most equipment connections and wiring of instruments in the system cabinet was done at the factory.

Unpacking the S540 system accessories

The accessories are shipped in a separate box or in multiple boxes, depending on how many accessories are ordered.

Figure 16: S540 system accessories



The accessories box contains a computer monitor, keyboard, and mouse. It also includes required installation hardware, USB extension cables, cable support arm, connectors for the keyboard and mouse, and any other accessories that may have been ordered with the system (for example, probe card adapter, cables to connect to the test fixture or probe card adapter, or advanced seismic securement kit). You will also find all of the documentation that is shipped with your order. Please reuse or recycle packaging materials in accordance with your local requirements.

NOTE

The following figures are examples of system accessories that may be included in your shipment. What you receive may be different depending on your system configuration.

Figure 17: Typical system accessories



Figure 18: Monitor arm accessory



Figure 19: Keyboard tray and arm accessory



Figure 20: Cable support arm accessory



Chuck cables for optional probe card adapters

A set of chuck cables is included with the optional 9140A-PCA probe card adapter. Model numbers of cables vary based on the prober you are using. For example, the Keithley Field Service Engineer (FSE) will install the cables shown in the following table for Tel P8 probers.

Model	Quantity	Description
CA-63-12	2	12 ft three-lug triaxial cables
237-TRX-T	1	Three-slot male to dual three-lug female triaxial tee adapter
237-BNC-TRX	1	High-voltage two-slot BNC to three-lug female triaxial adapter

NOTE

If a different cable termination scheme is required, a customer-supplied solution can be used.

Optional probe card adapter vacuum requirement

9140A-PCA probe card adapter requirement: A 50.80 cm (20 in.) Hg (which is the same as 40.73 PSI) vacuum supply, with a hose connection of 0.64 cm (1/4 in.) outside diameter and 0.32 cm (1/8 in.) inside diameter.

For detailed information about the 9140A-PCA probe card adapter, see the *9140A-PCA Probe Card Adapter Instruction Manual* (part number 9140A-901-01). This manual is available for download at tek.com/keithley.


Keithley field service engineer installation tasks

The Keithley field service engineer (FSE) will perform the following tasks:

- Unpack the system components and accessories.
- Attach the keyboard arm and monitor arm to the system.
- Install the keyboard and the mouse on the keyboard arm, and the monitor on the monitor arm.
- Install the cable support arm to the system.
- Install the probe card assembly (PCA) (if ordered) on the back of the system cabinet, and the 60190-PCA (probe card assembly) to the correct prober plate (customer-supplied from the prober company). The prober plate is attached to the prober.
- Plug in the system to your power facilities (supplied by your facilities department at the final location for the S540 system cabinet) and power up the entire cabinet.
- Verify communications of all instruments and with the properly configured prober.
- Perform diagnostics and system verification tests of the entire S540 system, to include the 60190-PCA (if ordered).
- Record all the information on the System Installation Form.

Example Series 500 System Installation Form

Figure 21: Example Series 500 System Installation Form page 1



KEITHLEY
A Tektronix Company

28775 Aurora Road
Cleveland, Ohio 44139
1-800-935-5595
tek.com/keithley

Series 500 Parametric Test Systems

Installation/Delivery Form

System installation:

Company: _____	Sales order #: _____
Address: _____	Date: _____
_____	QMO #: _____

Contact: _____	Phone #: _____

System configuration:

System: <input type="checkbox"/> S530/S540 low-current <input type="checkbox"/> S500 <input type="checkbox"/> S530 high-voltage (1 kV)	<input type="checkbox"/> S535 <input type="checkbox"/> S540 high-voltage (3 kV)
Software: <input type="checkbox"/> ACS version: _____	<input type="checkbox"/> KTE version: _____
System options: <input type="checkbox"/> CVU, quantity: _____	<input type="checkbox"/> DMM, quantity: _____
<input type="checkbox"/> Frequency measure	<input type="checkbox"/> Pulse generator (PGU)
<input type="checkbox"/> RSA306B	PGU quantity: _____
Matrix installed/configuration: <input type="checkbox"/> 707B, quantity: _____	<input type="checkbox"/> 2-wire
# pins wired: _____	<input type="checkbox"/> Kelvin (4-wire)
<input type="checkbox"/> HVM1212	<input type="checkbox"/> No matrix
# LV pins wired (S540 only): _____	
Probe card adapter (PCA): <input type="checkbox"/> Yes, model #: _____	<input type="checkbox"/> No
# of pins wired: _____	
<input type="checkbox"/> Yes, custom: _____	
Prober: <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> GPIB
Prober manufacturer: _____	<input type="checkbox"/> Serial

Other system options or noteworthy details:

Figure 22: Example Series 500 System Installation Form page 2

System quality:

Were all parts included in shipment? Yes No

Was the installation documentation correct and sufficient? N/A Yes No

Was adequate labeling applied? N/A Yes No

Did the computer contain the correct software? N/A Yes No

Did the software run flawlessly? N/A Yes No

Installation complete? Yes No

System diagnostics passed? N/A Yes No

System verification passed? N/A Yes No

Deficiencies	Resolution	Due date

Notes:

Installation signatures:

Keithley Instruments Date Customer Date

Please return to KI-CLE-fsinstall@keithley.com when installation is completed even if delivery is not complete.

Figure 23: Example Series 500 System Installation Form page 3

System delivery:

Mutually agreed-upon work necessary for delivery

Items	Resolution	Due date

Delivery signatures:

Keithley Instruments Date Customer Date

Please return to **KI CLE fsinstall@keithley.com** when delivery is completed.

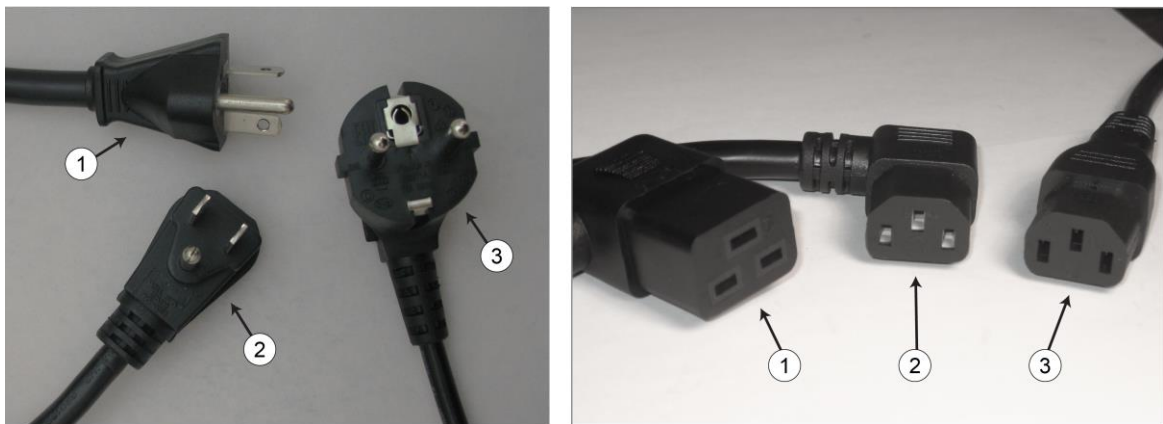
Power and operating conditions

The following topics contain information about power and operating environment conditions.

Supplied power cords

Keithley Instruments provides power cords that match the power requirements of the system. The following figure and table describe these cords.

Figure 24: Supplied power cables



Number	Description
1	20 A, 125 V American
2	15 A, 125 V American
3	16 A, 250 V Eurostyle cord

If power cords with different cord ends are needed, you must provide those cords.

Line power requirements

Nominal input line voltage: 100 VAC, 115 VAC, 220 VAC, 240 VAC (50 Hz, 60 Hz)

Short-circuit current rating: 5 kA

Power consumption: Rated at 2.4 kVA for the 2 kW power distribution unit (PDU)

Heat generation: Quiescent heat of 1720 BTU (1815 kJ) to maximum heat of 8191 BTU (8642 kJ)

⚠ WARNING

Severe personal injury or death due to electric shock or electrocution or equipment damage may occur if you do not have the correct circuit amperage.

S540 systems that are configured to operate between 100 VAC and 120 VAC must use a 20 A circuit; systems that are configured to operate between 200 VAC and 240 VAC must use a 15 A circuit.

System power dissipation

The total power dissipated by the S540 depends on the type and number of instruments in the test system. The power distribution unit (PDU) limits the incoming power to these instruments.

Though the PDU ensures electrical safety and compliance to the required standards, it does not prevent the system from overheating.

When a Series 2600B or 2657A instrument detects an excessive heat condition, the instrument turns the output off to minimize power dissipation. This safeguard prevents damage to individual Series 2600B and 2657A instruments, but may result in test instability. For instance, if you continuously source more than 1 A from all the source-measure units (SMUs) for more than 100 seconds, it may trigger a temperature error in one or more of the Series 2600B or 2657A instruments. However, an average output of less than 1 A for an indefinite period will not cause a temperature error.

For additional information about the Keithley Instruments Series 2600B and 2657A SourceMeter® instruments, refer to the documentation at tek.com/keithley.

Operating environment conditions

To ensure operation within specifications, the S540 must be operated inside of the following environmental conditions.

Temperature: 23 °C ±5 °C

Operating humidity: 30% to 60% relative humidity, noncondensing, after a two-hour warm up time

Vibration: High ambient vibration levels may require isolation pads or the repositioning of equipment

Air quality: The S540 system is compatible for use in a Class 10 clean room

Audible system noise: Decibel level is 65 dBA in optimal environmental conditions

Airflow: The S540 system is configured for top to bottom airflow

Altitude: Less than 2000 m (6,561 feet) above sea level

Noise interference: To prevent electrical noise from interfering with measurements, the ambient AC magnetic field must not exceed 2×10^{-3} G (2×10^{-7} T):

- Avoid locating the S540 next to plasma etchers, large motors, magnets, RF transmitters, equipment with flash lamps, and other potential sources of interference
- Position equipment to avoid routing signal and power cables near sources of electrical noise

Triaxial connector handling and avoiding contamination

Keep source-measure triaxial cable connectors (if applicable) clean and free of any foreign contaminants. Do not touch the connector pins of the triaxial connectors. Contamination can cause current leakage in the source-measure signal paths to the device under test (DUT), which can significantly degrade the test results.

CAUTION

Do not touch any connector pins or the areas adjacent to the electrical contacts of the triaxial connectors; contamination will degrade the performance of the test system.

Cleaning: Use lint-free swabs moistened with methanol or isopropyl alcohol to clean contaminated connectors and then blow-dry them with nitrogen gas. After blowing dry, wait several minutes before using.

Lockout and tagout

For maximum safety while power is applied, always perform a lockout and tagout procedure. Remove power from the entire test system and discharge capacitors before connecting or disconnecting cables or any instrument, including the device under test. When you perform lockout and tagout procedures, make sure that you read all warning labels on the cabinet and instruments (see the following figure).

Figure 25: Hazardous warning label



⚠ WARNING

Severe personal injury or death due to electric shock or electrocution may result if power is not removed before working inside the cabinet. Always perform the lockout and tagout procedure before opening the system cabinet. Also, never turn on the system until all connections and safety grounds are installed.

To remove system power:

You must shut down the software and remove all power from the computer and the system (see [Shut down using ACS](#) (on page 3-5) or [Shut down using KTE](#) (on page 3-6)).

⚠ WARNING

Before proceeding, you must make sure the power indicator on the front door is not illuminated. See the following figure for an example of what the indicator looks like when illuminated.

Figure 26: Indicator showing system power is still on



If this indicator is illuminated, system power is on.

1. Place the breaker for the power distribution unit (PDU) in the OFF position. The PDU is at the back of the cabinet below the rear door. See the figure in [Power distribution unit connections and power distribution basics](#) (on page 4-10) for a simplified drawing of the PDU.
2. If you are working in the system cabinet, disconnect the system cabinet line cord from the AC line power receptacles.
3. Verify that all power has been removed and discharged from the system cabinet by switching the main power switch (on the front door of the cabinet) to the ON position and verify that the green light does not illuminate. If the light does not come on, the power is off. Turn the main power switch back to the OFF position.
4. With the PDU breaker in the OFF position, lockout and tagout the system source power connection by locking a padlock through the hasp that surrounds the PDU breaker.

Installation and connections

WARNING

The following installation and connection procedures should be performed by trained site installers who are familiar with the associated physical and electrical hazards. Also, you should never turn on the system until all connections and safety grounds are installed.

Position the system cabinet

The system cabinet contains the controller and instrumentation for the test system. The cabinet is on casters, which allows you to easily roll it on a hard floor surface. The two steering casters in the rear are swivel type, and the two casters at the front are in fixed positions.

To position the system cabinet:

1. Carefully roll the system cabinet to its location next to the prober, allowing a minimum distance of 15 cm (6 in.) up to a maximum distance of 122 cm (48 in.). Allow approximately 60 cm (23.5 in.) (nominal) of clearance between the cabinet and other instrumentation.
2. Lock the casters by pushing down on the caster-locking mechanisms near the front-bottom of the cabinet.
3. Adjust the height of the four legs so that the weight of the cabinet is on the legs and not on the casters. Adjust the legs so that the cabinet is level and does not move (see [Physically securing the system](#) (on page 2-27)).

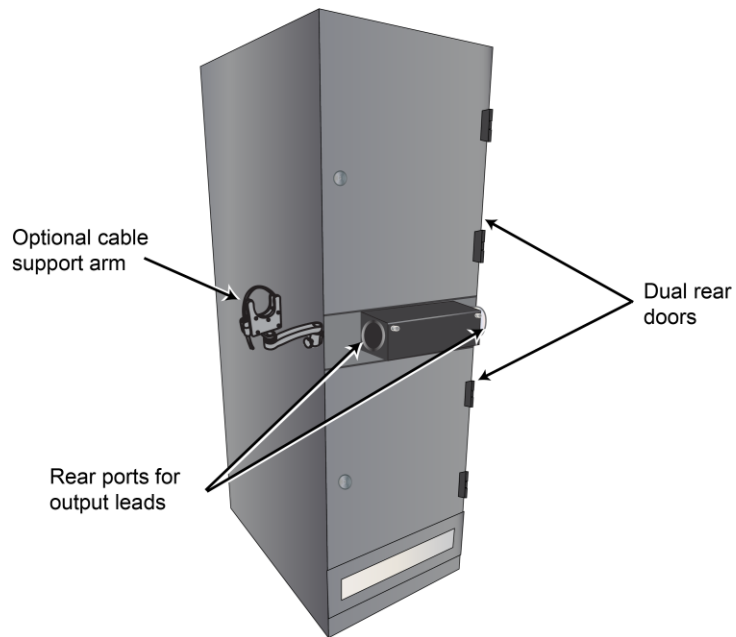
WARNING

System securement is required for safety of the S540 system and for personnel. You must bolt the legs adjacent to the four casters to the floor. See [Physically securing the system](#) (on page 2-27) for details.

Cable harness routing

The S540 has a dual-door rear portal for output leads. Cables can be routed from the cable harness at the rear portal to either the right or left of the cabinet.

Figure 27: S540 cabinet rear doors and cable portal



You can mount cable support arms on either side of the cabinet to suspend cables off the floor and prevent a tripping hazard.

Floor plan

NOTE

The following floor plan information is for the system cabinet only. Be sure to place the cabinet a minimum distance of 15 cm (6 in.) up to a maximum distance of 122 cm (48 in.) from the prober. Refer to the documentation for the prober or other test-fixturing equipment to determine its floor space requirements.

The system cabinet requires a floor space of approximately 1.2 m x 2.1 m (4 ft x 7 ft), plus additional room for service personnel access from the front and back of the cabinet. The following figures show a top view of the floor plan and the typical S540 system cabinet weight distribution and center of gravity. [System cabinet size and weight](#) (on page 2-26) lists the dimensions and weight of the system cabinet.

See the figure on the following page for floor plan specifications.

Figure 28: S540 floor plan, top view

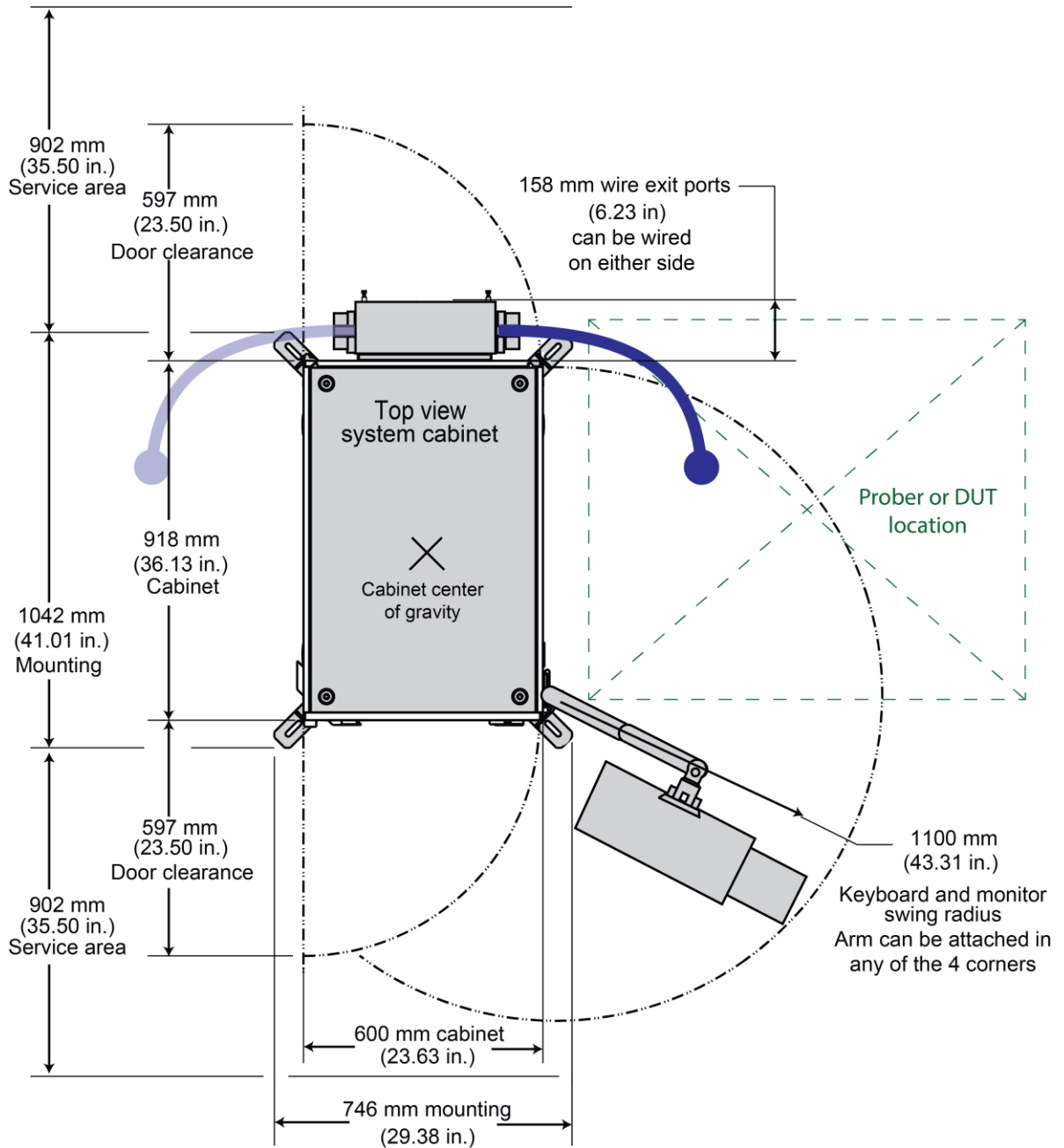
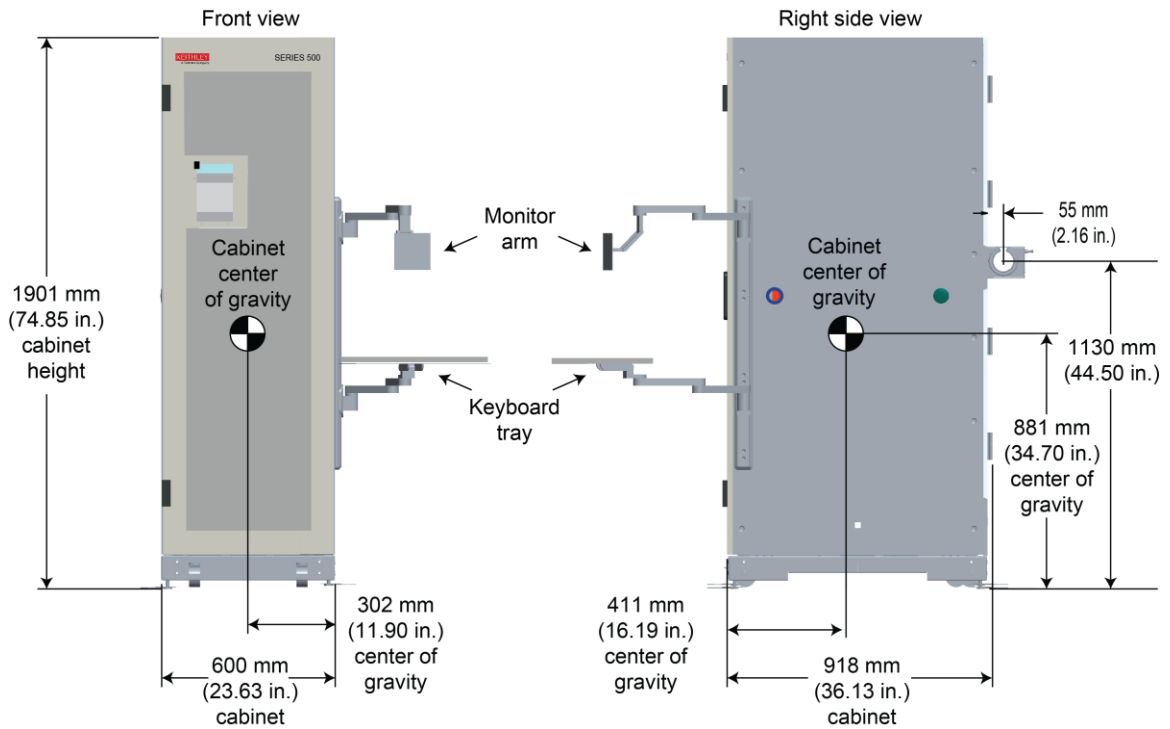


Figure 29: S540 weight distribution and center of gravity



System cabinet size and weight

The size and weight specifications for the system cabinet are listed in the following table. See [Floor plan](#) (on page 2-24) for details about designing a floor plan for the system cabinet.

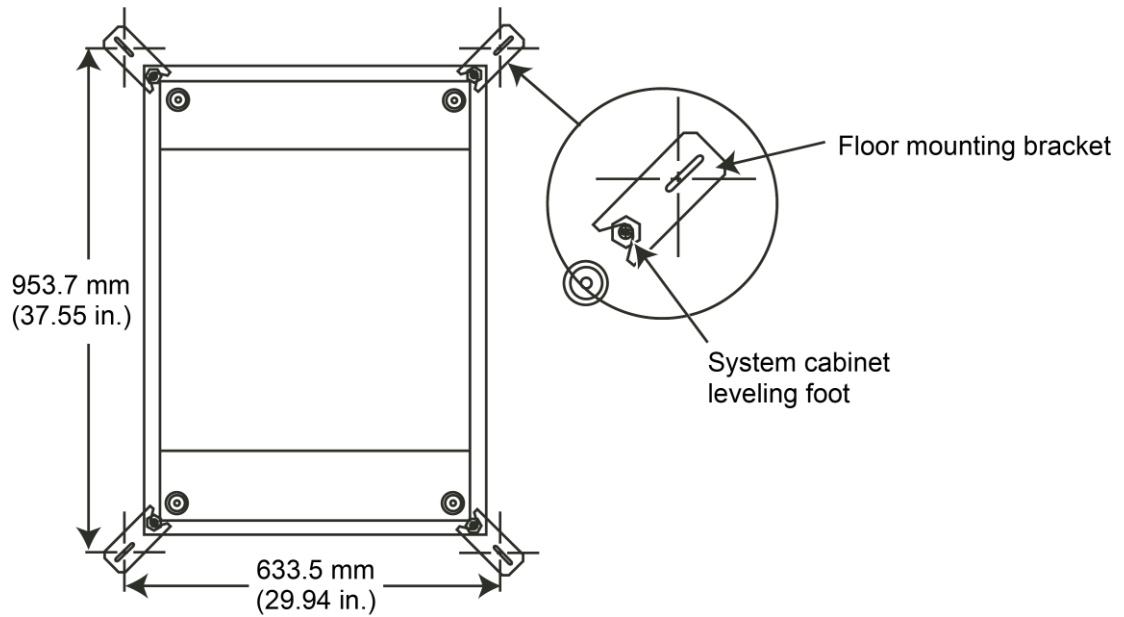
System cabinet size and weight						
Size (width x depth x height)	Weight					
	Minimum configuration			Maximum configuration		
600 mm x 918 mm x 1905 mm (23.63 in. x 36.13 in. x 75.00 in.)	195.05 kg (430 lb)			396.89 kg (875 lb)		
	Front feet	Left	51.83 kg (114.25 lb)	Front feet	Left	105.46 kg (232.50 lb)
		Right	51.83 kg (114.25 lb)		Right	105.46 kg (232.50 lb)
	Rear feet	Left	45.70 kg (100.75 lb)	Rear feet	Left	92.98 kg (205 lb)
		Right	45.70 kg (100.75 lb)		Right	92.98 kg (205 lb)

Physically securing the system

You must bolt the S540 system cabinet to the floor for safety purposes and to ensure the cabinet will not tip over.

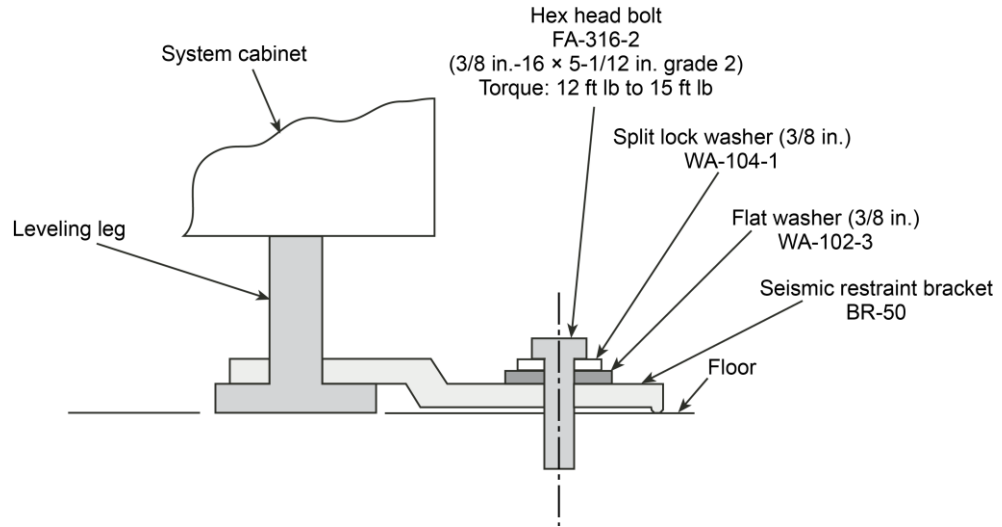
The following figure shows the restraint brackets and bolt installation dimensions for the system cabinet.

Figure 30: S540 system securement dimensions



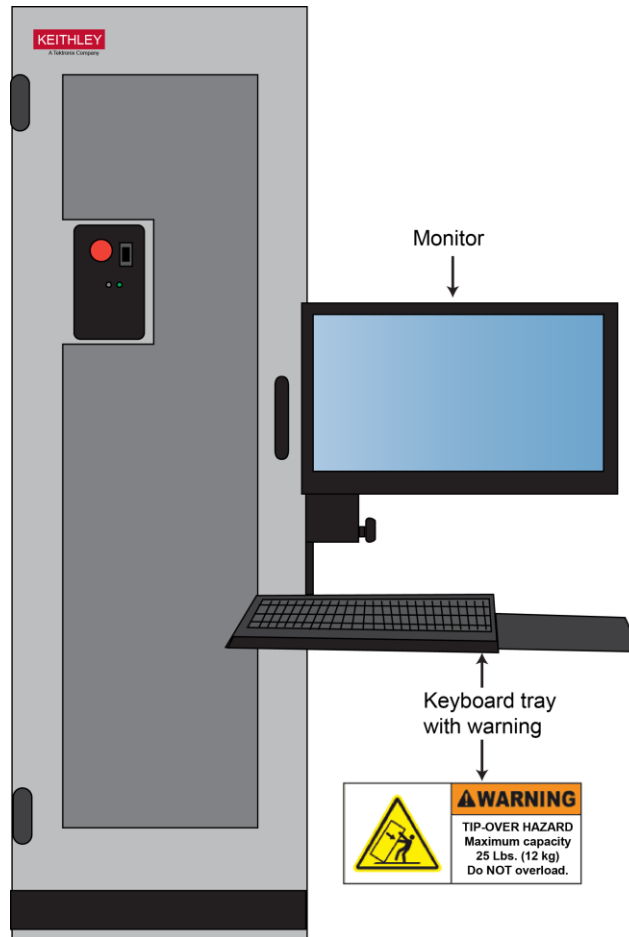
The following figure shows how a floor-mounting bracket is installed. Keithley part numbers are included for the required hardware.

Figure 31: S540 system cabinet floor mount



The following figure shows a label on the keyboard tray that indicates a tip-over hazard. The maximum weight capacity for the keyboard tray is 12 kg (25 lb).

Figure 32: S540 tip-over hazard warning label on keyboard tray



Optional advanced seismic securement

The S540 system can be ordered with an advanced seismic fastening option that has been tested and certified to the standards stated in IEC 61587-2 Ed. 2.0 Mechanical structures for electronic equipment — Tests for IEC 60917 and 60297 Part 2: Seismic tests for cabinets and racks.

If your system has this option, use the following installation instructions.

To install advanced seismic securement:

NOTE

You must supply the washers (flat and lock), threaded insert anchors, and mounting bolts that attach the mounting brackets to the floor (16 of each). The bolts should be at least grade-five bolts.

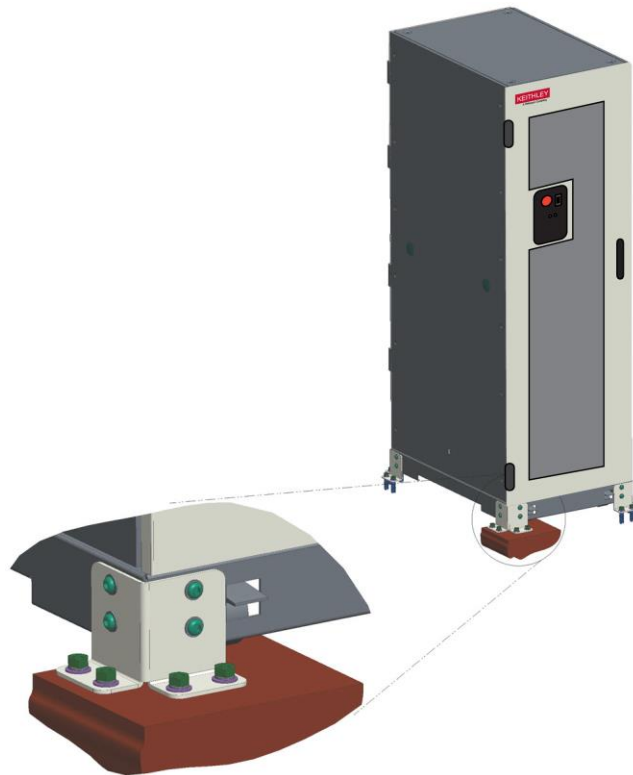
1. Position the cabinet where needed on a smooth, level floor.
2. Place the floor mounting brackets at the corners and make sure you have enough room for proper placement.
3. To properly place the mounting brackets, lift the cabinet by the leveling legs.

NOTE

Lifting the cabinet allows the holes in the mounting brackets to line up with the holes in the lower frame of the cabinet.

4. Temporarily attach the mounting brackets to each corner with the provided screws.
The following figure shows the restraint brackets and bolt installation for the system cabinet.

Figure 33: S540 seismic restraints



5. Mark the position of the mounting holes to the floor with a marker.
6. Remove the mounting brackets and also mark the location of the cabinet leveling legs.
7. Lower the cabinet and move as needed for drilling and installing the customer-supplied floor anchors.

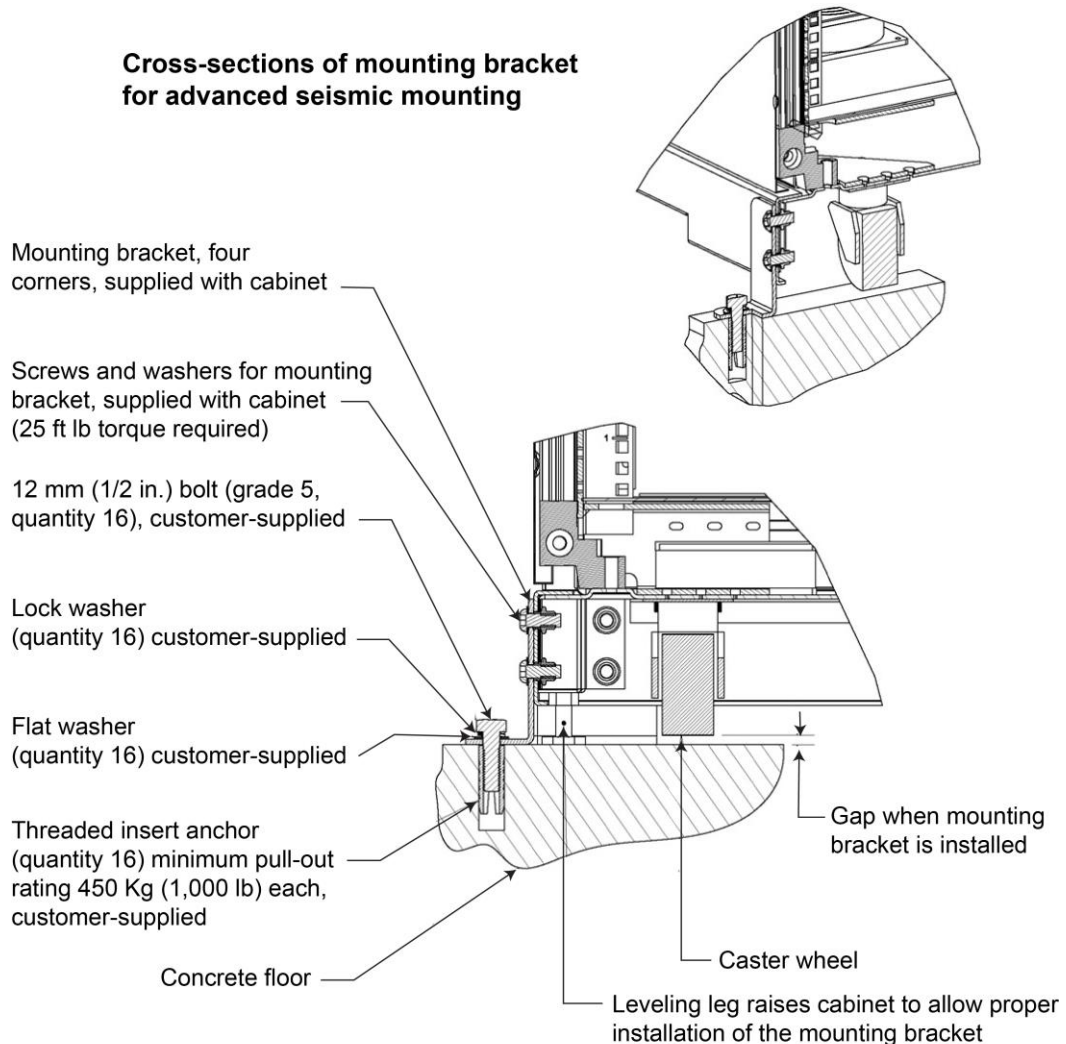
NOTE

Anchors should have a minimum pullout rating of 450 kg (1000 lb) each. Install 16 anchors for maximum protection.

8. Return the cabinet to marked locations on the floor and use the leveling legs to lift the cabinet to the proper height.
9. Attach the mounting brackets to the corners with the mounting hardware provided (16 screws and washers; 25 ft lb torque required).
10. Fasten brackets to the floor with user-supplied washers and grade-five (or higher) bolts.

The following figure shows how a floor-mounting bracket is installed.

Figure 34: S540 advanced cabinet floor mount



Equipment startup

In this section:

Introduction	3-1
Initial equipment startup	3-1
System startup	3-2
Before starting system software	3-3
Start the KTE software	3-4
Start the ACS software.....	3-5
Shut down using ACS	3-5
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Emergency OFF button.....	3-6
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LO patch panel.....	3-11
Prober safety.....	3-11
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Introduction

All of the instruments in the equipment rack are connected to one power distribution unit (PDU), which is in the back of the cabinet.

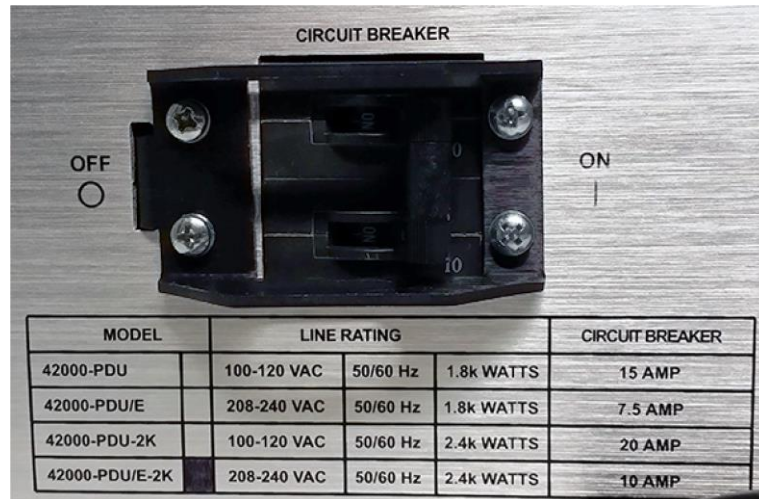
Follow the instructions in the following topics to start up your system and software.

Initial equipment startup

To begin equipment startup:

1. Check that all power cords for the system cabinet are connected to AC power.

Make sure that the circuit breaker on the power distribution unit (PDU) is in the ON position.

Figure 35: S540 power distribution unit (PDU) circuit breaker

2. Press the power/standby button on the computer and monitor.
3. Set the power button on the front door of the system cabinet to the ON position.

Figure 36: S540 power ON switch

System startup

To start up the system:

1. Make sure that the power switch on the power distribution unit (PDU) is set to ON.
2. Set the power button on the front door of the system cabinet to the ON position.
3. If the computer has not started to boot, open the front cabinet door and press the power/standby switch on the host computer.
4. Wait for all of the instruments to power up.
5. Log onto your computer.

Before starting system software

- You must make sure that all of the instruments are connected with the appropriate interface cable and a TSP-Link® connection between any Series 2600B/2657A or DMM7510 instruments.
- Assign GPIB or TCP/IP addresses (as appropriate) and node numbers to the hardware and instruments.

ATTENTION

To avoid instrument errors, make sure that all of the instruments in the system are completely powered up and have finished self-testing before starting the system software.

NOTE

The S540 system includes the following system software option:

- Keithley Test Environment (KTE)

For more information about the KTE software setup procedures, refer to the *KTE S530/S535/S540 Release Notes* document (part number PA-1036).

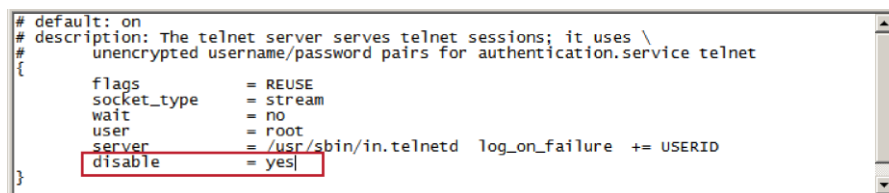
Using Telnet

Telnet is not enabled by default on the S540 system; you must to enable it to use it.

To enable Telnet:

1. From the command prompt (as root user), type `su` and the root password.
2. Type `gedit /etc/xinetd.d/telnet` to open the Telnet server configuration file.
3. In the opened file, change the line that says `disable = yes` to `disable = no` (see the following figure).

Figure 37: Enabling Telnet



```
# default: on
# description: The telnet server serves telnet sessions; it uses \
# unencrypted username/password pairs for authentication.service telnet
{
    flags            = REUSE
    socket_type      = stream
    wait             = no
    user             = root
    server           = /usr/sbin/in.telnetd log_on_failure += USERID
    disable          = yes
}
```

4. Save and close the file.
5. At the command prompt (as root user), type the following:

```
service xinetd start
chk config telnet on
chk config xinetd on
```

Start the KTE software

To start the KTE software, first start the instrument controller (IC) process. To start the IC process, log on to the computer and enter the following command:

```
run_ic.pl
```

NOTE

The IC process must be started manually after you log on.

The first time the IC process is started after a new KTE software installation, all instruments in the TSP-Link® network are initialized, which may take a few minutes. A status message is displayed on the TSP master instrument (Model 2450) during this process.

After the initial software installation, `run_ic.pl` initializes only the TSP-Link master instrument, and the other TSP instruments in the system execute the appropriate TSP script without delay.

IC process log messages

The `run_ic.pl` script sends any output messages from the IC process to the `$KILOG/ic_<QMO>_YYYYMMDD_HHMM.log` file, where:

- `<QMO>` is the QMO number of the tester.
- `YYYYMMDD_HHMM` is the date and time when the IC process was started.

The IC process by default only outputs `DEBUG` and `ERROR` messages. You can use the `KI_TRACE_LEVEL` environment variable to define the minimum level of messages to display. Valid values of this variable are: `TRACE`, `DEBUG`, and `ERROR`. After changing the environment variable, the IC process must be restarted by executing `$KIHOME/IC/bin/run_ic.pl`.

Stopping the IC process

To stop the IC process, enter the following command:

```
$KIHOME/IC/bin/stop_ic.pl
```

Start the ACS software

To start the ACS software, log on to the computer and double-click the ACS icon.

For more information about the ACS software setup procedures, refer to the *Automated Characterization Suite (ACS) Reference Manual* (part number ACS-901-01).

Shut down using ACS

To shut down using the Automated Characterization Suite (ACS) software:

NOTE

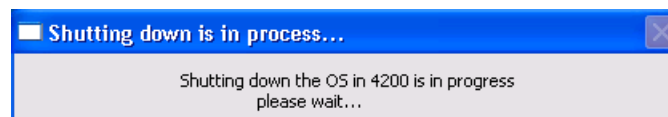
You must have administrator rights in the ACS software to shut down the S540 system.

1. Double-click the **Shutdown** icon on the computer desktop.
2. In the dialog box that opens, click **Yes** that you want to shut down the S540 tester.

NOTE

The message in the following figure opens after you click **Yes** to shut down the S540. You must wait until the 4200A-SCS and the system computer shut down before you press the power button on the system cabinet. It may take several minutes for the system to shut down.

Figure 38: Shut down the S540



3. Once the ACS host computer has shut down, press the power button on the front door of the system cabinet.

Shut down using KTE

To shut down using the Keithley Test Environment (KTE) software:

1. Close all KTE programs.
2. In the LINUX® terminal, type the following command:
`sudo $KIBIN/shutdown_s530.pl`
3. Enter the requested password.
4. Wait for the system computer to stop.
5. Turn off power to the cabinet.

Emergency OFF button

An EMERGENCY OFF (EMO) button is on the system cabinet front door (see the following figure). If you push the EMERGENCY OFF button, it removes power to all of the system instruments except the host computer.

Figure 39: EMERGENCY OFF button



The EMO TRIPPED indicator light (on the cabinet door) turns on when the system has undergone an emergency shutdown.

Emergency shutdown procedure

Press the red **EMERGENCY OFF** button on the front of the system cabinet. The instruments power down and the red EMO TRIPPED indicator illuminates.

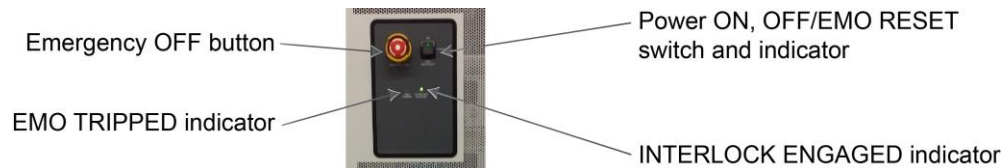
The red indicator also illuminates when the system recovers from a sudden power loss.

Recovering from an emergency shutdown

To recover after an emergency shutdown:

1. Verify that the hazardous condition or emergency situation is no longer present.
2. Rotate the **EMERGENCY OFF** button to release it.
3. Toggle the power switch from ON to OFF, and then back to ON again. All of the system instruments should power up.
4. Open the front cabinet door and press the power/standby switch on the host computer.
5. Call `run_ic.pl` to reinitialize the instrumentation.

Figure 40: S540 front-panel controls and indicators



Safety interlocks

⚠ WARNING

Failure to make sure that the safety interlock and safety shields and guards are properly installed and arranged as indicated will put personnel in severe danger. Severe personal injury or death due to electric shock or electrocution may result.

For the safety interlock to function properly, the device under test (DUT) interlock sensor must be installed near the DUT connections and the interlock magnet must be installed on the safety shield. It must be set up so that when the magnet is near the switch (interlock closed) the operator cannot touch voltage-carrying conductors. If not properly installed, it will render the interlock inoperative and place personnel at severe risk.

For operator safety, the S540 has interlocks on both the front and back cabinet doors and at the DUT. Also, the optional probe card adapter (PCA) has interlocks that provide protection for connections to a prober.

If you open a cabinet door or open the DUT interlock while instruments are sourcing, the interlock activates and disconnects the hazardous voltage from the source-measure instruments, stopping any tests in progress.

An indicator on the front door of the S540 cabinet illuminates, and the KTE software immediately notifies you of the interlock activation.

Figure 41: Interlock indicator



Once the interlock has been activated, you must clear the cause of the interlock activation.

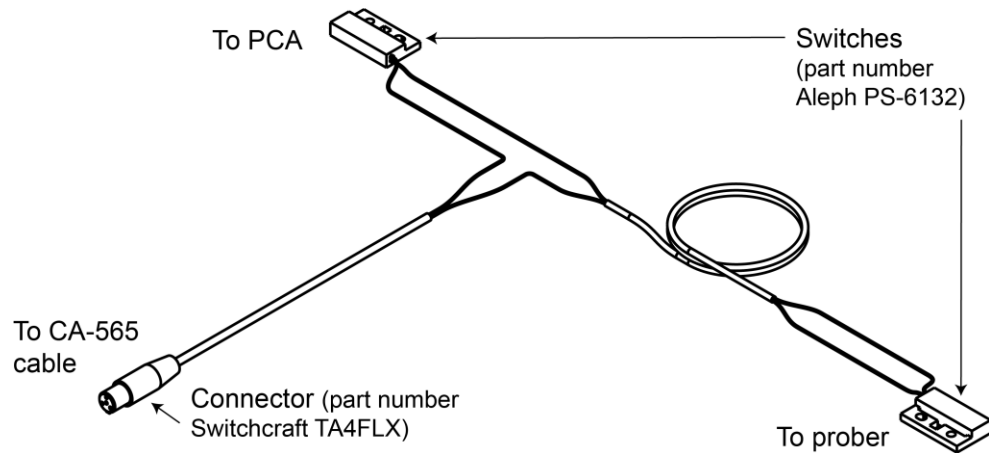
To clear the interlock activation:

1. Follow the instructions on the computer.
2. Make sure the front and rear doors are closed.
3. Make sure the DUT interlock is properly set for safe operation.
4. Close the DUT safety shield.
5. The software must recover before you can continue normal operation. You may need to rerun your tests.

Additional probe card adapter safety interlock cable

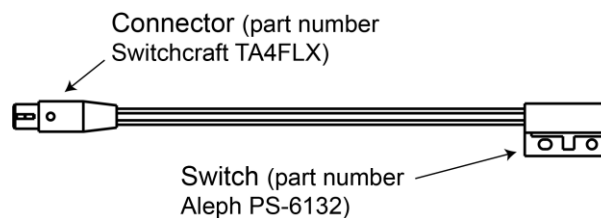
The Model 174-7047-XX Safety Interlock Cable provides additional protection from electric shock at the Keithley probe card adapter (PCA). The cable attaches to the prober top plate and the PCA so that if you unlatch the top plate of the prober and lift it up to change a probe card or take off the PCA, the interlock is tripped.

Figure 42: Model 174-7047-XX Safety Interlock Cable



The Model 174-7037-XX cable can be used with customer-supplied PCA solutions.

Figure 43: Model 174-7037-XX interlock cable



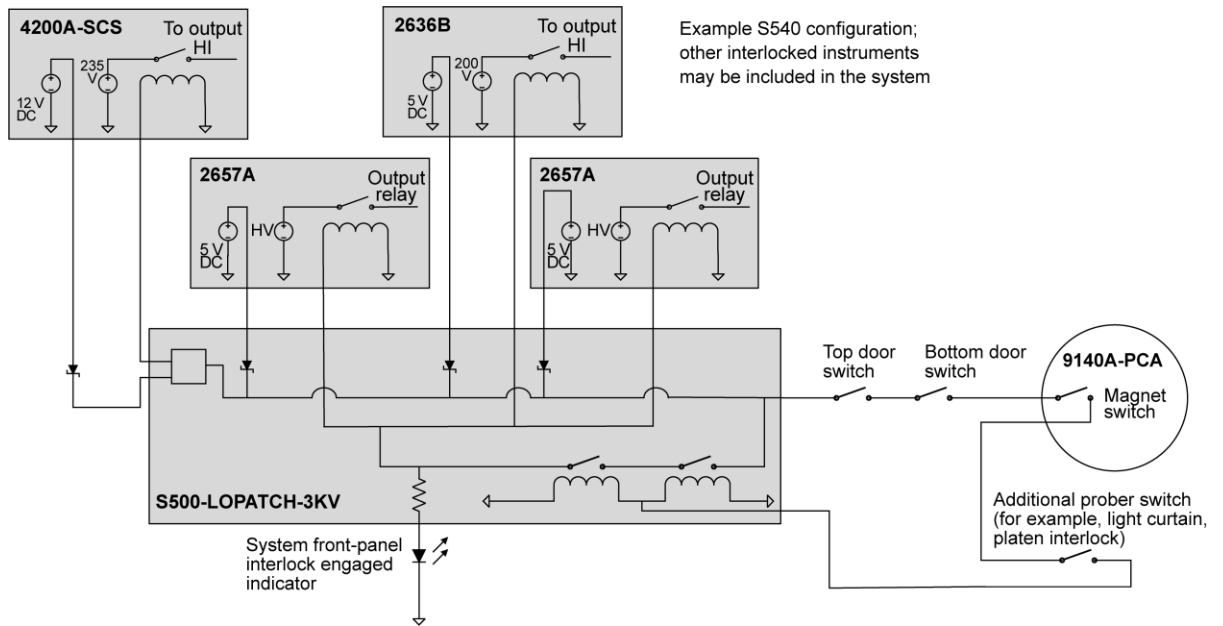
NOTE

The Model 174-7047-XX cable interfaces with your prober interlock through a relay contact. A shorted prober contact engages the interlock circuit. An open contact interrupts the interlock, turning off hazardous voltage.

9140A-PCA interlock connections for S540 systems

The following diagram shows the interlock connections to the optional 9140A-PCA Probe Card Adapter.

Figure 44: 9140A-PCA interlock block diagram for S540 systems



For additional information about the 9140A-PCA, see the *9140A-PCA Probe Card Adapter Instruction Manual* (part number 9140A-901-01). This manual is available for download at tek.com/keithley.

LO patch panel

The S540 must have a single, direct connection between instrument lows and protective earth (safety ground). The S500-LOPATCH-3KV panel provides this common LO connection and protective earth (safety ground) reference.

Figure 45: S500-LOPATCH-3KV



The LO patch panel provides:

- A common reference point for all the instrument low-side connections
- In 4-wire systems, a common connection for the sense low terminals of the source-measure units (SMUs)
- Connections from low to sense low using a 100 k Ω resistor to enable autosensing

Prober safety

⚠ WARNING

Hazardous voltages may be present on the probe card adapter, even after you disengage the interlock. Cables can retain charges after the interlock is disengaged, exposing you to live voltages that, if contacted, may cause personal injury or death.

Never attempt to touch or change a probe card when tests are running. You must be absolutely certain that all tests have stopped before making contact with anything in the vicinity of the probe card adapter. Also, never run tests without a probe card installed.

Network information

The network connections for the system computer include:

- System controller network interface: Ethernet port (10, 100, or 1000 Base-T capable using RJ-45)
- Supplied cables: One ethernet crossover cable (connects the computer to the tester)
- One 10Base-T patch cable (connects to your network)
- IP address is specified by you

ATTENTION

When setting up the computer for the S540 system, do not change the computer name. Software licenses are tied to the computer name. If you change the computer name, the Keithley Interactive Test Tool (KITT), Keithley Test Execution Engine (KTXE), and other Keithley Test Environment (KTE) tools will not work.

Maintenance

In this section:

Hardware replacement.....	4-1
Handling and cleaning precautions	4-2
Electrical hazard tasks	4-3
Instrument removal and installation.....	4-4
Power distribution and emergency off	4-8
Data hub license	4-13
Editing the icconfig_<QMO>.ini file	4-13
Using NPLCs to adjust speed and accuracy	4-14
Decommissioning an S540 test system	4-16

Hardware replacement

WARNING

The information in this section is intended only for qualified service personnel, as described in [Safety precautions](#) (on page 1-1). Because some of these procedures may cause exposure to hazardous voltages that could result in personal injury or death, service personnel must wear personal protective equipment (PPE) suitable for voltages greater than 40 VAC. Do not attempt to perform these procedures unless you are qualified to do so.

This section contains information about removal and installation of system cabinet components, and instructions for replacing components determined to be faulty.

Handling and cleaning precautions

CAUTION

Always grasp cards by the side edges and shields to avoid contamination that will degrade the performance of the components. Do not touch the connectors, the board surfaces, or components. On plugs and receptacles, do not touch areas adjacent to the electrical contacts.

Take care when handling or servicing to prevent possible contamination in high-impedance areas, which could degrade performance. Take the following precautions when servicing any system component:

- Do not store or operate the system in an environment where dust could settle on the components.
- Use dry nitrogen gas to clean dust off the components, if necessary.
- Handle cards only by the side edges and shields.
- Do not touch any board surfaces, components, or connectors.
- Do not touch areas adjacent to electrical contacts.
- Wear clean-room approved gloves when servicing any component.
- If necessary, make solder repairs on a circuit board using lead-free solder. Remove the solder from the work areas when the repair is complete. Use pure water and clean cotton swabs or a clean, soft brush to remove the solder. Take care not to spread the solder to other areas of the components. Once the solder is removed, use a swab moistened with methanol or isopropyl alcohol to wipe only the repaired area, and then blow-dry the board with dry nitrogen gas.
- After cleaning, place the components in a 50 °C low-humidity environment for several minutes before use.

Special handling of static-sensitive devices

CAUTION

System components can be damaged by electrostatic discharge (ESD). Wear a ground strap and attach the clip lead to the grounding bar in the test head or the system cabinet frame before working on the system. Assume all parts are static sensitive.

High-impedance devices are subject to possible static discharge damage because of the high-impedance levels involved. When handling such devices, assume all parts are static sensitive:

- Static-sensitive components should be transported and handled only in containers designed to prevent or dissipate static buildup. Typically, these components are received in anti-static containers made of plastic or foam. Keep these parts in their original containers until ready for installation or use.
- Remove the components from their protective containers only at a properly grounded workstation. Also, ground yourself with an appropriate wrist strap while working with these components.
- Handle the connectors only by their bodies. Do not touch the boards, pins, or terminals.
- Any printed circuit board into which the device is to be inserted must first be grounded to the bench or table.
- Use only anti-static type desoldering tools and grounded-tip soldering irons.

Electrical hazard tasks

Definitions of electrical hazard tasks (as defined in the SEMI S2-0715a standard) are listed in this section. For S540 systems, Type 2 electrical hazard tasks are typically performed.

For additional information about diagnostics, troubleshooting, or maintenance of specific Keithley instruments, refer to the documentation for that instrument for details before attempting to repair it. You can download manuals for related instruments at tek.com/keithley.

Types of electrical hazard tasks

Live circuit type	Description
1	Equipment is fully de-energized.
2	Equipment is energized. Energized circuits are covered or insulated. SEMI S2-0715a standard, NOTE 41: Type 2 work includes tasks where the energized circuits are or can be measured by placing probes through suitable openings in the covers or insulators.
3	Equipment is energized. Energized circuits are exposed and inadvertent contact with uninsulated energized parts is possible. Potential exposures are no greater than 30 V _{RMS} , 42.4 V _{peak} , 60 VDC, or 240 VA in dry locations.
4	Equipment is energized. Energized circuits are exposed and inadvertent contact with uninsulated energized parts is possible. Potential exposures are greater than 30 V _{RMS} , 42.4 V _{peak} , 60 VDC, or 240 VA in dry locations. Potential exposures to radio-frequency currents, whether induced or via contact, exceed the limits in SEMI S2, Appendix 3, Table A3-1.

Repair and replacement

Keithley Instruments offers a fee-based service agreement with all S540 systems. Under this agreement, a field service engineer will either repair or replace equipment. For more information about this service agreement, contact Keithley Instruments at 1-800-935-5595.

For additional information about specific parts, operations, and maintenance of Keithley instruments, refer to the documentation for the instrument for details before attempting to replace or repair any equipment. You can download manuals for related instruments at tek.com/keithley.

Instrument removal and installation

The following topics describe the process for removing or installing instruments in the system, and any special precautions that must be taken.

Remove system power

WARNING

Severe personal injury or death due to electrical shock or electrocution may result if power is not removed before moving, removing, or installing equipment. Do not attempt to perform these procedures unless you are qualified to do so and are wearing personal protective equipment (PPE) suitable for voltages greater than 40 VAC.

Make sure the system and instruments that are being installed, moved, or removed are turned off with all power source/cables unplugged.

To remove system power before performing maintenance or replacement of components:

CAUTION

Follow precautions for removing hazardous voltage from the probe or other types of test fixtures before handling.

1. Close any software that is open on the computer.
2. Shut down the system computer using the instructions in [Shut down using KTE](#) (on page 3-6).
3. Place the system cabinet power switch on the front-panel door in the OFF position.
4. Place the main circuit breaker on the power distribution unit (PDU) on the back of the cabinet in the OFF position.
5. Disconnect the source power to the S540 system (power cord on back of the PDU).
6. Place a lock and tag on the main circuit breaker of the PDU.
7. Wait five minutes before accessing any high-voltage units.

Heavy instrument removal and installation

Special handling precautions should be taken for heavy instrumentation removal and installation. The following topics describe these precautions.

Moving instruments weighing 20 pounds to 40 pounds

The following instruments require two people to move them. Some of these instruments may require mechanical lifting equipment if they have additional options installed that cause them to weigh more than 40 pounds or if they are located at or near the top of the system cabinet.

NOTE

Some instruments in the S540 system are not heavy enough to require a two-person lift individually, but when put together in a rack, require two people to remove and install them safely.

Instruments in the S540 system that require a two-person lift include:

- 4200A-SCS Parameter Analyzer with only the CVU option installed
- 707B Switch Matrix Mainframe with no cards installed
- Multiple 2636B or 2657A SourceMeter® Instruments racked together horizontally
- Multiple DMM7510 Digital Multimeters racked together horizontally
- The Comp-41 system computer, if not located near top of the system cabinet

Moving instruments weighing more than 40 pounds

When installing or removing equipment heavier than 40 pounds, use a mechanical lifting device. If there is an instrument mounted below the heavy instrument, it must be removed to provide clearance for the lifting forks. You will also need to allow for additional space outside of the cabinet for the lifting device.

Refer to the lifting device operating manual for proper usage.

Instruments in the S540 system that require a mechanical lifting device include:

- 4200A-SCS Parameter Analyzer with multiple options installed
- 707B Switch Matrix Mainframe with cards installed
- HVM1212A High-Voltage Matrix
- The Comp-41 system computer, if located near top of the system cabinet

General replacement procedure

WARNING

Severe personal injury or death due to electric shock or electrocution may result if power is not removed before working inside the cabinet. Always disconnect the cabinet line cords from the AC line power receptacles before opening the system cabinet. Also, never turn on the system until all connections and safety grounds are installed.

1. Remove power and place a lock and tag on the main circuit breaker of the power distribution unit (PDU) (see [Lockout and tagout](#) (on page 2-21)).
2. Disconnect and tag cabling to the unit requiring removal. Do not change cable routing or securement.
3. Properly supporting the unit, remove it from the system cabinet.

CAUTION

The HVM1212A high-voltage matrix is very heavy and requires a mechanical lifting device to safely lift it.

Adjustment

Keithley Instruments recommends annual adjustment of the individual instruments in your system and offers this as an on-site service. A field service engineer (FSE) will adjust instrumentation and perform system verification according to the warranted system specifications. For more information about adjustment or other S540 services, contact your sales representative.

You can also do system verification as described in the *S540 Reference Manual* (part number S540-901-01).

⚠ WARNING

Hazardous voltages may be present on the probe card adapter, even after you disengage the interlock. Cables can retain charges after the interlock is disengaged, exposing you to live voltages that, if contacted, may cause personal injury or death.

Never attempt to touch or change a probe card when tests are running. You must be absolutely certain that all tests have stopped before making contact with anything in the vicinity of the probe card adapter. Also, never run tests without a probe card installed.

For information about instrument-level adjustment, refer to documentation for each of the instruments in the system (available on the [Product Support web page \(tek.com/product-support\)](http://tek.com/product-support)).

Restore system power

Restore system power after properly performing the required maintenance or replacement of components. Make sure that all connections are secure and connected correctly.

To restore system power:

1. Remove the lock and tag placed on the main circuit breaker of the power distribution unit (PDU).
2. Connect the source power to the S540 system (power cord on the back of the PDU).
3. Place the main circuit breaker on the PDU in the ON position.
4. Close the rear cabinet door.
5. Make sure the system computer and all instrument power switches are in the ON position.
6. Close the front cabinet door.

NOTE

With the system cabinet POWER switch in the OFF position, the EMERGENCY OFF (EMO) light should be off. If the EMO light stays on, the power is not restored to all instruments in the system.

7. Place the system cabinet POWER switch (on the front-panel door) in the ON position.
8. Make sure the computer is turned on.
9. Start the computer and the system software.

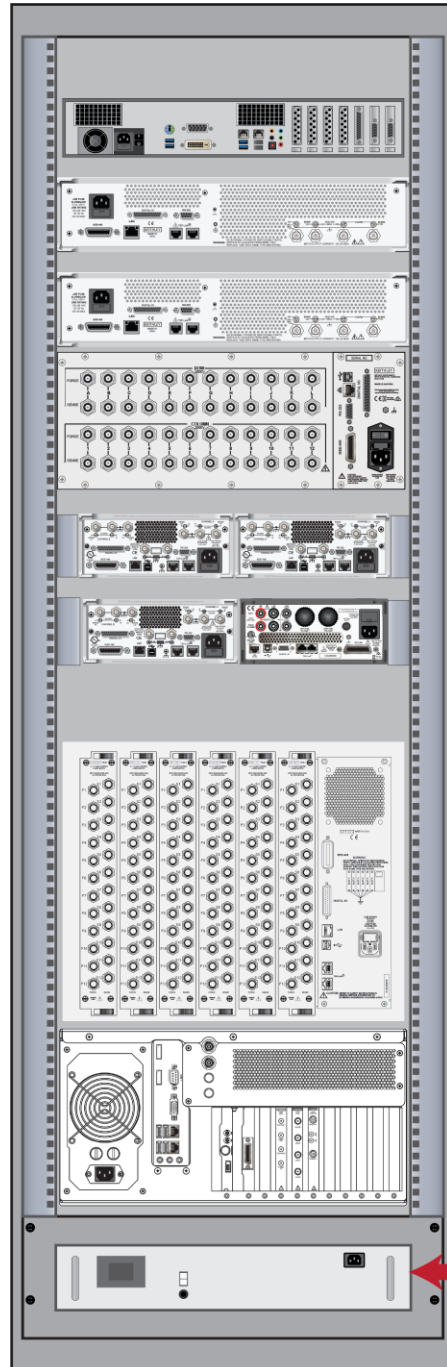
Fuses

Refer to the applicable instrument documentation that is included with the product for fuse replacement.

Power distribution and emergency off

The following figure contains a simplified example layout of various components in the S540 system.

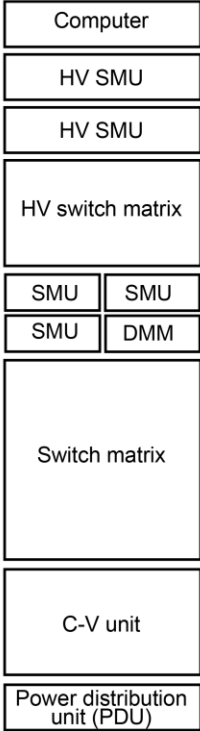
Figure 46: S540 system cabinet rear view



All system components (except the system computer) are controlled by the EMO switch.

External mains power

Block diagram legend of the S540 rear view



External mains power connection

Connection should be easily accessible and visible to the operator.

Power distribution unit connections and power distribution basics

The 42000-PDU consists of:

- 24 VDC output to emergency off (EMO) circuits and cabinet fans with power
- 24 VDC output through banana jacks
- Two specially switched power outlets (factory configuration: Always on)
- Three groups of four switched outlets (off with EMO condition)
- Remote connection to other 42000-PDUs through a 25-pin D-sub connector

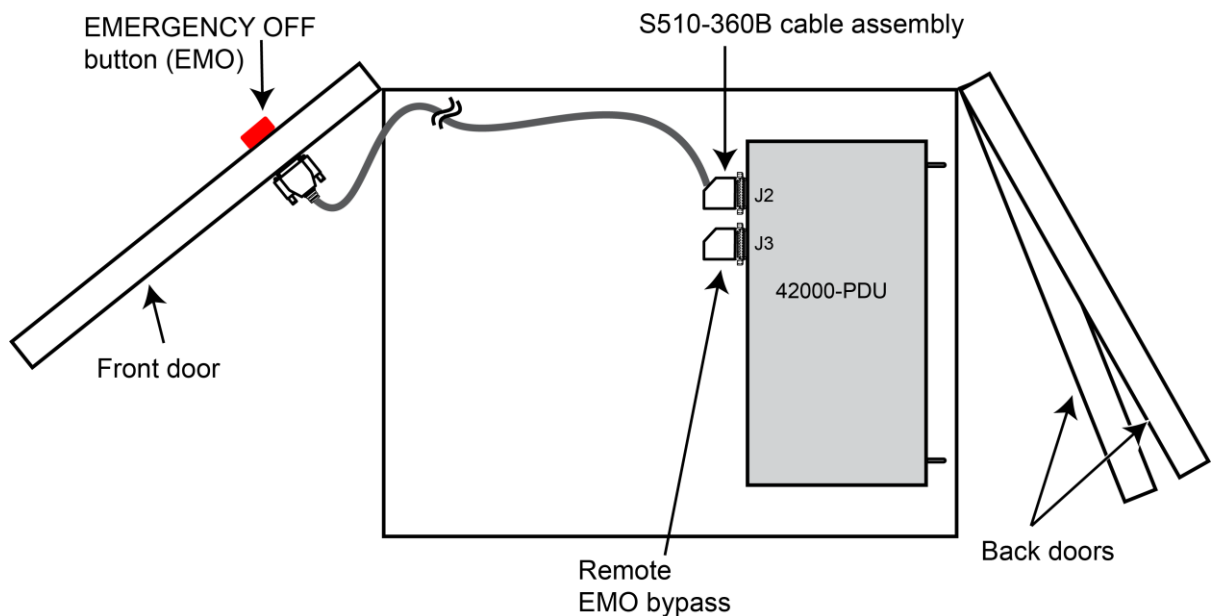
⚠ WARNING

Properly lockout and tagout the system before beginning installation or connection. Also, never turn on the system until all connections and safety grounds are installed. Make sure the main circuit breaker on the PDU is placed in the OFF position before making or breaking any connections.

The following figure shows how the PDU is connected to the system EMO circuit.

Figure 47: PDU connection to the EMO circuit

Top view of system cabinet
showing PDU at bottom of cabinet



The following table provides a detailed description of the available connections in the 42000-PDU. Information about the EMO circuit connections and operation is also in the table.

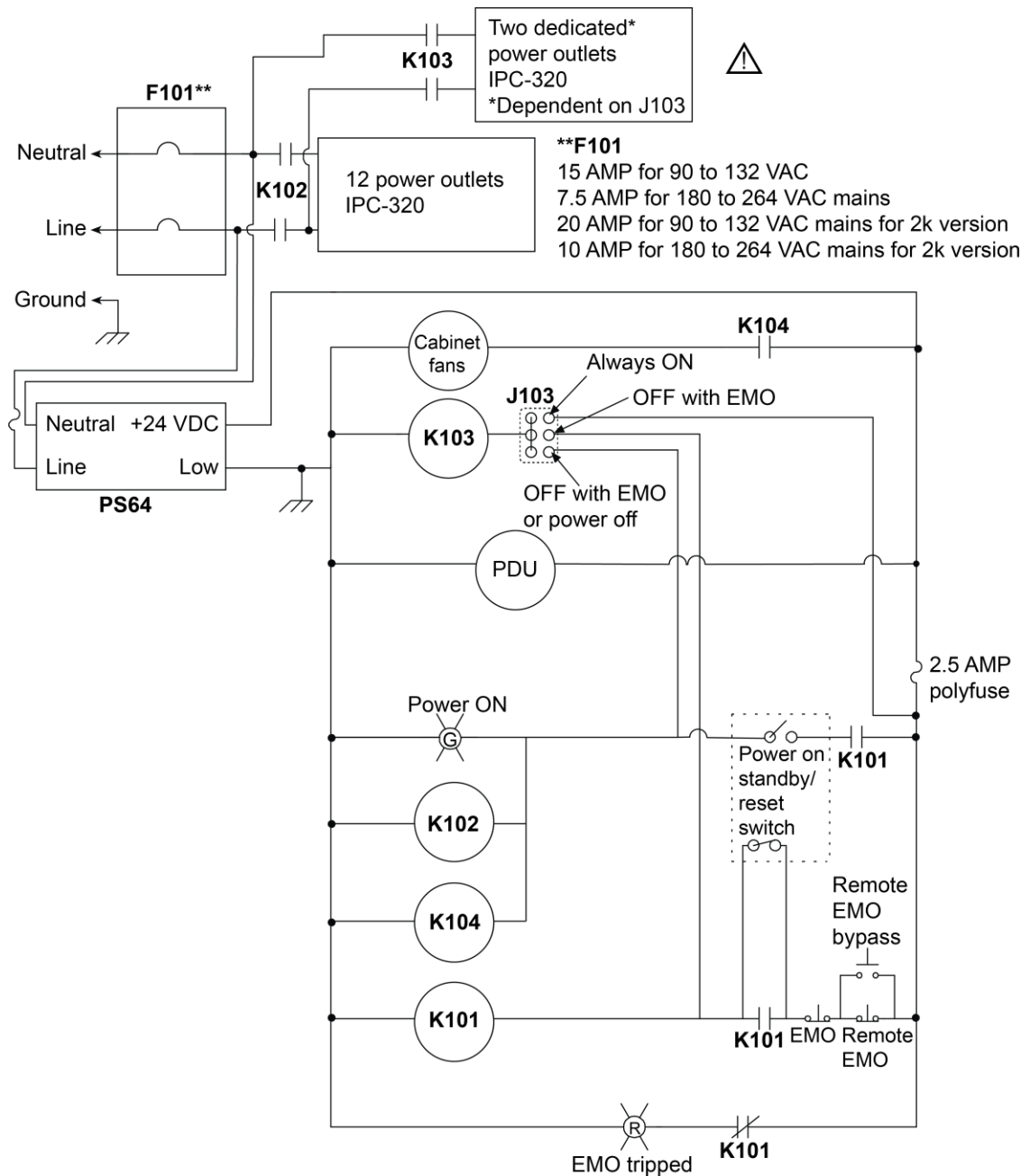
42000-PDU connection descriptions

Connection	Description
Specially switched outlets	Two power outlets on the power distribution unit (PDU) rear panel.
	WARNING: Severe personal injury or death due to electric shock or electrocution may result if power is not removed before working inside the cabinet. Do not use power outlets for accessories (for example, a soldering iron or drill). Use for instruments that do not have hazardous voltages and do not need to have power removed through the EMO circuit (for example, a computer). In the factory default configuration, these outlets have dedicated power and will remain live even if power is removed through the EMO circuit.
	The specific configuration is marked on the PDU rear panel.*
To PDU box DB-25 cable connector	Connector providing control of the PDU box. Connect the PDU box to the EMO box with the supplied DB-25 male-to-female cable.
Switched outlets	Twelve power outlets on the PDU rear panel. Do not use power outlets for accessories (for example, soldering iron or drill). Use for equipment with hazardous voltages that need to be removed with the EMO circuitry.*
Ground connection (optional)	Connect to a quality ground within your facility with 18 AWG wire.
External fan connection	Connector providing 24 VDC to cabinet fans.
External EMO/shorting plug connection	DB-25 connector providing connection to external EMO devices. Make sure the shorting plug is installed if the system is not configured for external EMO.
24 VDC (-) banana plug	Banana plug providing 24 VDC (-) power connection.
24 VDC (+) banana plug	Banana plug providing 24 VDC (+) power connection.
* Outlet connector description: - Class 1 applications (42000-PDU (PDU/E) (PDU/E-2K) 15 A and 42000-PDU-2K 20 A). - Type: Push-in mount mates with IEC standard 320 C20 (20 A) or the IEC standard 320 C14 (15 A) power cords.	

System emergency off circuit

The following figure shows a simplified schematic of the 42000-PDU power distribution unit (PDU) emergency off (EMO) circuit.

Figure 48: 42000-PDU simplified schematic



Data hub license

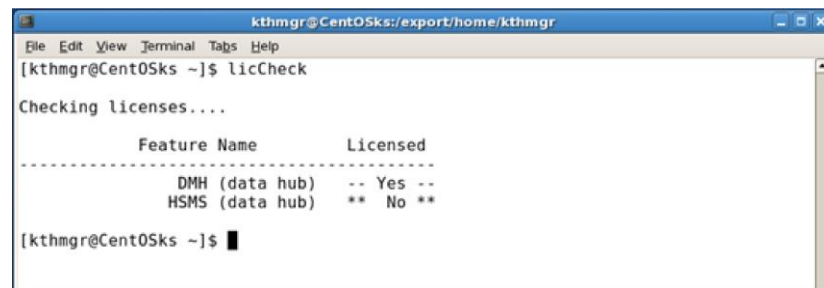
The data hub license allows the Keithley Test Environment (KTE) software to communicate with a prober. This license is installed on all systems when they are shipped.

If you upgrade or reinstall the KTE software, you may need to reinstall the data hub license.

To upgrade systems with KTE version 5.8.0 and later:

1. Open a new Linux® terminal session.
2. Type `licCheck` and press **Enter** to check if the datahub license is installed correctly.

Figure 49: Check datahub license installation



```

kthmgr@CentOSks/export/home/kthmgr
File Edit View Terminal Tabs Help
[kthmgr@CentOSks ~]$ licCheck
Checking licenses...

      Feature Name      Licensed
-----
      DMH (data hub)    -- Yes --
      HSMS (data hub)   ** No  **

[kthmgr@CentOSks ~]$

```

3. If it is not installed correctly, you will need to edit the file at `$KIHOMe/.ki_setup`, where `$KIHOMe/.ki_setup` is usually `opt/kiS530/.ki_setup`.
4. Go to line 33 in the file and change it to `setenv COMPUTERTNAME q1234` (where 1234 is your QMO number).
5. Reboot the computer to reinitialize the datahub.

Editing the `icconfig_<QMO>.ini` file

The `$KIHOMe/IC/icconfig_<QMO>.ini` file is a system configuration file that defines the types of instruments installed in the S540 system, matrix and terminal configuration, and default system settings. Your Keithley field service engineer (FSE) configures this file when your system is installed.

The FSE can edit this file to reflect changes in system hardware or to set different default system settings.

When editing the `icconfig_<QMO>.ini` file (where `<QMO>` is the system QMO number), follow the guidelines below:

- Make a backup copy of the file before making edits.
- Use only upper case characters.
- Do not use space or tab characters.

- Lines should be terminated with newline characters only (`\n`).
- Avoid duplicate entries and assignments.

Using NPLCs to adjust speed and accuracy

You can adjust the amount of time that the input signal is measured. Adjustments to the amount of time affect the usable measurement resolution, the amount of reading noise, and the reading rate of the instrument.

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).

The shortest amount of time results in the fastest reading rate, but increases the reading noise and decreases the number of usable digits.

The longest amount of time provides the lowest reading noise and more usable digits, but has the slowest reading rate.

Settings between the fastest and slowest number of PLCs are a compromise between speed and noise.

Setting the number of power line cycles

The default number of power line cycles (NPLCs) for measurements using the S540 can be set in several ways:

- Specify in the `icconfig_<QMO>.ini` file; your field service engineer (FSE) can change this from the factory default setting (see [Setting a custom system speed](#) (on page 4-14))
- Specify using the `setmode KI_INTGPLC` modifier (see "setmode" and "setmode modifier tables" in the *Keithley Test Environment (KTE) Programmer's Manual* (part number S500-904-01) for details); this setting does not persist through a power cycle

NOTE

The system default NPLC setting is 0.01. However, this setting differs for some commands, source-measure unit (SMU) instruments, and ranges. See [NPLC default differences](#) (on page 4-15) for details.

Setting a custom system speed

NOTE

The `LEGACY` speed mode has been deprecated in KTE version 5.8.0. If you select this mode, the default system speed settings are used.

If you need different system speed settings than those set at the factory, you can ask your field service engineer (FSE) to specify custom speed settings in the `icconfig_<QMO>.ini` file. Systems upgraded from an older Keithley Test Environment (KTE) version may not have a `[SYSTEM SPEED MODE]` section in their `icconfig_<QMO>.ini` file. This can be added, but is not necessary unless you want to change the settings.

NOTE

The system default NPLC setting is 0.01. However, this setting differs for some commands, source-measure unit (SMU) instruments, and ranges. See [NPLC default differences](#) (on page 4-15) for details.

To set a custom default system speed mode, the FSE can add the following block to the top of the `icconfig_<QMO>.ini` file (example):

```
[SYSTEM SPEED MODE]
MODE=CUSTOM
SOURCE_SETTLING=3
NPLC=0.01
ANALOG_FILTER=1
DELAY_FACTOR=0
```

NOTE

If you have problems with correlation of data using the system speed settings from the factory, your FSE can add the following line to your `icconfig_<QMO>.ini` file to force the system to use the older error mode: `TSP_ERROR_MODE OFF` (in KTE version 5.6.5 or later).

NPLC default differences

There are some instances where the number of power line cycle (NPLC) default values may be different than what is specified in the `icconfig_<QMO>.ini` file or `KI_INTGPLC` setmode modifier:

- The `measX` command always measures with an NPLC of 0.01.
- The default NPLC setting for the `intgX` and `sintgX` commands is 0.1 NPLC, except when using the 10 nA and lower ranges on a 2636B (default NPLC of 1).
- The NPLC setting for measurements when running diagnostics is always 1.

Decommissioning an S540 test system

The S540 Power Semiconductor Test System does not contain any intentionally released substances, but may contain substances that are potentially hazardous to the environment if not properly recycled.

For example, systems produced before July 22, 2017 and shipped into the European Union may contain lead (Pb) as a part of the solder to connect electronic components and system interconnects. A list of possible hazardous substances is in European Union Directive “Restricting the use of hazardous substances in electrical and electronic equipment” (RoHS) Directive 2011/65/EU or later. This list includes:

- Lead (Pb)
- Mercury (Hg)
- Cadmium (Cd)
- Hexavalent chromium (Cr6+)
- Polybrominated biphenyls (PBB)
- Polybrominated diphenyl ether (PBDE)
- Bis (2-ethylhexyl) phthalate (DEHP)
- Butyl benzyl phthalate (BBP)
- Dibutyl phthalate (DBP)
- Diisobutyl phthalate (DIBP)

For more detailed information, see the European Union Directive.

To minimize environmental impact at system end of life, treat the system, cables and connections, and all subassemblies as waste electrical and electronic equipment (WEEE) category 9. Reference the European Union Directive on waste electrical and electronic equipment (WEEE Directive 2012/19/EU or later).

Follow these directives to minimize environmental impact at any location in the world. Always follow all local, state, and country environmental laws; these take priority over other directives.

Take all product and subassemblies to a reputable electronics recycle company for proper recycling. Several approved recyclers are identified on the Tektronix website at tek.com.

Any cleaning solutions used during the life of the system (such as isopropyl alcohol (IPA)) should be disposed of separately and properly.

The S540 system may be used with other equipment such as automatic probers and third-party probe card adapters. Tektronix is not in control of these products and the original equipment manufacturer should always be contacted for proper recycling procedures.

Instrument specifications and documentation

In this section:

Introduction	5-1
Switching.....	5-2
Sourcing and measuring	5-3
Optional instrumentation	5-4
Typical matrix connections	5-4
S540 KTE communications.....	5-8
S540 ACS communications diagrams.....	5-9

Introduction

This section contains an overview of the instruments used in S540 test systems and examples of typical connection schemes.

For more specific information about instruments used in the S540 Power Semiconductor Test System, refer to the documentation for each specific model:

- 4200A-SCS Parameter Analyzer
- Series 2600B System SourceMeter® Instrument
- 4210-CVU Capacitance-Voltage Unit Card
- 4220-PGU High-Voltage Pulse-Generator Unit Card
- RSA306B Signal Analyzer
- 707B Semiconductor Switch Matrix
- 2657A High-Power System SourceMeter Instrument
- DMM7510 7-1/2 Digit Graphical Sampling Multimeter

Refer to the documentation that is bundled with the Keithley Test Environment (KTE) software installation. You can also visit the Keithley Instruments website at tek.com/keithley to search for updated information by model number.

NOTE

Example wiring diagrams for the S540 test system are shown later in this section.

Switching

The following components provide the switching capabilities of the S540.

Model 707B Switch Matrix Mainframe

The 707B Semiconductor Switch Matrix Mainframe, which is included in S540 3000 V, low-current systems, is a programmable switch for connecting signal paths in a matrix structure. The six-slot mainframe accepts any combination of compatible plug-in matrix cards. Model 7531 matrix cards are used in the 707B in S540 systems.

Figure 50: 707B Semiconductor Switch Matrix Mainframe



Model 7531 Low-Current, High-Speed Matrix Card

The 7531 matrix card is an 8 × 12 low-current, high-speed Kelvin matrix with high-voltage protection up to 3 kV. The S540 3000 V high-voltage, low-current systems include one 707B System Switch Mainframe populated with 7531 matrix cards.

The 7531 matrix card allows high-voltage source-measure units (SMUs) to provide output to low-voltage circuits without damage. The high-voltage pass-through signals are clamped at a safe level by the protection modules in the circuit.

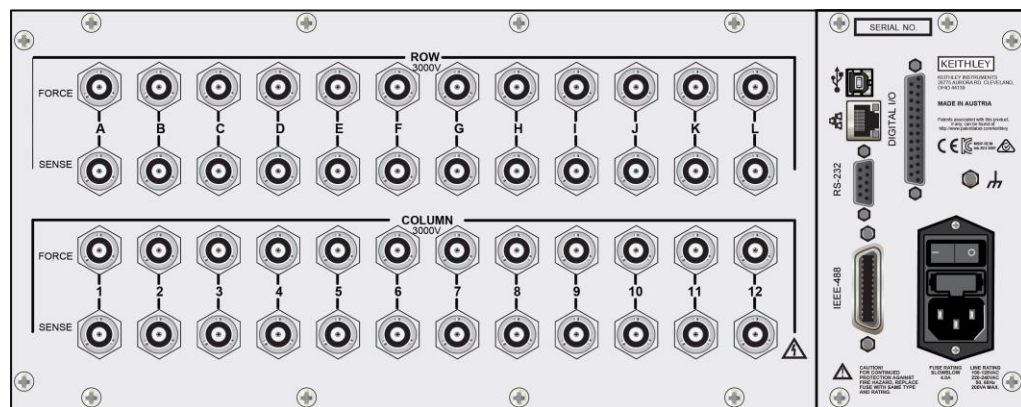
HVM1212A High-Voltage Switch Matrix

The HVM1212A is a 12 × 12 high-voltage switching matrix that can handle signals up to 3 kV. One HVM1212A High-Voltage Switch Matrix is included in both the S540 3000 V high-voltage test system and the 3000 V high-voltage, low-current test system.

Figure 51: HVM1212A High-Voltage Matrix

In 3000 V high-voltage, low-current systems, the HVM1212A connects pass-through signals to the 707B low-current matrix through protection modules to one of the 7531 matrix cards. This allows you to do high-voltage, low-voltage, low-current, and capacitance tests in a single probe touch-down.

The following figure shows the connections on the rear panel of the HVM1212A.

Figure 52: HVM1212A high-voltage switch matrix rear panel

Sourcing and measuring

The following instruments provide S540 source-measure capabilities.

Model 2657A High-Power System SourceMeter Instrument

The Model 2657A is a high-voltage, high-power, low-current source measure unit (SMU) instrument. You can have up to two 2657A SMUs in the S540.

Figure 53: 2657A High-Power System SourceMeter Instrument

Features include:

- Source \pm DC voltage from 5 mV to 3030 V
- Source \pm DC current from 30 fA to 120.12 mA
- Measure \pm DC voltage from 1 mV to 3030 V
- Measure \pm DC current from 20 fA to 120.12 mA

Optional instrumentation

Keithley Test Environment (KTE) version 5.7.0 supports several optional instruments:

- DMM7510 7½ Digit Graphical Sampling Multimeter
- 4200A-SCS Parameter Analyzer
- 4210-CVU Capacitance-Voltage Unit Card
- 4220-PGU High-Voltage Pulse Generator Unit Card
- RSA306B USB Spectrum Analyzer

NOTE

The cards and columns of each instrument connection shown in the following diagrams may differ from your actual system. The flexibility of the S540 configuration allows for various numbers and combinations of instruments. Attempting to show examples of every possible scenario would be prohibitive.

For high-voltage systems with two 707B switch matrices, the high-voltage connections for the second matrix (not shown) are identical to the ones in the diagrams in this manual.

Typical matrix connections

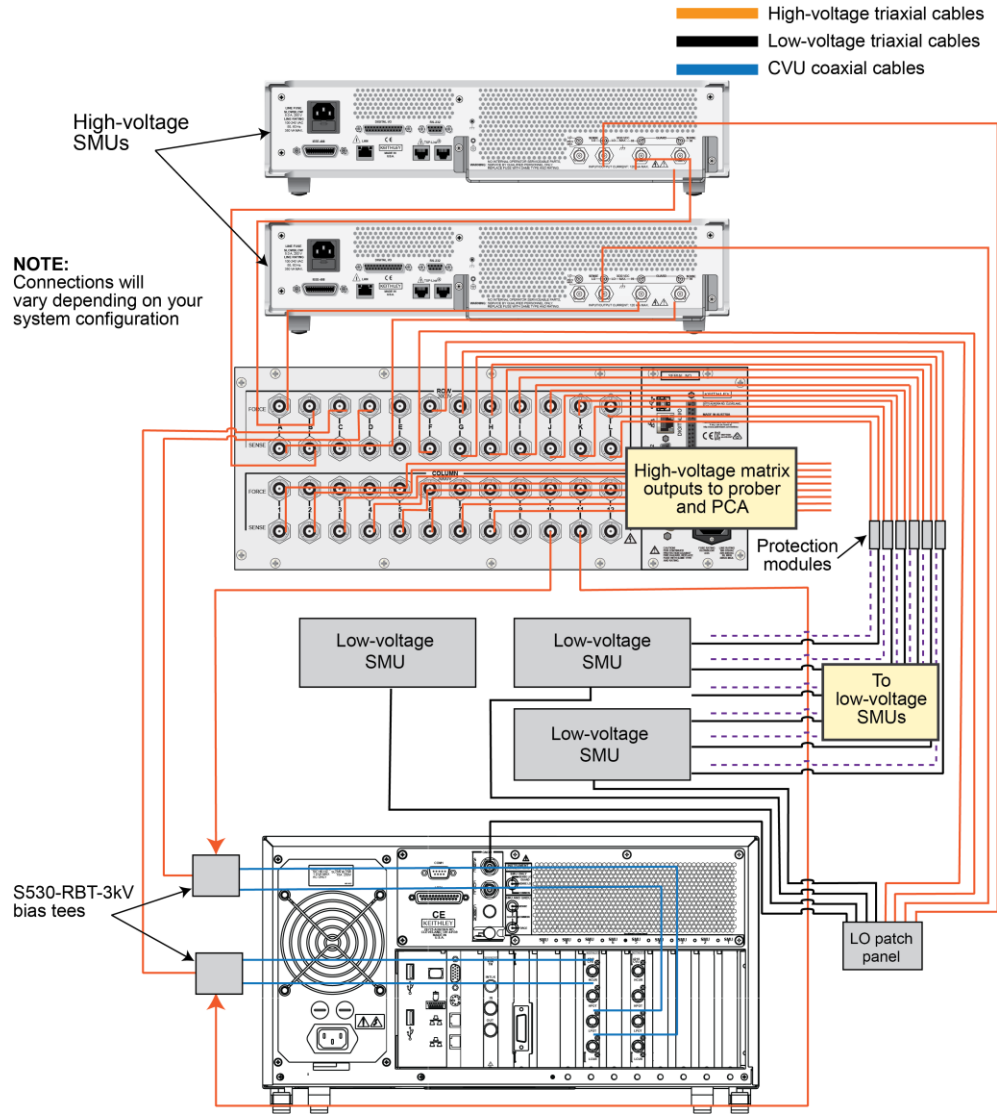
The following figures show typical matrix connections for the S540 3000-V high-voltage system and the 3000 V high-voltage, low-current system.

NOTE

The cards and columns of each instrument connection shown in the following diagrams may differ from your actual system. The flexibility of the S540 configuration allows for various numbers and combinations of instruments. Attempting to show examples of every possible scenario would be prohibitive.

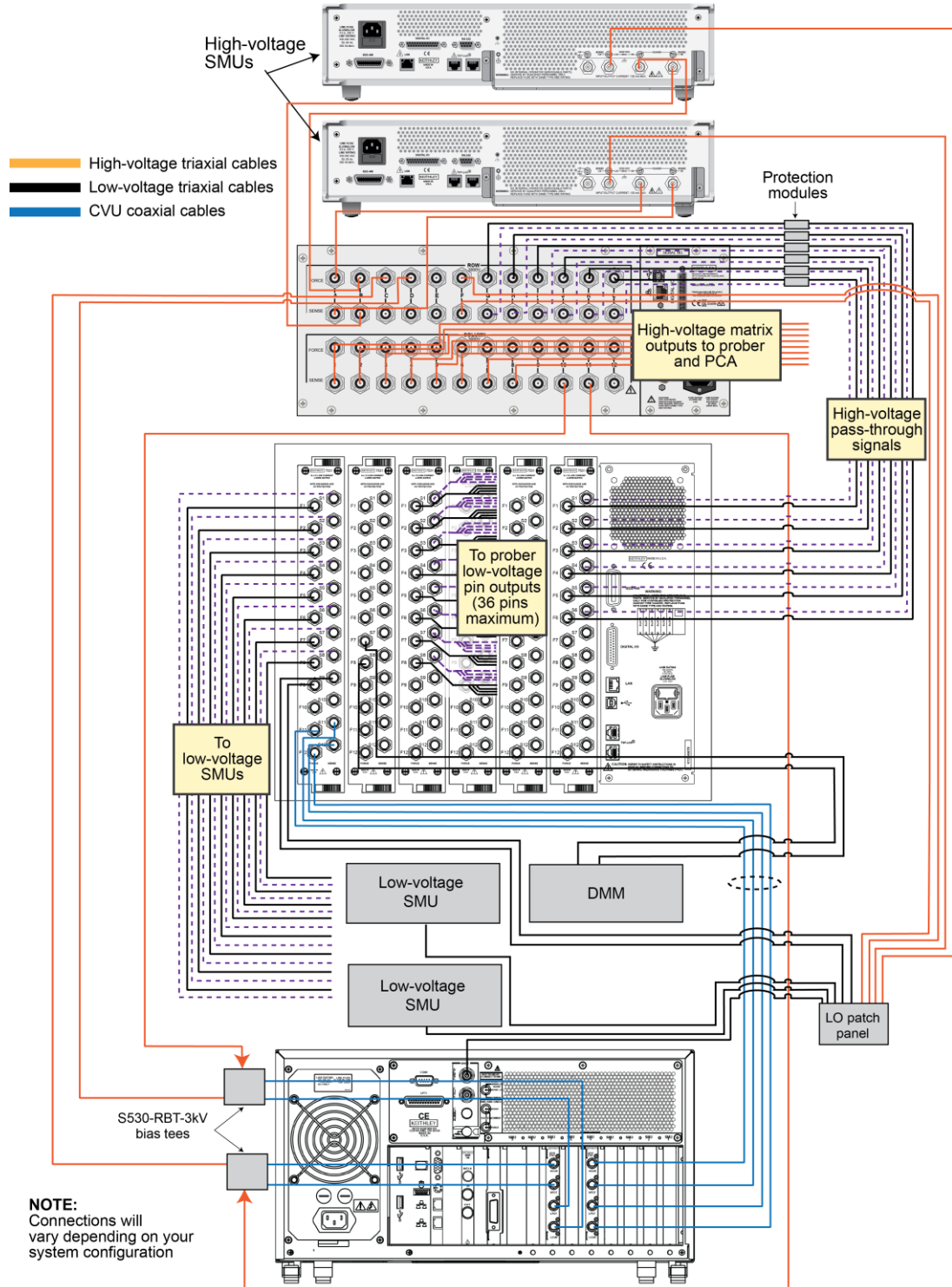
S540 3000 V high-voltage system

Figure 54: S540 3000 V high-voltage system



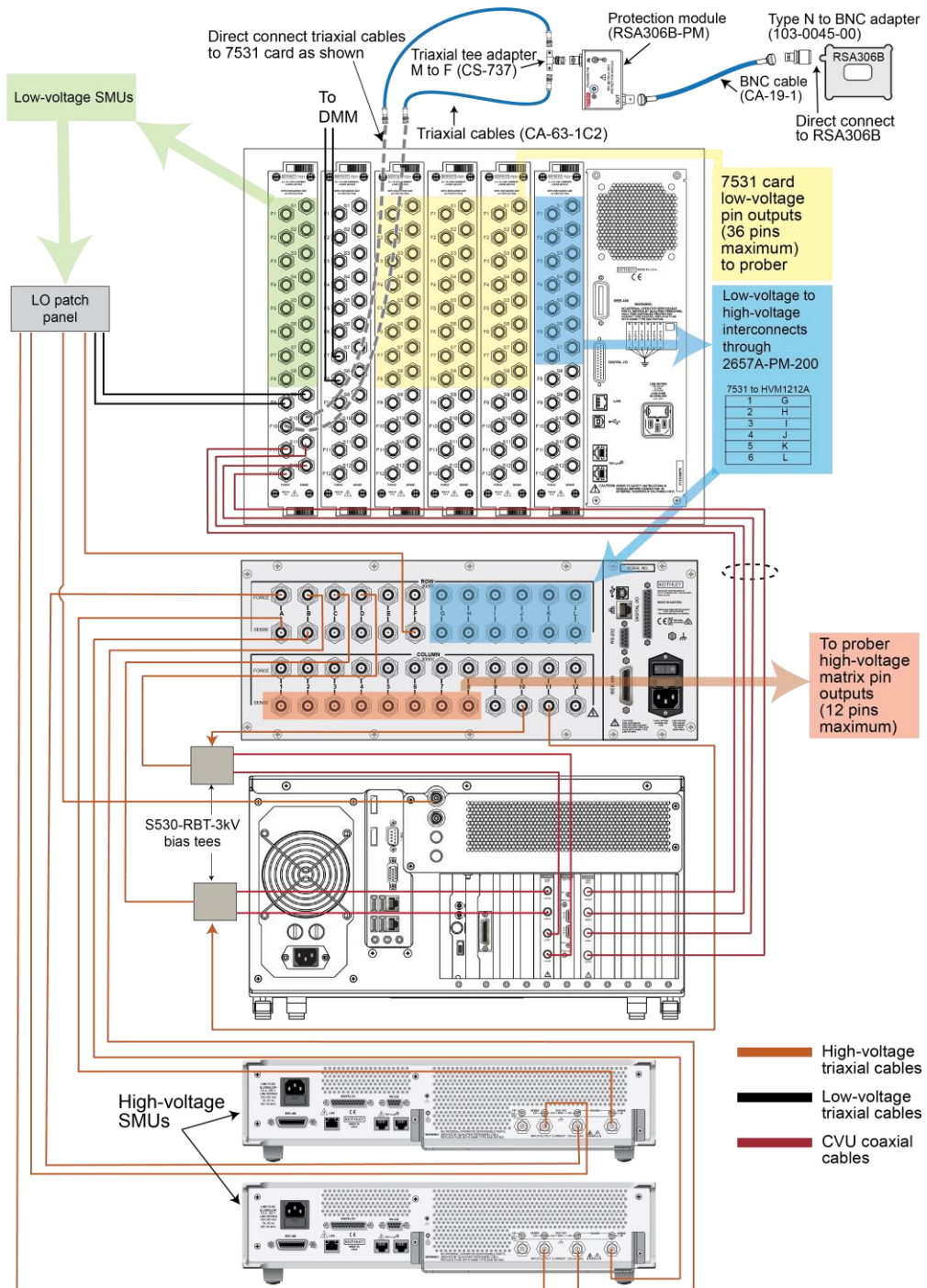
S540 3000 V high-voltage, low-current system

Figure 55: Matrix connections for the 3000 V high-voltage, low-current system



S540 high-voltage, low-current system using an RSA306B spectrum analyzer

Figure 56: S540 connections with an RSA306B spectrum analyzer



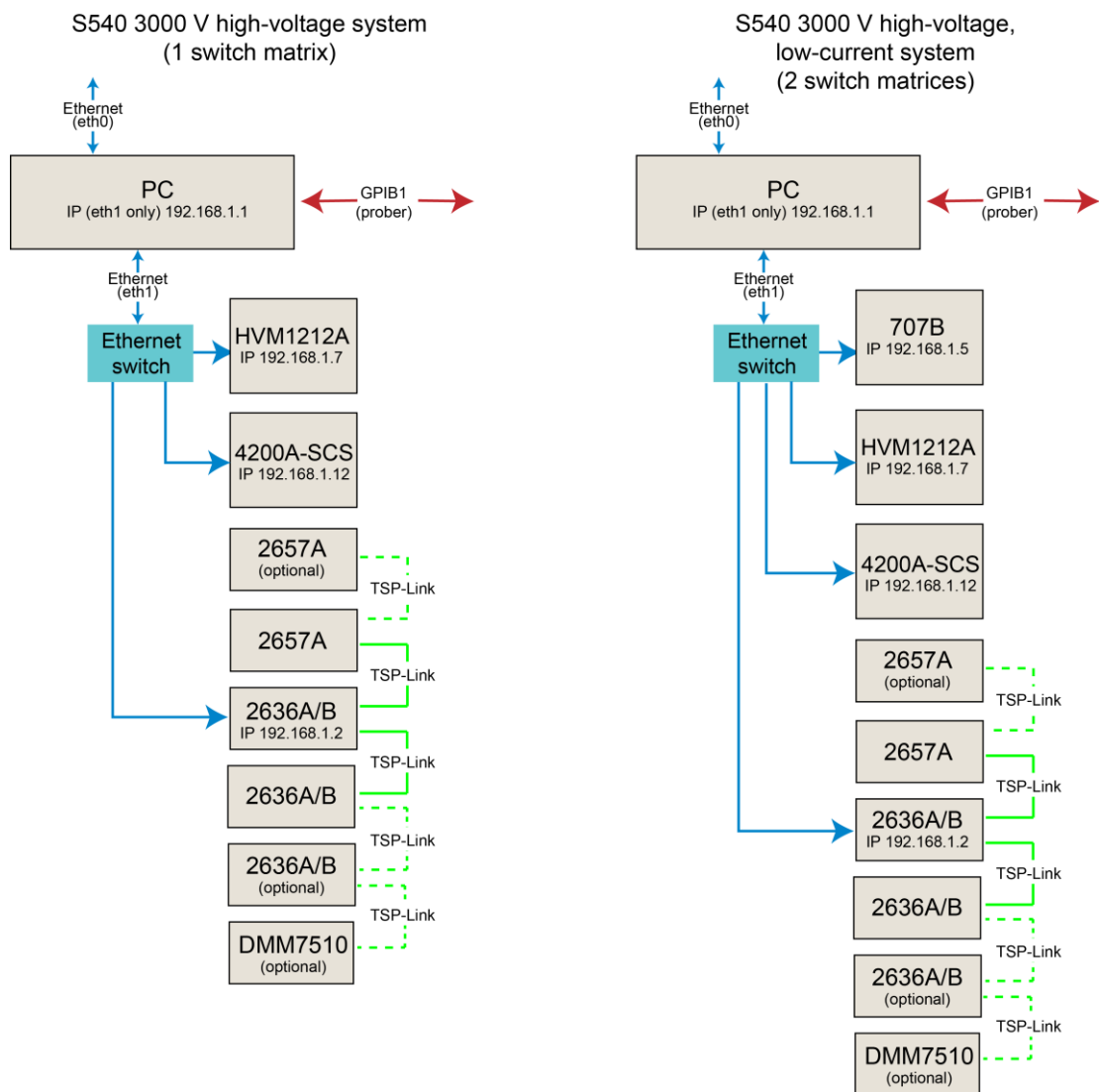
S540 KTE communications

The S540 KTE system uses both ethernet and GPIB to communicate with and control the instruments. The following diagrams show how the instruments are connected to each other and what type of communications are used.

NOTE

The following figure shows multiple 2636B source-measure units. However, the system only requires one 2636B.

Figure 57: S540 KTE communication diagrams

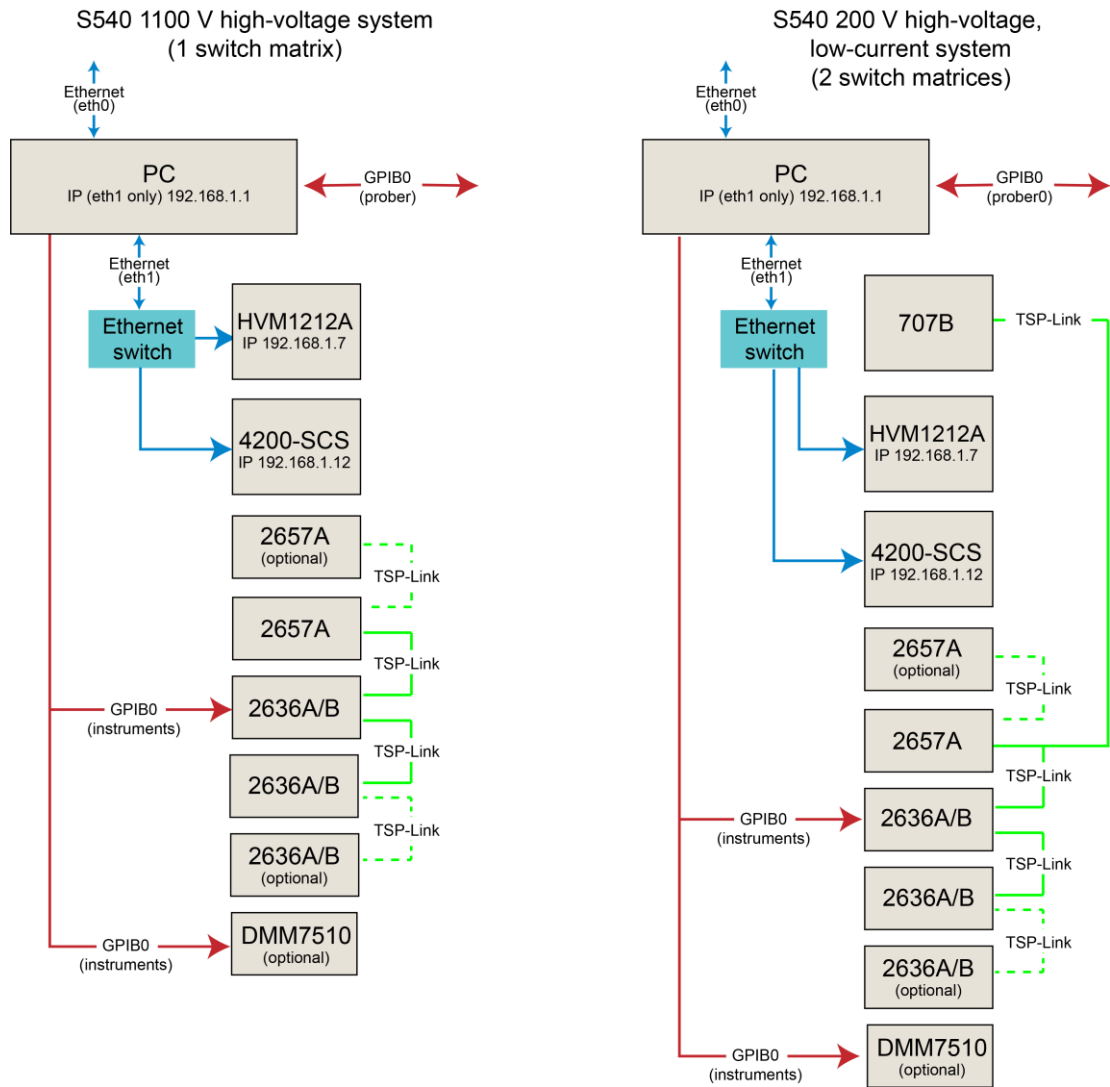


S540 ACS communications diagrams

NOTE

The following figure shows multiple 2636B source-measure units. However, the system only requires one 2636B.

Figure 58: S540 ACS communications diagrams



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