
PD1550A Advanced Dynamic Power Device Analyzer

System Installation Guide



Provides detailed information to install the Double-Pulse Test Rack and Safety Enclosure for power modules at a customer site. The Rack and Safety Enclosure is used with the PD1550A Dynamic Power Device Analyzer/Double-Pulse Tester.

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Manual Part Number
PD1550-90002

Edition

First Edition, May 2023

Published by

Keysight Technologies, Inc.
900 S. Taft Ave.
Loveland, CO 80537 USA

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WARNING



HIGH VOLTAGE

is used in the operation of this equipment.

LETHAL VOLTAGE on CONTACT

may be present at measurement terminals if you fail to implement all safety precautions.

- When the **RED** light is on in the light tower Double-Pulse Test Rack and Safety Enclosure, lethal voltage may appear at measurement terminals.
- Never attempt to defeat the safety interlock function of the safety doors.
- Do not operate the system unless another person is around the work space who is familiar with system operation and hazards for administering first aid.
- Potential voltages less than ± 500 V may cause death under certain conditions. Therefore, adequate preventive measures must be taken at all times!

Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this system. Failure to comply with these precautions or with specific warnings elsewhere in this manual may impair the protections provided by the system. In addition, it violates safety standards of design, manufacture, and intended use of the system. Keysight assumes no liability for customer's failure to comply with these requirements.

Product manuals are available on the Web. Go to www.keysight.com/find/PD1550A for all documentation.

WARNING



Hazardous voltage: System maximum output voltage may appear at the measurement terminals inside the safety enclosure. Never attempt to bypass the safety interlock and features of the PD1550A Double-Pulse Test system safety enclosure. To avoid contact with extremely high voltages, the rack cabinet must be operated with all side, front, and rear panels in place and the safety enclosure must remain closed. There are no user-serviceable parts inside.

Do not intentionally modify the interlock function of the safety enclosure. While the high voltage indicator is lit, dangerous voltage or residual charge may appear on the measurement terminals.

CAUTION

Some of the material in the safety enclosure can generate static electricity. Take care if you are using ESD sensitive devices in its vicinity.

NOTE

Do not use this system in any manner not specified by the manufacturer. The protective features of this system may be impaired if it is used in a manner not specified in the operation instructions. This system is an INDOOR USE product only.

This system complies with INSTALLATION CATEGORY II for mains input and INSTALLATION CATEGORY I for measurement input terminals, and POLLUTION DEGREE 2 defined in IEC 61010-1.

If an system is marked CAT I (IEC Measurement Category I), or it is not marked with a measurement category, its measurement terminals must not be connected to line-voltage mains.

Safety of any system incorporating the equipment is the responsibility of the assembler of the system.

DANGEROUS PROCEDURE WARNINGS

- Warnings shall be complied. Procedures throughout in this manual prevent you from potential hazardous situations. The instructions contained in the warnings must be followed.

BEFORE APPLYING POWER

- Verify that all safety precautions are taken. Make all connections to the system before applying power. Note the system's external markings described under "Safety and Regulatory Symbols".

GROUND THE RACK

- This is Safety Class I system. To minimize shock hazard, the Rack and Safety Enclosure must be connected to an electrical ground. The power terminal and the power cable must meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

- Do not operate the system in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

DO NOT REMOVE COVERS

- No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock do not remove covers.

IN CASE OF DAMAGE

- Instruments, probes or cables that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel. Return the product to a Keysight sales or service office for service and repair to ensure that safety features are maintained.

USE ONLY THE SPECIFIC ACCESSORIES

- Specified accessories satisfy the requirements for specific characteristics for using the instruments and the Rack and Safety Enclosure.

CLEANING

- Disconnect the power from the rack before cleaning the Rack and Safety Enclosure. Use only a damp cloth to clean the surfaces of the Rack and Safety Enclosure.

Safety Information

The following general safety precautions must be observed during all phases of operation of these instruments. Failure to comply with these precautions or with specific warnings or operating instructions in the product manuals violates safety standards of design, manufacture, and intended use of the instruments. Keysight Technologies assumes no liability for the customer's failure to comply with these requirements.

General

Do not use these instruments in any manner not specified by the manufacturer. The protective features of these instruments must not be impaired if it is used in a manner specified in the operation instructions.

Before Applying Power

Verify that all safety precautions are taken. Make all connections to the instruments before applying power. Note the external markings described under "Safety Symbols".

Ground the Instrument

Keysight instruments are provided with a grounding-type power plug. The instruments must be connected to an electrical ground to minimize shock hazard. The ground pin must be firmly connected to an electrical ground (safety ground) terminal at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

Unless otherwise noted in the specifications, these instruments or system is intended for indoor use in an installation category II, pollution degree 2 environment per IEC 61010-1 and 664 respectively. They are designed to operate at a maximum relative humidity of 50% to 80% at 30 °C or less (non-condensing). These instruments or system are designed to operate at altitudes up to 3000 meters, and at temperatures between 20 and 30 °C.

Do Not Operate in an Explosive Atmosphere Do not operate in the presence of flammable gases or fumes.

Do Not Operate Near Flammable Liquids

Do not operate the instruments in the presence of flammable liquids or near containers of such liquids.

Cleaning

Clean the outside of the Keysight instruments with a soft, lint-free, slightly dampened cloth. Do not use detergent or chemical solvents.

Do Not Remove Instrument Cover

Only qualified, service-trained personnel who are aware of the hazards involved should remove instrument covers. Always disconnect the power cable and any external circuits before removing the instrument cover.

Keep away from live circuits

Operating personnel must not remove equipment covers or shields. Procedures involving the removal of covers and shields are for use by service-trained personnel only. Under certain conditions, dangerous voltages may exist even with the equipment switched off. To avoid dangerous electrical shock, DO NOT perform procedures involving cover or shield removal unless you are qualified to do so.

DO NOT operate damaged equipment

Whenever it is possible that the safety protection features built into these instruments have been impaired, either through physical damage, excessive moisture, or any other reason, REMOVE POWER and do not use the instrument until safe operation can be verified by service-trained personnel. If necessary, return the product to a Keysight Technologies Sales and Service Office for service and repair to ensure the safety features are maintained.

DO NOT block the primary disconnect

The primary disconnect device is the appliance connector/power cord when an instrument used by itself, but when installed into a rack or system the disconnect may be impaired and must be considered part of the installation.

Do Not Modify the Instrument

Do not install substitute parts or perform any unauthorized modification to the product. Return the product to a Keysight Sales and Service Office to ensure that safety features are maintained.

In Case of Damage

Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

Measurement Limits

The Truevolt Series DMMs provide protection circuitry to prevent damage to the instrument and to protect against the danger of electric shock, provided the Measurement Limits are not exceeded. To ensure safe operation of the instrument, do not exceed the Measurement Limits shown on the front and rear panel.

The DMMs comply with EN/IEC 61326-2-1, for sensitive test and measurement equipment.

When subjected to transient radiated and/or conducted electromagnetic phenomena, the DMMs may have temporary loss of function or performance which is self-recovering. Recovery may take longer than 10 seconds.

When subjected to continuously present electromagnetic phenomena, some degradation of performance may occur.

Safety and Regulatory Symbols

CAUTION

A CAUTION denotes a hazard. It calls attention to an operating procedure or practice that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

WARNING

A WARNING denotes a hazard. It calls attention to an operating procedure or practice, that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Products display the following:



CAUTION. Refer to documentation for safety information.



Earth Ground.



Chassis Ground.



Alternating Current (AC).



Direct Current (DC).



Standby Power. Unit is not completely disconnected from AC mains when power switch is in standby position.



Indicates that antistatic precautions should be taken.



DANGER: Hazardous voltage, potential for electric shock. Do not touch terminals.



Cold Surface, avoid contact. Low temperature or freezing conditions. Surfaces are cold and may cause personal injury.



Hot Surface, avoid contact. Surface is hot and may cause personal injury.



The CE marking is a registered trademark of the European Community (if accompanied by a year, it is the year when the design was proven). It indicates that the product complies with all relevant EU directives.



The Regulatory Compliance Mark (RCM) is a registered trademark of the Australian Communications and Media Authority.



The CSA mark is a registered trademark of the Canadian Standards Association and indicates compliance to the standards laid out by them. Refer to the product Declaration of Conformity for details.



This symbol represents the time period during which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use. Forty years is the expected useful life of this product.



Universal recycling symbol. This symbol indicates compliance with the China standard GB 18455-2001 as required by the China RoHS regulations for paper/fiberboard packaging.



R-R-Kst-SP21786

South Korean Certification (KC) mark. It includes the marking's identifier code.

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The crossed-out wheeled bin symbol indicates that separate collection for Waste Electric And Electronic Equipment (WEEE) is required, as obligated by the EU DIRECTIVE and other National legislation.

Please refer to [keysight.com/go/takeback](https://www.keysight.com/go/takeback) to understand your trade-in options with Keysight in addition to takeback instructions.

Traditional Chinese

根據歐盟指令和其他國家的法律規定，帶有X標誌的帶輪垃圾桶圖案，表示該產品屬於需要進行單獨回收的電子電器產品。

請參考 [keysight.com/go/takeback](https://www.keysight.com/go/takeback)，了解產品回收說明以及Keysight的以舊換新方式。

Simplified Chinese

根据欧盟指令和其他国家的法律规定，带有X标志的带轮垃圾桶图案，表示该产品属于需要进行单独回收的电子电器产品。

请参考 [keysight.com/go/takeback](https://www.keysight.com/go/takeback)，了解产品回收说明以及Keysight的以旧换新方式。

Japanese

車輪付きゴミ箱に×マークは、EU DIRECTIVEやその他の国の法律で義務付けられている廃電気・電子機器（WEEE）の分別回収が必要であることを示しています。

[keysight.com/go/takeback](https://www.keysight.com/go/takeback) では、製品のテイクバック方法に加えて、Keysight の下取りオプションについてもご紹介しています。

Korean

바퀴달린 쓰레기통의 X 표시는 EU 지침 및 기타 국가 법률에 따라 전기 및 전자 장비 폐기물(WEEE)에 대한 별도 수거가 필요함을 나타냅니다.

제품 회수 지침과 함께 Keysight를 통한 보상 판매 옵션을 이해하려면 [keysight.com/go/takeback](https://www.keysight.com/go/takeback) 을 참조하십시오.

German

Das Symbol der durchgestrichenen Mülltonne auf Rädern weist darauf hin, dass eine getrennte Sammlung von Elektro- und Elektronik-Altgeräten (WEEE) gemäß der EU-RICHTLINIE und anderer nationaler Gesetze erforderlich ist.

Bitte informieren Sie sich unter [key-sight.com/go/takeback](https://www.keysight.com/go/takeback) über Ihre Rücknahmeoptionen bei Keysight sowie über die Anweisungen zur Produktrücknahme.

French

Le pictogramme de la poubelle barrée indique que la collecte séparée des déchets d'équipements électriques et électroniques (DEEE) est requise, comme l'oblige la directive européenne et d'autres législations nationales.

Veuillez vous référer à [keysight.com/go/takeback](https://www.keysight.com/go/takeback) pour obtenir les options d'échange Keysight en plus des instructions de reprise de produit.

Italian

Il simbolo del bidone barrato indica che è richiesta la raccolta separata dei rifiuti di apparecchiature elettriche ed elettroniche (RAEE), come previsto dalla DIRETTIVA UE e da altre legislazioni nazionali.

Si prega di fare riferimento al sito [key-sight.com/go/takeback](https://www.keysight.com/go/takeback) per comprendere le opzioni di Commercializzazione con Keysight oltre alle istruzioni per il ritiro del prodotto.

Spanish

El símbolo del contenedor de basura tachado indica la obligación de recogida selectiva de los residuos de aparatos eléctricos y electrónicos (RAEE), tal y como lo establece la DIRECTIVA de la UE y otras legislaciones nacionales.

Acceda a nuestra página [key-sight.com/go/takeback](https://www.keysight.com/go/takeback) para obtener información sobre las opciones de recuperación que ofrece Keysight, y las instrucciones de recuperación del producto.

Portuguese

O símbolo da lata de lixo riscada indica que a necessidade da coleta seletiva dos resíduos de equipamentos eléctricos e electrónicos (REEE) é obrigatória, em consonância com a DIRETIVA da União Europeia (WEEE) e outras legislações nacionais.

Consulte [keysight.com/go/takeback](https://www.keysight.com/go/takeback) para verificar suas opções de "trade in" com o escritório Keysight local, ou para receber as instruções de reciclagem do produto.

Russian

Символ перечеркнутого мусорного контейнера на колесиках указывает на необходимость раздельного сбора отходов электрического и электронного оборудования (WEEE) в соответствии с требованиями ДИРЕКТИВЫ ЕС и других национальных законодательств.

Пожалуйста, обратитесь к сайту [keysight.com/go/takeback](https://www.keysight.com/go/takeback), чтобы узнать о возможностях торговли с компанией Keysight, а также об инструкциях по возврату продукции.

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1 Site Preparation

IMPORTANT

Keysight recommends that a trained Keysight Application Engineer install and setup the Double-Pulse Test Rack and Safety Enclosure. The instructions in this guide are written for the trained Application Engineer.

End users should have the installation site prepared before beginning installation. See “Customer Responsibilities” on page 16.

This System Installation Guide provides step-by-step instructions to install the PD1550A Dynamic Power Device Analyzer/Double-Pulse Tester and connect accessories. Note that the PD1550A is part of the overall PD1000A Power Device Measurement System for Advanced Modeling.

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Customer Responsibilities

The final location at customer site must meet the following requirements prior to the installation.

☐	Receive the PD1550A Double-Pulse Test System.
☐	Uncrating – You should remove the PD1550A system the shipping crate. You may inventory the shipment using the enclosed packing list. See Chapter 2.
☐	Site Preparation and Maintenance – Ensure the operating environment (space, noise, etc.) is suitable.
☐	Electrical and environmental requirements are met. Wiring primary power to the system is your responsibility, as is installing communications cabling to the system. The actual power connection to the system will be made after the Keysight representative has removed the system from the pallet and moved it to the desired location.
☐	Host Computer requirements are met.
☐	All necessary software licenses and software are installed on the host computer.
☐	Additional supplies including but limited to host computer, LAN cable, etc. These are not included with the PD1550A.

Keysight's PD1550A Rack and Safety Enclosure is a free-standing rack with test instruments installed and a Safety Enclosure on top. Consider your anticipated location and requirements to ensure safety and optimize access to test and control instrumentation.

Rack and Safety Enclosure Dimensions and Weight



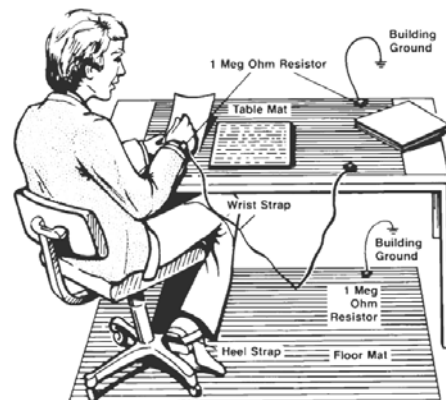
	Weight	Height	Depth	Width
Shipping Crate (with DPT Rack and Safety Enclosure inside)	~ 567 kg (~ 1250 lbs)	2.1 M (83 in)	1.27 M (50 in)	1.5 M (59 in)
Rack and Safety Enclosure (all test equipment and fixtures installed)	~ 234 kg (~715 lbs)	2.0 M (78 in.)	1.1 M (42 in.)	1.27 M (50 in.)

Static-safe Handling Procedures

Electrostatic discharge (ESD) can damage or destroy electronic components. Use a static-safe work station to perform at work on electronic assemblies. This figure shows a static-safe work station using two types of ESD protection:

- Conductive table-mat and wrist-strap
- Conductive floor-mat and heel-strap

Both types, when used together, provide a significant level of ESD protection. Of the two, only the table-mat and wrist-strap combination provides adequate ESD protection when used alone. To ensure user safety, the static-safe accessories must provide at least 1 M Ω of isolation from ground.



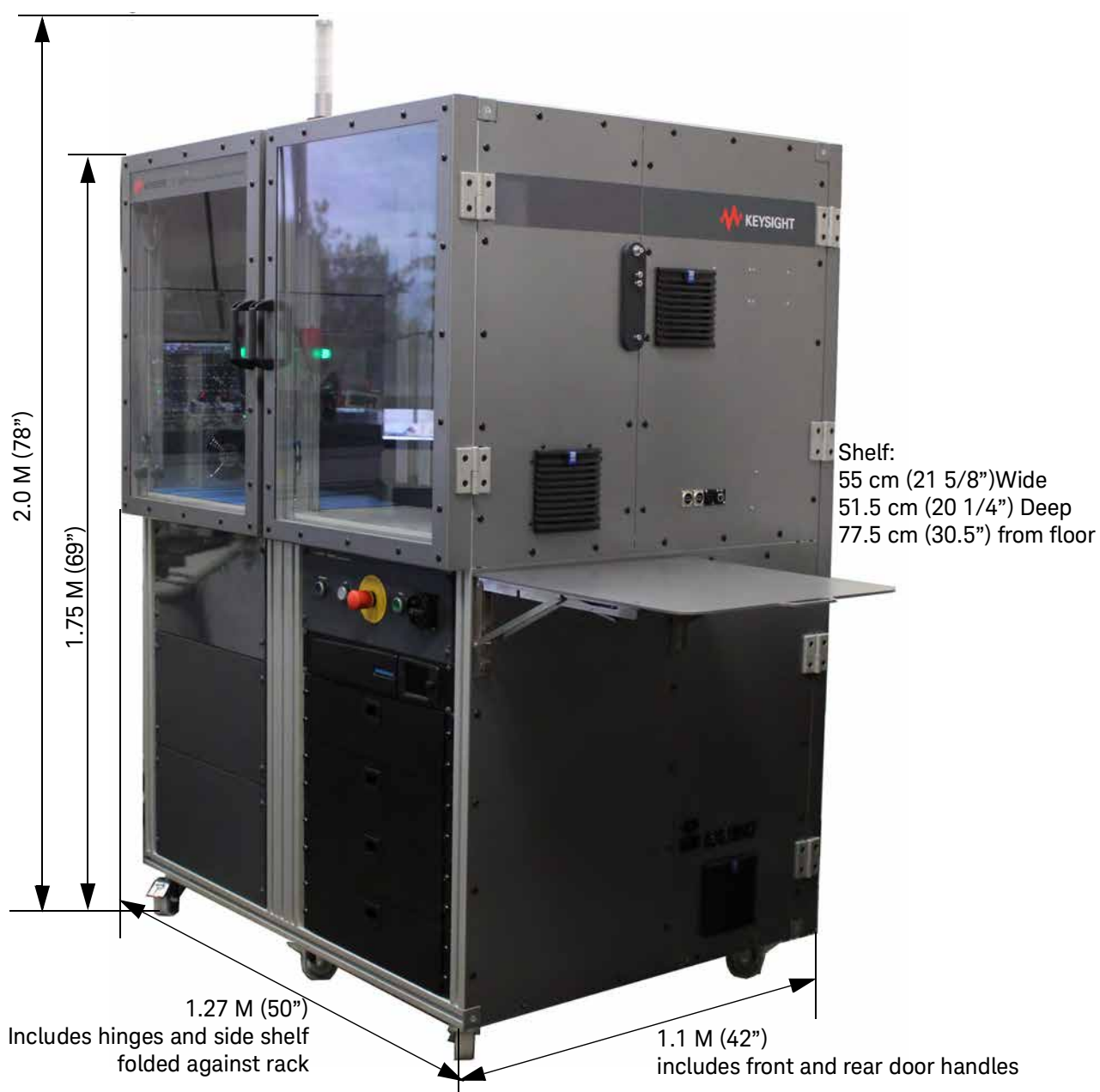
CAUTION

Some of the material in the safety enclosure can generate static electricity. Take care if you are using ESD sensitive devices in its vicinity.

Power Module Test Rack and Safety Enclosure Location

The Rack and Safety Enclosure is a free-standing rack with test instruments installed. It is the customer's responsibility to consider the anticipated location and requirements to ensure safety and optimize access to instrumentation.

The following figure shows Rack and Safety Enclosure dimensions (doors closed). You should allow a minimum one meter of space in front of the rack for operator access, one meter behind the system for service and one meter on each side of the rack for opening rack doors and sufficient air flow for cooling and ventilation.



NOTE

The Air Intake fans on the Test Rack and Safety Enclosure sides and top are temperature controlled. They turn on only when the temperature in the lower portion of the rack exceeds approximately 35°C.

Rack Ventilation

The Rack and Safety Enclosure has six air intake fans and eight exhaust fans. See the graphic below.

CAUTION

For proper air flow through the Rack and Safety Enclosure, do not block air vents or rack cooling fans. Allow a minimum of 1 M on each side, above the rack, and on the rear of the Rack and Safety Enclosure for ventilation.

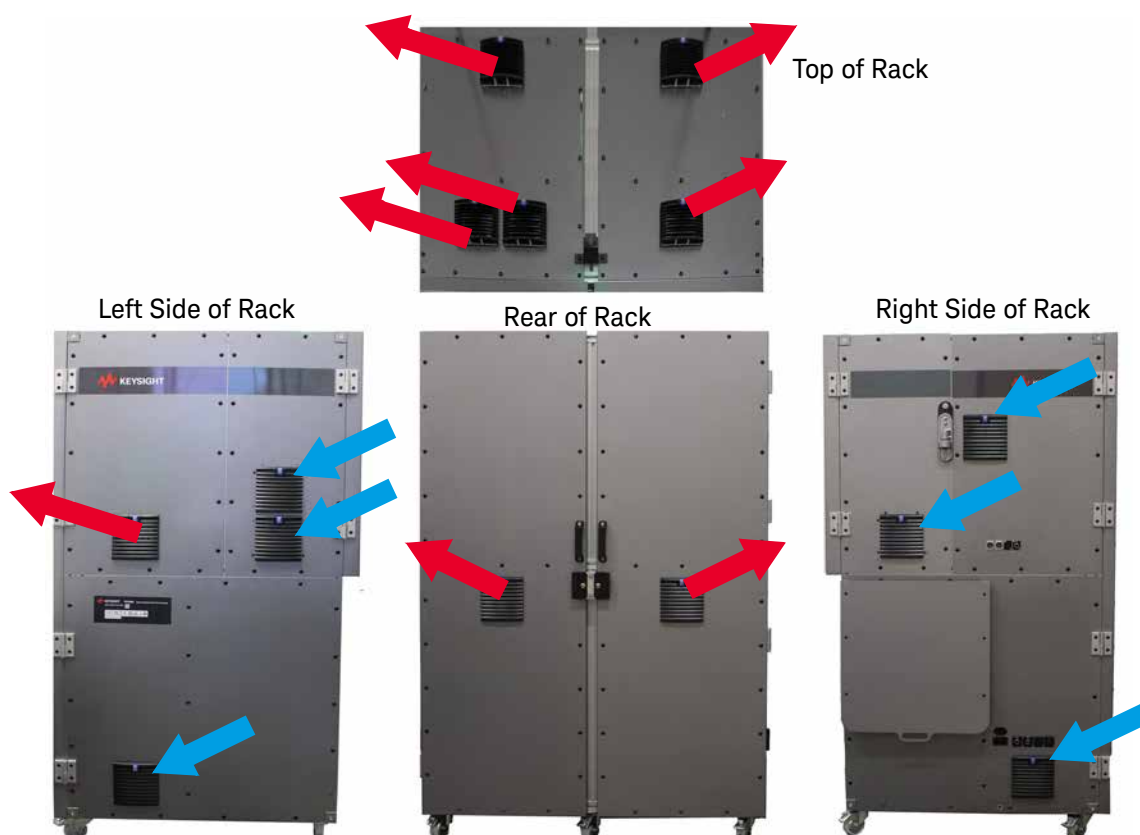


Figure 1 Air Flow through the DPT Rack and Safety Enclosure
(Blue arrows are fresh air in / Red arrows are hot air exhaust)

Connect the Rack and Safety Enclosure to AC Mains

WARNING

AC wiring and the Mains Disconnect are subject to local and regional electrical codes. A licensed electrician must determine and install the appropriate Mains Disconnect.

Copper wire must be used in the power drop. A licensed electrician must determine the wire size for the power drop according to local and regional electrical codes. The wires must be sized to ensure that the voltage at the system does not drop below 90% of the nominal voltage.

AC Power Cord

A country-specific mains power cord (2.5 m [98 inches] long, 3 conductor, IEC-60320 C19 socket on one end) is available with the PD1550A Rack and Safety Enclosure.

WARNING

LEAKAGE CURRENT! Due to the types of instruments installed in this cabinet, there is a risk of leakage current (> 3.5 mA). Reliable ground circuit continuity is required for safe operation of this product. To reduce the risk of electrical shock, an earth (ground) connection is essential before connecting the AC power mains. Never operate the system with the ground connector disconnected. Use a permanent safety ground connection (recommended) or a plug meeting the IEC 60309 (CEE plug) requirements.

Connection of the PD1550A to the AC Mains

WARNING

AC wiring and the Mains Disconnect are subject to local and regional electrical codes. A licensed electrician must determine and install the appropriate Mains Disconnect.

Copper wire must be used in the power drop. A licensed electrician must determine the wire size for the power drop according to local and regional electrical codes. The wires must be sized to ensure that the voltage at the system does not drop below 90% of the nominal voltage.

Mains Disconnect

A mains disconnect – providing over-current and short circuit protection – must be provided. It disconnects the mains circuits from the mains supply. It may be a switch disconnect or a circuit breaker. The DPT Rack and Safety Enclosure front panel switch is only a standby switch and is not a LINE switch (disconnecting device). The disconnect must:

- Comply with UL 489/CSA C22.2 No.5 standard; rated current 20 A or below.
- Open all line conductors and neutral conductors where local code applies, but does not open the protective earth conductor.
- Be marked “System Mains Disconnect” or the equivalent in your language.
- Be marked with a “I” for the “On” position and a “O” for “Off.”
- Be capable of being locked in the “**Off**” position but not in the “**On**” position.
- Be installed within three meters of the DPT Rack, where it can be easily reached by the system operator without requiring the system to be moved.

Convenience outlets should be installed near the system for external equipment. Locate the outlets within one meter (three feet) of the rear of the system.

Circuit Breakers

Circuit breakers must comply with either UL489 or, CSA C22.2 No.5 or, IEC 60947 part 2. Permanently connected systems need to test the Earth connection integrity by testing with current twice the rated current of branch circuit breaker.

Optional Safety Ground Connection

This DPT Rack must be grounded properly for proper operation and safety. The rack connects to AC mains by a plug/socket with ground connection; a permanent earth ground connection is not necessary but one is provided.

Receiving the PD1550A

Your DPT Rack and Safety Enclosure shipment arrives in multiple shipping containers – a large wood shipping crate for the rack and one or more boxes with the accessories. Before uncrating the Rack and Safety Enclosure or unpacking any accessories, carefully inspect the shipping containers for any damage that may have occurred during shipment such as:

- dents
- scratches
- cuts
- water damage

If any damage is discovered, leave the instruments in the shipping containers. Report any damage to the shipping agent immediately and request an inspection. Shipping damage is not covered by the Keysight warranty.

IMPORTANT: Make sure that all doors, elevators, and passageways in route to the site are large enough to accommodate the rack and are capable of carrying the weight.

The packaged physical specifications for the racks are listed in the “Rack and Safety Enclosure Dimensions and Weight” on page 16. Floor elevators and lifting equipment must be of sufficient capacity. If the rack or other instrument shipping crate is damaged upon receipt, request that the carrier's agent be present when the protective covering is removed. Inspect the rack and instruments for damage (scratches, dents, bent pieces, etc.). If the rack or any instrument is damaged, notify the carrier and the nearest Keysight Sales and Service office immediately.

Moving the Rack and Safety Enclosure

On initial receipt, the Rack and Safety Enclosure plus shipping crate exceeds 560 kg (1,290 lbs). Use a mechanical lift to lift the shipping crate.

The rack has six casters for moving it around on a level floor.

When transporting the Rack and Safety Enclosure for long distances or outside of a building always make sure that the environmental conditions like humidity, temperature and air pollution never exceed the related instrument specification. The temperature should not exceed -20 °C to +60 °C.

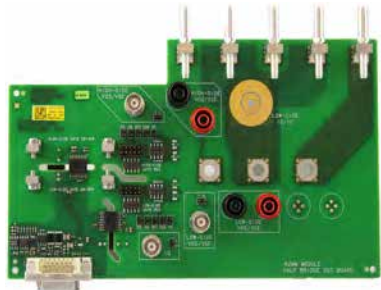
Inventory the Shipment

The DPT Rack and Safety Enclosure comes in at least two shipping containers - a wood crate for the PD1550A (all test instruments are factory installed) and one or more cardboard box for all accessories. Use the packing list that comes with your system to ensure you received all pieces of the system.

Your shipment should include the following:

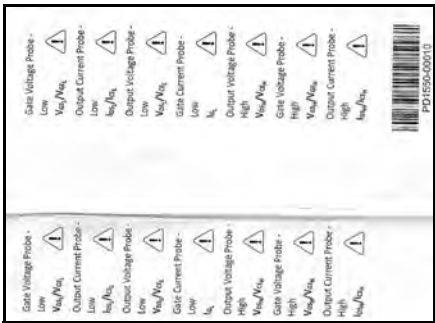
- PD1550A DPT Rack and Safety Enclosure (the following test instruments are pre-installed in the PD1550A system rack):
 - Keysight MXR108A 8-Channel Oscilloscope
 - Keysight 33512B Waveform Generator
 - Keysight B2902B Precision Source/Measurement Unit
 - Heinzinger EVO High Voltage Power Supply, (PD1080A-FG for repair and Cal services)
 - PD1550A-010 Dynamic Test Fixture (standard, 1000 A, PD1550-68710)
 - PD1550A-020 Dynamic Test Control Unit
 - PD1550A-030 Dynamic Test Safety Unit
 - PD1550A-090 Dynamic Test Inductor Unit
 - PD1550A-080 Isolated Probe Technology Unit (for measuring $V_{GS,H}$), (PD1550-68760, PD1081A-FG for repair and Cal services)
- Country-specific Power Cord

Accessories included with the PD1550A

Description and Keysight Part Number	Quantity	Graphic
PD1550-67601 Red/Yellow/Green/Blue tower light, (to be installed at customer site on top of rack)	1	
PD1550-66560 DPT Test Interface Board for 62 mm Modules <u>without</u> decoupling capacitors. Note: This Interface Module is suitable for testing the PD1550A system or commissioning the system. It is <u>not</u> the best option for testing 62 mm DUT modules, it will exhibit excessive ringing on the oscilloscope.	1	

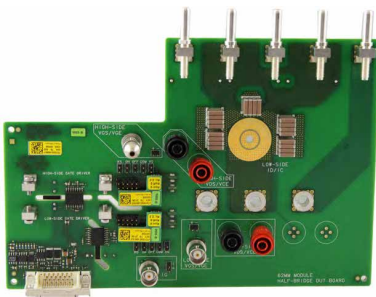
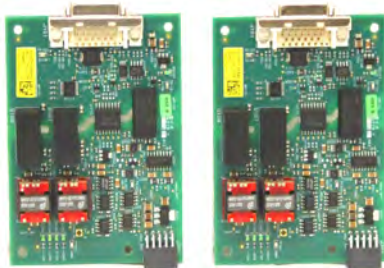
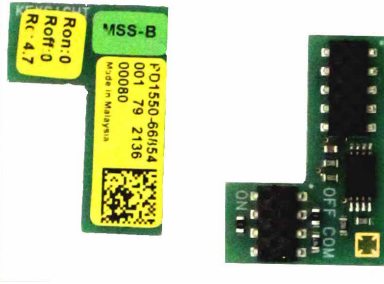
Description and Keysight Part Number	Quantity	Graphic
1854-2245 62 mm IGBT Half-Bridge Test Module (Infineon FF500R17KE4 or equivalent)	1	
1855-3111 62 mm MOSFET Half-Bridge Test Module (CREE [Wolfspeed] CAS300M17BM2 or equivalent)	1	
PD1550-61901 0.05 Ω (50 m Ω) Shunt , (PD1072A-FG for repair and Cal services)	1	
PD1550-61902 0.005 Ω (5 m Ω) Shunt, (PD1073A-FG for repair and Cal services)	1	
PD1550-61602 UDI Cables	3	
DP0001A 400 MHz High Voltage Differential Probe	2	
PD1550-61203 Probe Holder for DP0001A	2	

Description and Keysight Part Number	Quantity	Graphic
DP0031A 200 MHz High Voltage Differential Probe NOTE: Your system may have been provided with PMK PD1802A Differential Probes instead of the Keysight DP0031 probes, These probes are identical in performance.	2	
PD1550-61204 Probe Holder for DP0031A	2	
1254-5602 Probe Adapter, BNC Male to Dual 4 mm Banana Jacks	2	
N2873-60001 10:1, 500 MHz Passive Probe includes Oscilloscope Probe to BNC Adapter (used with Keysight Isolated Probe Technology for High-Side V_{GS}/V_{GE} measurements only)	1	
PD1000-60002 Protection Probe (one supplied standard, additional are optional)	1	
54609-61611, Cable Assembly - 50 Ohm, BNC to SMA, for $I_{D,L}$ Goes from PD1000-60002 Protection Probe to Shunt on DUT Interface Board IMPORTANT: Replace this cable only with same Keysight PN. This is required to maintain deskew in the system.	1	
PD1550-60003, Standard Lift Table 180 mm x 100 mm	1	

Description and Keysight Part Number	Quantity	Graphic
Holdit Pro-Set Probe Holders (no Keysight part number)	5	
Ferrite-core Inductor (9170-1792) One core for the N2873A Oscilloscope Probe. The remaining three are not used.	4	
PD1550-00010 Sheet of 14 probe labels for Probe Adapters	1	
Keys -- 4 for the rear doors of the rack and 2 for the Safety Interlocks on the front doors. One key is in the rear panel of the PD1550-030 Safety Unit. DO NOT REMOVE THIS KEY!!! ! No replacement keys or KEY part numbers are available.		
Tool kit	1 kit	Shipped in accessories box
Power Cord, country dependent with C19 Latching Socket, 3-Conductor, 250VAC	N/A	

PD1550A Accessories (not included)

The following accessories are used in the PD1550A but you must specify the quantity in the product order.

Description and Keysight Part Number	Quantity	Graphic
PD1550-66561 DPT Interface Board for 62 mm DUT modules <u>with</u> decoupling capacitors. Note: This optional Interface Module is the best choice for testing 62 mm DUT modules. It will not exhibit the ringing (oscillations) that the PD1550-66560 has.	1	
PD1550-66540 ± 28 V Gate Drive Modules Calibrated and tested (Option GD1)	Minimum 2 required, (1 for High-Side and 1 for Low-Side, they are identical)	
Gate Drive Resistor modules PD1000-66550 No installed Gate Resistor ¹ (Opt. G01) PD1000-66551 0,0,0 Ω Gate Resistor ² (Opt. G02) PD1000-66552 0,0,1.0 Ω Gate Resistor ² (Opt. G03) PD1000-66553 0,0,2.2 Ω Gate Resistor ² (Opt. G04) PD1000-66554 0,0,4.7 Ω Gate Resistor ² (Opt. G05) PD1000-66555 0,0,10.0 Ω Gate Resistor ² (Opt. G06) PD1000-66556 0,0,22.0 Ω Gate Resistor ² (Opt. G07) PD1000-66557 0,0,100 Ω Gate Resistor ² (Opt. G08) PD1000-66558 0,0,400 Ω Gate Resistor ² (Opt. G09)	Two modules are provided with each part number. Two of same resistance value are required for PD1550A	

¹ See Appendix A for instructions on selecting gate resistors (R_G). See Appendix B for instructions on installing custom gate resistors on PD1000-66550 Gate resistor modules. After installation, module requires calibration.

² For Gate Resistor value, the first two 0's are the $R_{G,ON}$ and $R_{G,OFF}$ values. The third value (e.g., 1.0, 2.2, etc.) is the shared resistor value. These Gate Resistor modules are tested and programmed.

Optional (not required) PD1550A Accessories

The following accessories are used in the PD1550A but not required.

Description and Part Number	Quantity	Graphic
PD1550-60004 (Opt. LT2) Heavy Duty Lift Table 300 mm x 150 mm (for larger DUT modules)	1	

The following cables are included with the PD1550A and are used only for the AutoCalibration procedure:

Description	Quantity	Graphic
Black Test Patch Lead, 0.64 mm Square Pin Socket to 4 mm Stackable Banana Plug, 1 M	2	
Red Test Patch Lead, 0.64 mm Square Pin Socket to 4 mm Stackable Banana Plug, 1 M	2	

What is Not Supplied with the Rack and Safety Enclosure

- Dedicated host computer. See **Host Computer System Requirements** below.
- Standard CAT5e LAN cable (to go from host computer to the DPT Rack and Safety Enclosure). This cable should be less than 3 M long.
- A qualified electrician must provide AC Power connection.

Host Computer Requirements

Operating System	Windows 10
OS versions:	64-bit.
Processor Speed:	1 GHz 32-bit (x86), 1 GHz 64-bit (x64), Itanium64 not supported
Computer memory:	1 GB minimum
Available hard disk space ¹ :	1.5 GB available hard disk space, includes: 1 GB available for Microsoft .NET Framework 4.5.2 100 MB for Keysight IO Libraries Suite
Video:	Screen resolution -- Full HD (1920x1080) at 100%. Support for DirectX 9 graphics, 128 MB graphics memory
1. Less memory may be required for operation than is required for installation.	

PD1550A Documentation

Keysight test instruments comes complete with its own documentation. Country-specific power cords and other cables or accessories may be discarded. All necessary power cords and cables are included in the DPT system Rack and Safety Enclosure.

- **PD1550A Control Software Guide:** Provides detailed information to install, configure, and use the PD1000A Control Software for the PD1550A DPT system. PN: PD1550-90001
- **PD1550A Operation and General Maintenance Guide:** Provides detailed information to operate and maintain the PD1550A Test Rack and Safety Enclosure. PN: PD1550-90003
- **PD1550A System Installation Guide:** Provides detailed information for Keysight personnel to install the Double-Pulse Rack and Safety Enclosure at a customer's site. PN: PD1550-90002
- **PD1000A Control Software Help File:** Provides the same information as this Software Guide plus additional information for using the PD1000A Control Software.

Documentation and software are available at: www.keysight.com/find/PD1550A

For detailed information about any of the test instruments, refer to the documentation provided with the instrument. Instrument documentation, data sheets, firmware updates, software updates, specifications, and more can be found on the product web pages listed below.

www.keysight.com/find/PD1000A (for Control Software, and PD1000A general information)

www.keysight.com/find/MXR108A 8-Channel Oscilloscope

www.keysight.com/find/33512B Waveform Generator, 2-Ch with ARB

www.keysight.com/find/B2902B Precision Source/Measurement Unit

www.Heinzinger.com High Voltage Power Supply Model EVO

NOTE

Adobe Reader is required to view PDF files. It is available free at: <https://get.adobe.com/reader>.

Simplified System Diagrams

Refer to “Simplified System Wiring Diagrams” on page 133 for diagrams. These diagrams illustrate the overall system wiring.

NOTE

The test instruments, Power Distribution Unit, instrument power cords, LAN cables, and all of the Safety Electronics are pre-installed in the PD1550A Rack and Safety Enclosure for your convenience.

2 Uncrate the PD1550A Rack and Safety Enclosure

The Double-Pulse Test (DPT) Rack and Safety Enclosure is the largest of the two shipping containers shipped for the system. This chapter describes how to uncrate the DPT Rack and Safety Enclosure.

In this chapter:

Tools Required for Uncrating the PD1550A Rack	page 33
Uncrate the Rack and Safety Enclosure	page 34
Moving the Rack and Safety Enclosure	page 41
Re-crating the Rack and Safety Enclosure for Shipping	page 42

CAUTION

To avoid possible injury, at least two people are required to uncrate the PD1550A Rack and Safety Enclosure.

NOTE

IMPORTANT: A minimum of 3 meters (9 ft) of clearance is required all the way around and above the shipping crate to enable removing of the packing material.

Tools Required for Uncrating the PD1550A Rack

- T40 Torx screwdriver
- Optional: pry bar to remove crate clamps

Uncrate the Rack and Safety Enclosure

Use the following procedure to remove the rack from the shipping crate. Keysight recommends using two people to uncrate the Rack and Safety Enclosure. Wear work gloves to protect against splinters.

- 1 Make certain you have adequate room to uncrate the Rack and Safety Enclosure. A minimum of 4 M (12 ft) is required in front of the crate (ramp+ Rack and Safety Enclosure), 2 M (6 feet) behind the crate, and 1 M (3 feet) above the crate. See Figure 2 below.

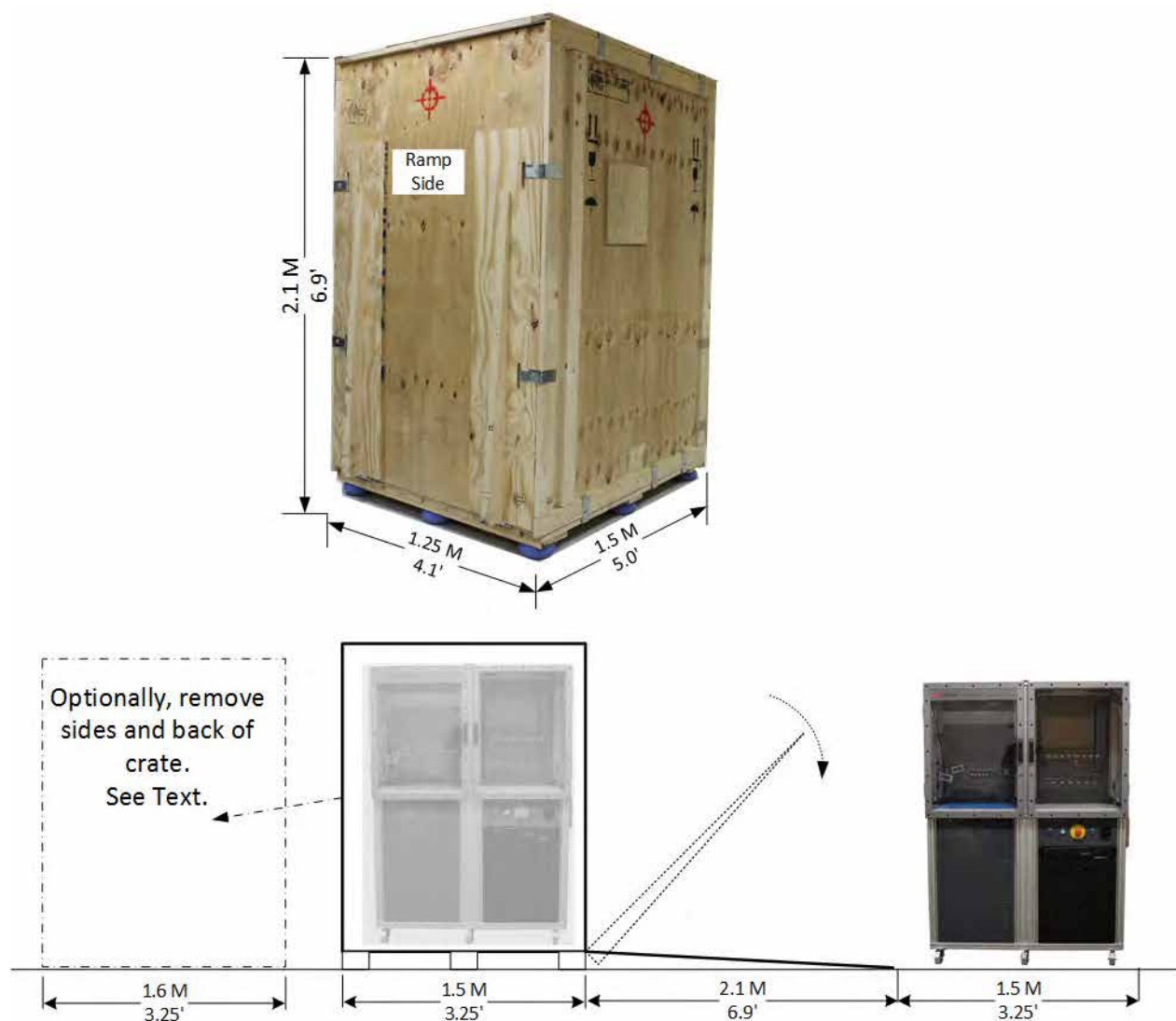


Figure 2 PD1550A Rack and Safety Enclosure Shipping Crate

- 2 Remove the TORX T40 screws and four clamps securing the ramp to the sides of the shipping crate.

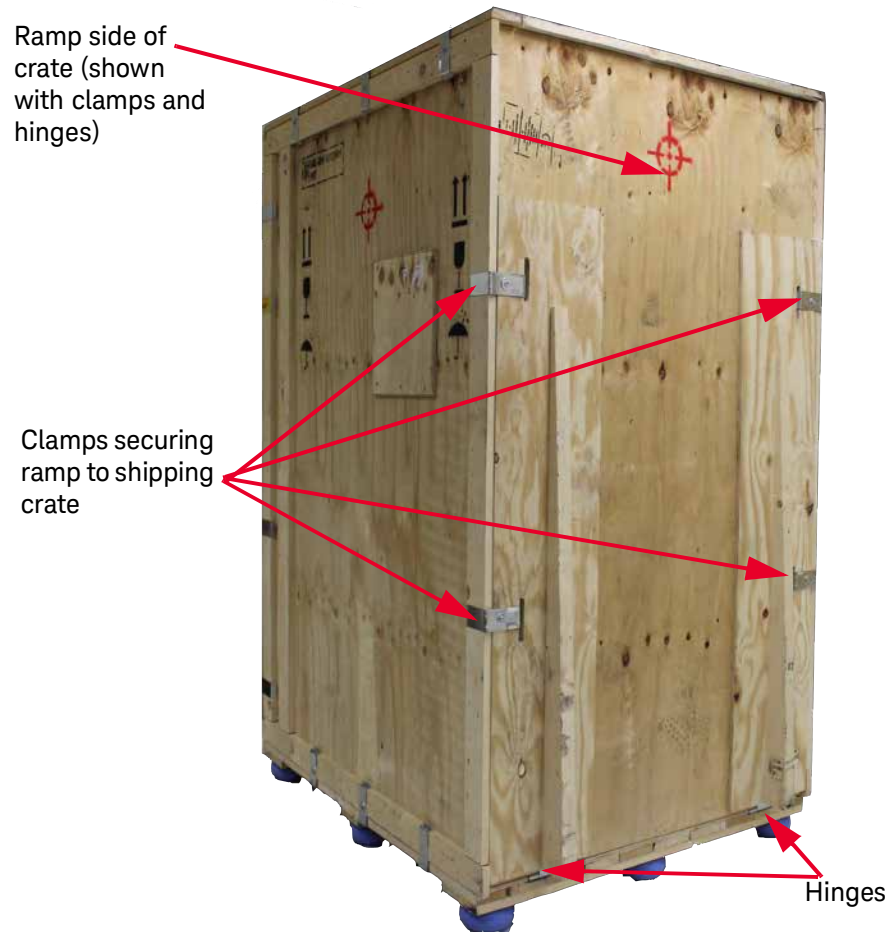


Figure 3 Remove screws and clamps from ramp

NOTE

The ramp is secured to the pallet by hinges.

- 3 Carefully unfold the ramp down to the floor.



Figure 4 Carefully open the ramp

- 4 Remove the top braces from inside the shipping crate.

Remove 8 lag bolts from sides of the shipping crate -
4 on each side of crate

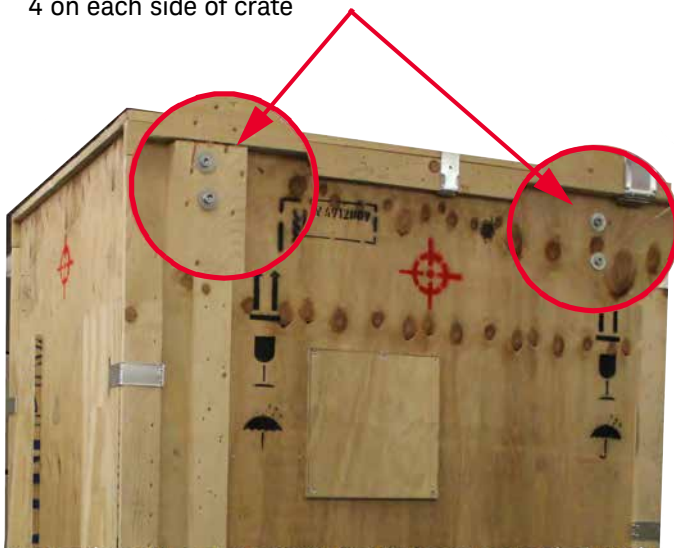


Figure 5 Remove Top Braces (Rack packing materials not shown)

NOTE

Although it is possible to remove the PD1550A Rack and Safety Enclosure from the shipping crate without removing the sides and back of the crate, Keysight recommends removing crate from the pallet. This is because the casters on the bottom of the rack must rotate freely. It is possible for the caster locking mechanism to dig into the bottom braces in the crate and not allow the casters to rotate properly.

- 5 Remove the screws and clamps that secure the crate to the pallet. Do **not** remove the screws and clamps from the sides of the crate.

Do **NOT** remove the clamps from the sides of the shipping crate

Remove the clamps from the bottom of the crate that secures it to the pallet



Figure 6 Remove clamps securing crate to pallet

- 6 Carefully slide the crate body (sides, back and top) of the shipping crate away from the shipping pallet. Set crate body on the floor behind the pallet.

CAUTION

Important: Two people are required for this step.



Figure 7 Remove crate body from the pallet (Rack packing material not shown)

- 7 Remove the front, side and rear braces from the pallet.

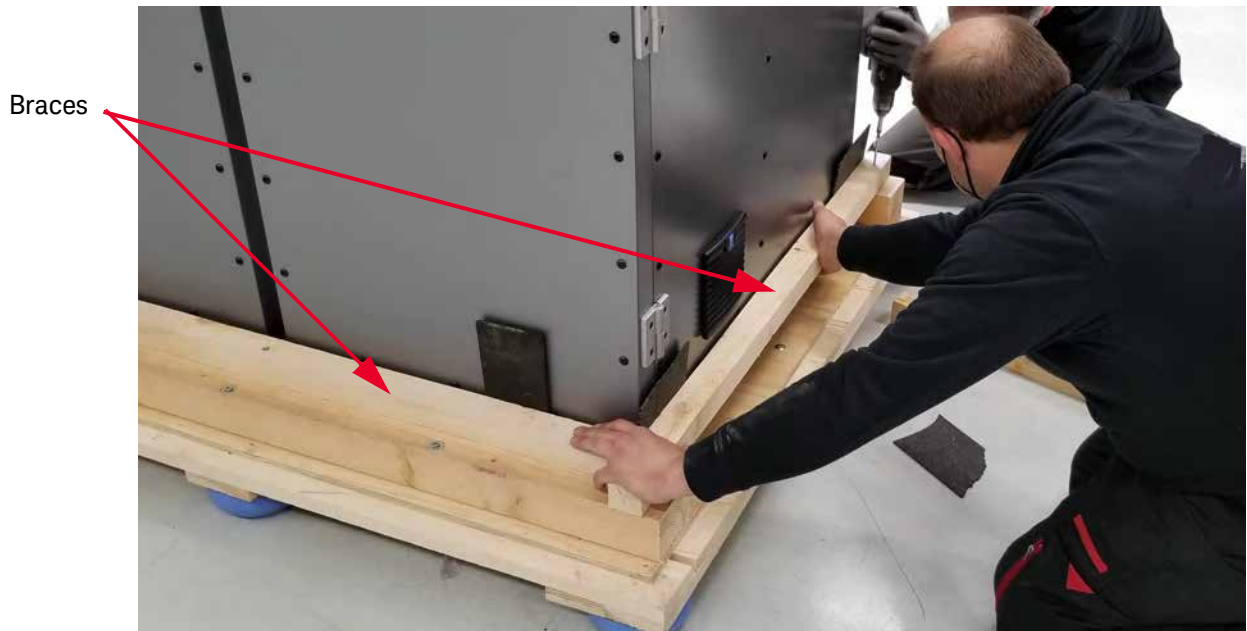


Figure 8 Remove the Braces from the Pallet (Rack packing materials not shown)

- 8 Remove packing materials from the Rack and Safety Enclosure.



CAUTION

Make sure that the casters on the bottom of the rack are unlocked before you roll the rack down the ramp.



Caster Locked



Caster Unlocked

- 9 Carefully roll the test rack and safety enclosure down the ramp.

CAUTION

At least two people are required to roll the Rack and Safety Enclosure down the ramp and to its final location.

NOTE

Keysight recommends, if possible, that you save the shipping crate and pallet if you plan to ship the rack to a different location. Refer to “Re-crating the Rack and Safety Enclosure for Shipping” on page 42 for detailed information.

Moving the Rack and Safety Enclosure

The Rack and Safety Enclosure has six wheels on the bottom of the rack. Be careful, the rack's center of gravity is high. The rack might tilt over when moving. All wheels have locking mechanisms. Ensure the wheels are locked when using the DPT Rack and Safety Enclosure and unlocked when moving the rack.

After uncrating the Rack and Safety Enclosure, it may be necessary to move the system to a new location.

Shut down the system correctly as described in the manual. Make sure the line power connection was removed correctly from the system. Make sure there is no energy left in the circuits by discharging all circuits to earth. Disconnect all adapters from the system. Disconnect all peripherals that are connected outside the system. Make sure there are no loose components inside the system rack.

NOTE

IMPORTANT: The DPT Rack and Safety Enclosure has six wheels or casters on the bottom. These casters are lockable to prevent the rack from moving. Make certain the wheel locks are disengaged before moving the rack.



Caster Locked



Caster Unlocked

CAUTION

Be very careful when moving the Rack and Safety Enclosure around. The rack's center of gravity is high and the rack might tilt over when moving.

Re-crating the Rack and Safety Enclosure for Shipping

If you need to ship the Double-Pulse Test system to a different location – beyond where it can be rolled on its casters – prepare the PD1550A system for shipping per the following instructions.

NOTE

IMPORTANT: For service and calibration of individual instruments in the PD1550A test system, **DO NOT SHIP THE ENTIRE** Rack and Safety Enclosure to Keysight. Instead, contact Keysight for an Application Engineer to come to your site, remove the individual instrument(s), and return to Keysight. Attach a tag indicating the type of service required, your return address, and model number of the device to be repaired. Refer to the instructions included with each instrument for return instructions.

- 1 Turn the system OFF with the Power On/Off Switch.
- 2 Unplug the AC power cord from the test system Rack and Safety enclosure.
- 3 Remove all test modules, oscilloscope probes, any loose parts from the DPT work surface. These should be packaged separately for shipping.
- 4 Remove any loose pieces (installation bolts, cables, etc.) before shipping.
- 5 Unplug the tower light and remove the tower light from the rack. Refer to “Install Tower Light on Top of the Rack,” starting on page 45 for detailed instructions.
- 6 Wrap the Rack and Safety Enclosure in plastic and foam before putting it in the shipping crate. Use the original packing material if possible. This will protect the rack and safety enclosure from dust, dirt, and scratches during shipping.
- 7 Place the Rack and Safety Enclosure inside the shipping crate. Lock the casters so that the rack does not shift during transportation.
- 8 Install the braces around the base of the rack and the two top braces to prevent it from moving around inside the shipping crate.

When transporting the Rack and Safety Enclosure for long distances or outside a building always make sure that the environmental conditions like humidity, temperature and air pollution never exceed the related instrument specification. The ambient temperature should not exceed -20 °C to +60 °C.

3 Accessory and Probe Installation

This chapter describes the PD1550A system installation process. It includes both system rack hardware assembly as well as installation requirements for general system operation.

Tools Required to Install Accessories	page 44
Install Tower Light on Top of the Rack	page 45
Apply Power and Turn On the PD1500A	page 47
Connect Three Short BNC Cables	page 48
Rack Connections	page 49
Open the Side Shelf	page 51
Install Probe Holders	page 53
Install Components on PD1550A Interface Module	page 56
Install Coaxial Shunt Resistor	page 56
Attach 62 mm DUT Module	page 57
Connect Interface Module to PD1550A Test System	page 65
Install Gate Drive Modules on the Interface Module	page 63
Install Gate Drive Resistor Modules on the Interface Module	page 60
Connect Probes to Oscilloscope	page 67
Connect Oscilloscope Probes to DUT Interface Module	page 70
Connect Probe for High-Side DUT Measurements	page 72
Install UDI Cables	page 75
Install Additional Test Fixture Accessories	page 76
External Loads	page 76
NTC Thermistor Connector	page 77
Fan Out 24 VDC	page 78
Type K Thermocouples, CH1 and CH2	page 78
Install Optional InTEST Temperature Controller with Heating Plate	page 81
Install Optional InTEST - Temptronic Thermostream Heater/Cooler System	page 85
Thermostream Compressed Air Requirements	page 87

Tools Required to Install Accessories

- Small step ladder to access top of rack to install Tower Light
- #2 Pozidrive screwdriver to attach Tower Light, 62 mm DUT module to Interface Module, etc.
- 10 mm open-end wrench to attach probe holders to rails inside of rack
- Optional 5/8" open-end wrench to tighten probe holders
- T10 Torx screwdriver to attach Gate Drive Modules to Interface Module

NOTE

IMPORTANT: Installing the Light Tower should be done before applying power and turning on the system.

Power must be supplied to the PD1550A system and the system turned on before the front safety doors can be opened. Refer to "Apply Power and Turn On the PD1500A" on page 47 for information regarding system turn on.

Stabilize the Rack

After moving the PD1550A rack to its final position, lock the casters to prevent accidental moving.



Caster Unlocked



Caster Locked

Figure 9 Caster Locked and Unlocked

Install Tower Light on Top of the Rack

Installing the Light Tower should be done before applying power and turning on the system. Make sure the rack is turned off and the power cord disconnected before installing the Tower light.

The four color tower light is shipped in an accessory box. Mount it on top of the PD1550A rack.

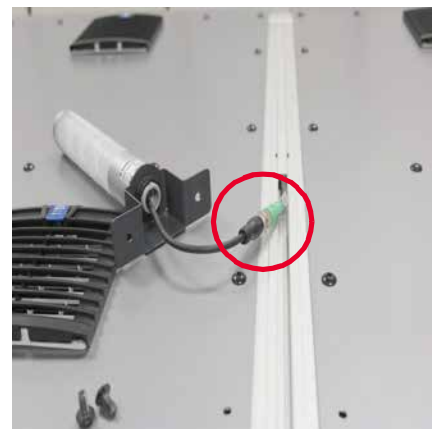
-
- 1** Locate the tower light in the group of accessories.



-
- 2** Standing on a small step ladder, locate and remove two Phillips mounting screws on top of the rack.



-
- 3** Connect the 8-pin Tower Light cable and securely tighten.



-
- 4** Using the two Phillips screws previously removed, install the Tower light. Securely tighten the mounting screws.



- 5** Ensure the tower light cable connector and the mounting screws are tight. Route the cable in the slot.



On the Tower Light:

- Red indicates high voltage >42 V to 1300V is present in the system.
- Yellow indicates a system failure or the system is turning on.
- Green indicates no high voltage is present, the front doors may be opened.
- Blue indicates a test is running, the front doors are locked.

Apply Power and Turn On the PD1500A

Connect the PD1500A to an appropriate AC power source (see Chapter 1 for detailed information). At this time all lights in the Tower Light should be off.

Turn the **Power** knob to the **ON** position. The **Yellow** tower light should be on; all other lights should be off.

Press the **RESET** button the front of the PD1500A rack. All Tower Lights should turn on **ON** for approximately 10 seconds. Afterward, only the **Red** Tower Light remains on. The two white lights inside of the rack may be on. After a few moments, the **Red** Tower Light turns off and the **Green** Tower Light turns on.

Wait a few minutes while the oscilloscope turns on and installs all of its applications. A single yellow trace appears when the oscilloscope is finished installing its applications.

Press and hold the **Door Open** button to open the two front doors.-- you may need to pull very hard to open the doors.

Remember, to open the doors on the PD1550A:

- Power must be supplied to the PD1550A system
- PD1550A system turned on
- **Green** Tower Light must be on - all other tower lights off

NOTE

All doors, both front and rear of the test rack, must be closed and locked before running any DPT test.

Connect Three Short BNC Cables

Three short BNC-BNC cables should come pre-installed from the factory. These BNC - BNC cables connect the Waveform Generator to the patch panel immediately below the oscilloscope. Ensure that these cables are in place.



Figure 10 Three short BNC - BNC cables

Rack Connections

USB, External LAN, and HDMI Connectors

The following sockets are on the right side of the PD1550A rack. Connect your site LAN cable or a LAN cable to the controller PC to the LAN External socket. The two USB and the HDMI sockets are reserved for future use only. Do not connect anything to these three sockets.

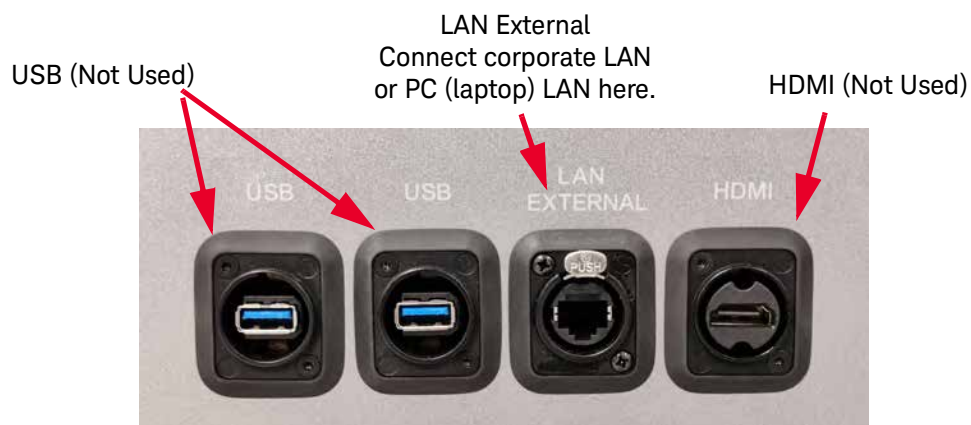


Figure 11 Electrical Jacks near the Shelf

NOTE

USB and HDMI jacks are reserved for future use only.

External Ground Connector

External Ground connection for safety ground on right side of PD1550A rack.



Figure 12 External Ground Connector on right side of Rack

LAN External, E-Stop Signal Light Connectors



Figure 13 External LAN and Emergency Stop Connectors

NOTE

These jacks are reserved for future use only.

Power In / Power Out Connectors

Maximum AC Power Input to the PD1550A is 12 A at 200 - 250VAC, 2800 Watts.

The Power Out socket is to power an external monitor. It is rated at 6 A maximum.



Figure 14 Power Input and Power Output Connectors

Open the Side Shelf

The shelf is already installed on the rack. It is suitable for holding a laptop computer, test modules, a notebook, etc.

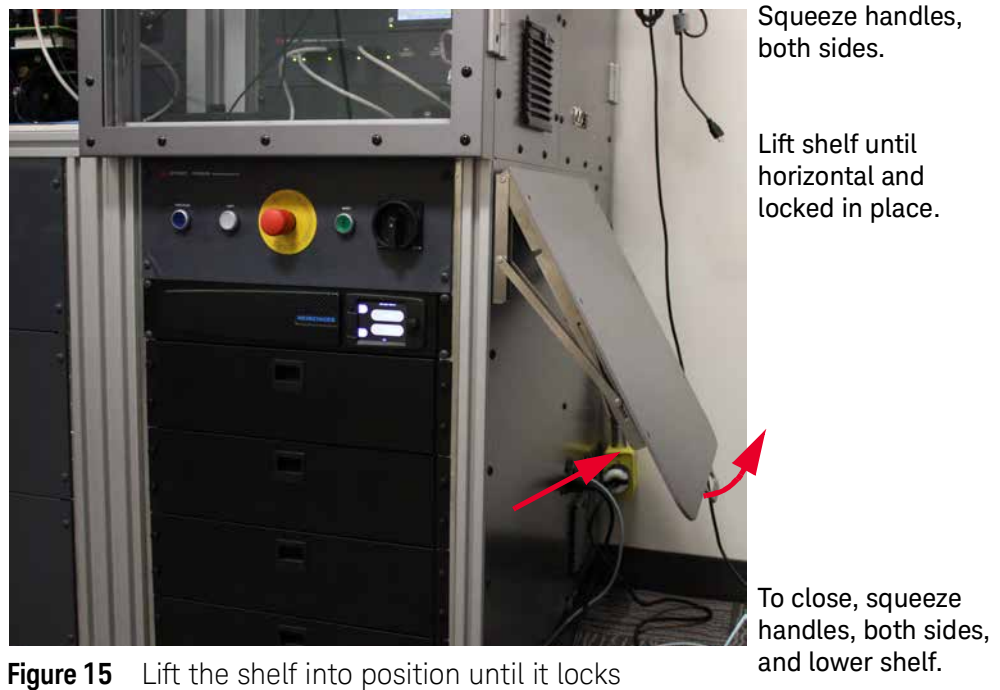


Figure 15 Lift the shelf into position until it locks

Open the Drawers

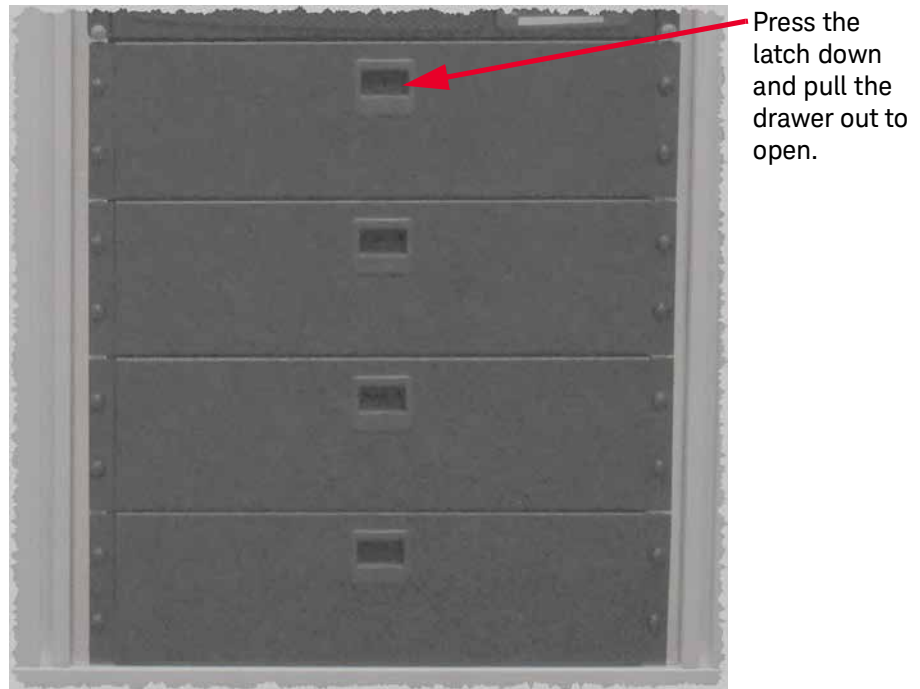


Figure 16 Opening the Rack Drawers

Install Probe Holders¹

Probe Holder Rails on either side of the left side of the Rack. You may install the probe holders in any of the rail mounting holes. Typically, three probe holders are installed on each side and equally spaced on the rails.

- 1 Remove the probe holders from their blister pack(s).¹



- 2 Thread the Quick Release onto the short threaded end of the articulating arm.



- 3 Locate the two probe holder mounting rails in the left side of the rack enclosure.



- 4 Insert and thread the long threaded arm of the Holdit Arm into the rail. Use a 10 mm wrench to tighten the arm on the rail.

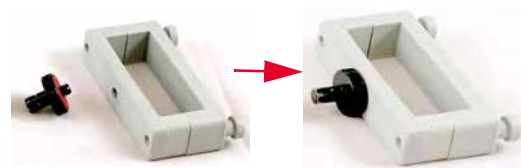


¹ Holdit Pro-Set HS9000 from Noga. For additional information see, www.hoditbynoga.com.

-
- 5** Thread a Nut onto the arm on the back side of the rail. Use a 10 mm wrench to hold the Holdit Arm while hand-tightening the Nut.



-
- 6** Screw the Quick Release Attachments onto the Probe Holders. Hand tighten.



-
- 7** To connect the Quick Release Attachment to the Quick Release, pull back on the red Quick Release sleeve and insert the attachment.



-
- 8** Attach one Probe Holder on each probe.

1 Converter and XchangeCube pieces are not used and may be discarded.

Add Ferrite Core Inductor to N2873A Probe

One 9170-1792 Common Mode choke (ferrite-core inductor clamp) must be added to the N2873A 10:1 Standard oscilloscope probe. On the N2873A probe locate the clamp six to seven inches (15 to 18 cm) from the BNC connector. Pass the cable through the clamp two times.

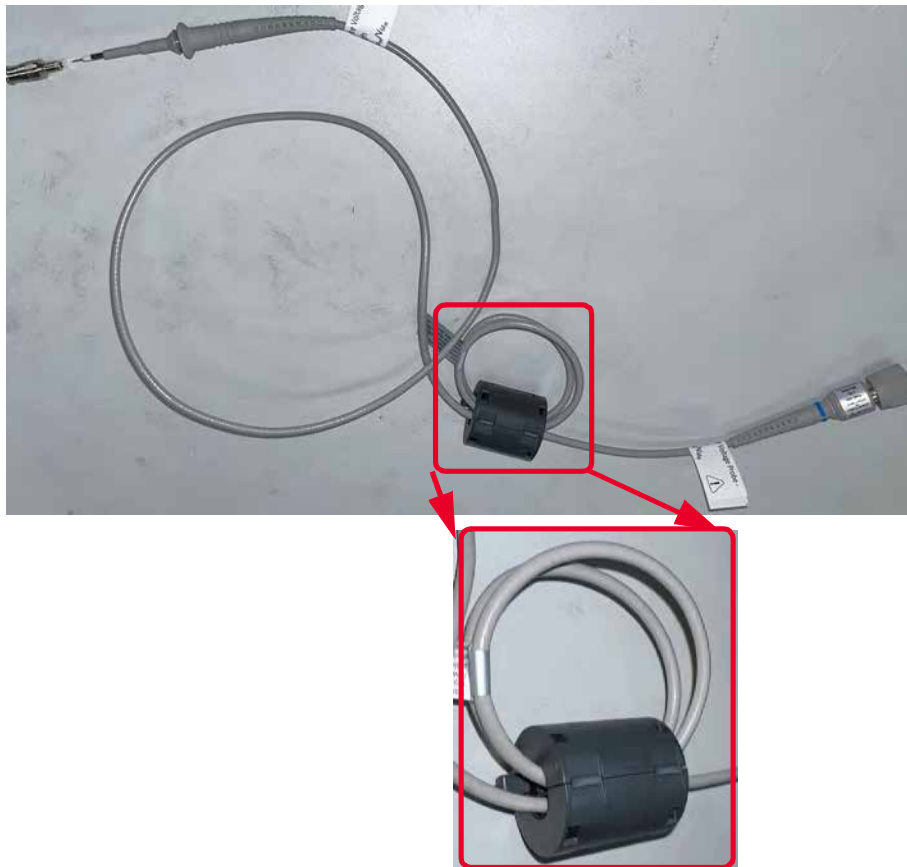


Figure 17 Install Ferrite Clamp on N2873A Oscilloscope Probe

NOTE

Handle with care. The ferrite-core or clamp case may crack if it is dropped or experiences mechanical shock. Do not use excessive force when closing the clamp. It should close with relative ease.

NOTE

Do not wind the cable too tightly or crimp the cable. You may want to add zip-ties to the cable to hold it in place. Do not over tighten the zip-ties and crimp the cable.

NOTE

Four ferrite clamps are provided with the PD1550A. Only this one is used. The remaining three clamps are extras and not used

Install Components on PD1550A Interface Module

NOTE

Important: This section and the following photographs show pictures with the standard 62 mm Interface Module supplied with the PD1550A system. Other Interface Modules including custom Interface Module may be different and require different connections.

Install Coaxial Shunt Resistor

Installation instructions are valid for:

- PD1550-61901, BNC Shunt Resistor, 0.05 Ω , Calibrated (for PD1550A)
- PD1550-61902, BNC Shunt Resistor, 0.005 Ω , Calibrated (for PD1550A)

The coaxial shunt must be installed on the DUT or interface module. It must be removed and re-installed when changing modules. It also must be removed and shipped to a Keysight Service Center for annual characterization. Refer to the *PD1500A Service Guide* or *PD1550A Service Guide* for detailed information.

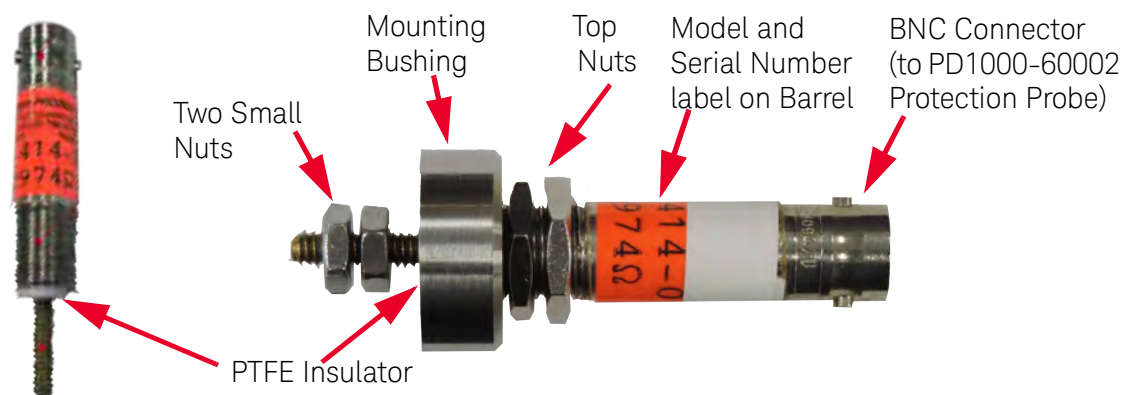


Figure 18 Coaxial Shunt Resistor

CAUTION

IMPORTANT: PD1550-61901, 0.05 Ω , has a 200 A limit. Any test currents or calculated currents greater than 200 A after the 2nd pulse will automatically fail the DPT test. For currents greater than 100 A, use the PD1550-61902, 0.005 Ω shunt.

NOTE

The PD1550-61901, 0.05 Ω , and PD1550-61902, 0.005 Ω shunts will not fit with the PD1500A system DUT modules.

The PD1000-61901, 0.01 Ω and PD1000-61902, 0.001 Ω shunts must not be used with the PD1550A system due to the higher currents used in the PD1550A system.

- 1 Remove both small nuts from the Shunt Resistor.
- 2 Screw the Top Nuts as far as possible to the top of the Shunt Resistor.
- 3 Screw the Mounting Bushing against the top nuts.
- 4 Insert the threaded shaft of the Shunt on the module. The PTFE Insulator must touch the top of the PC board.
- 5 Hand tighten one of the small nuts on the bottom of the module.
- 6 Screw the Mounting Bushing to the bottom, against the module. Hand tighten only.
- 7 Tighten the Top Nut(s) against the Mounting Bushing. Hand tighten only.
- 8 Tighten the second small nut against the first small nut on the bottom of the module. Hand tighten only.

**CAUTION**

Hand-tighten nuts and Mounting Bushing only. The Mounting Bushing must rest against the large circular copper pad on the Module. Ensure all nuts are snug. Do not use a wrench to tighten the nuts; do not over-tighten. Over-tightening the nuts may cause the PTFE insulator to split.

Attach 62 mm DUT Module

A standard 62 mm IGBT or FET power module may be attached to the PD1550-66560 or PD1550-66561 Interface Modules for testing.

NOTE

The PD1550-66560 Interface Module supplied with the PD1550A does not have decoupling capacitors installed on the module. It is suitable for testing the system or commissioning the system. It is not the best module for testing 62 mm DUT modules.

The PD1550-66560 Interface Module with decoupling capacitors is an option to the PD1550A; it is the best choice for testing 62 mm DUT modules.



Figure 19 Typical 62 mm IGBT Module (62 mm FET module is similar)

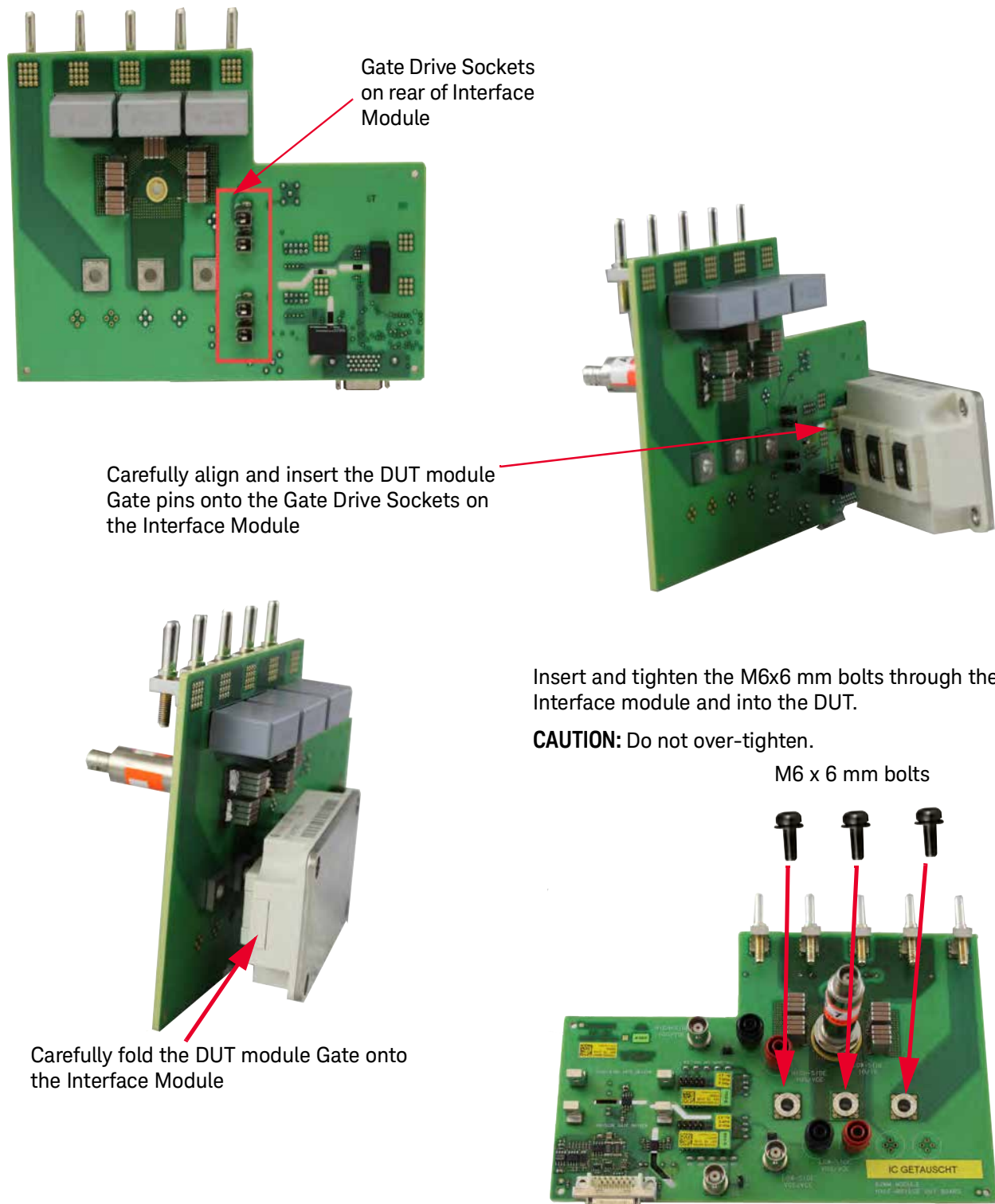


Figure 20 Installing a 62 mm DUT Module on the PD1550A Interface Module

CAUTION

Do not over-tighten bolts. Do not exceed maximum bolt depth into the module.

Install Gate Drive Resistor Modules on the Interface Module

These are tested and calibrated (except for the blank modules). Both High-Side and Low-Side Gate Drive Resistors should have the same resistor value.

Which resistor modules should you use or how do you select custom gate drive resistors? Many FETs and IGBTs have an internal gate resistor, but an external gate drive resistor plays a crucial role in limiting noise and ringing in the gate drive path. Parasitic inductances and capacitances, high dv/dt and di/dt can cause unwanted oscillations and other behavior unless an appropriate-valued gate drive resistor is used.

NOTE

Always use High-Side and Low-Side Gate Drive Modules with the same value resistors. For example, using a 100 Ω Gate Resistor on the High-Side transistor and a 0 Ω resistor on the Low-Side transistor, could cause false turn-on of the non-switching transistor due to high dv/dt and the weakly-driven gate. A 0 Ω resistor on the transistor that is not being switched is generally okay.

NOTE

Switching characteristics of the DUT are influenced by the gate resistor value. A small resistor value allows for faster switching but might increase the ringing. A large gate resistor value slows down the turn-on of the device but allows for a more accurate gate charge measurement.

NOTE

di/dt is a factor of R_G and V_G . If you are trying to match the di/dt value given in a device data sheet, install an appropriate gate drive resistor (R_G) on a blank Gate Drive Module; use an appropriate V_G . It may take several test iterations to match the data sheet di/dt .

PD1550A Gate Resistor Modules are labeled in the form: x, x, xxx, where the first value (typically 0) refers to the R_{ON} resistor value on the module, the second value (typically 0) refers to the R_{OFF} resistor value on the module. The final number (e.g., 4.7, 20, 100, etc.) refers to the value of the common resistor R_C .

Schematic of Path for Gate Resistors

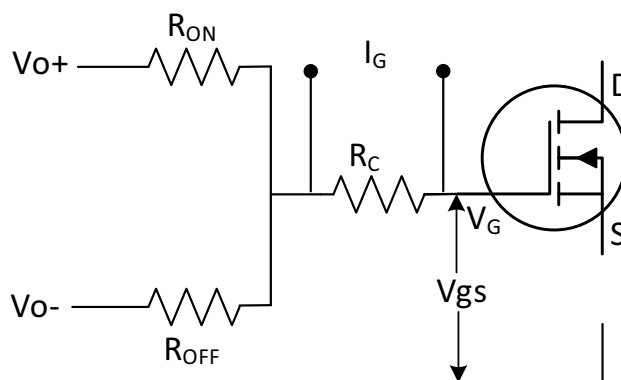


Figure 21 Schematic of Gate Drive Resistors

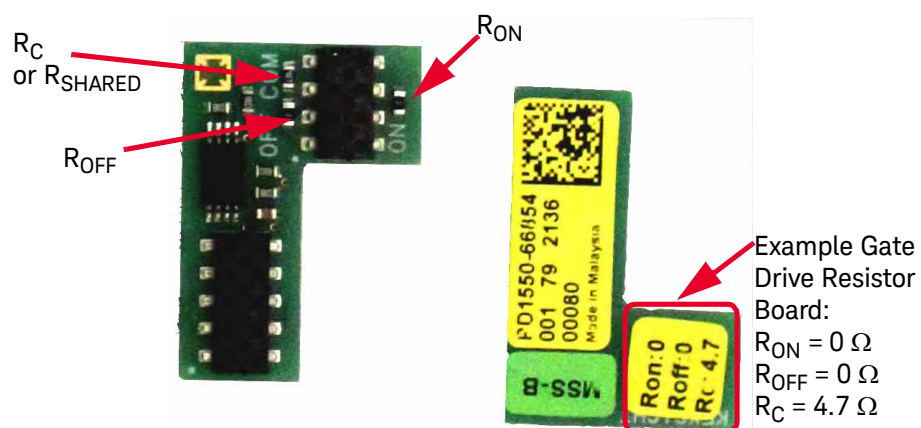


Figure 22 PD1550A Gate Drive Resistor Modules

How to Measure Gate Resistors

You can use a DMM to measure the Gate Resistors directly on the resistor module or, after installing the Gate Resistor Modules on the Interface Module, you can measure the resistor values on the Interface Module itself. This helps to insure the Gate Resistor Modules are properly installed.

- To measure R_C : **VG** to **RC** (R_{SHARED})
- To measure R_{ON} : **ON** to **RC** (R_{SHARED})
- To measure R_{OFF} : **OFF** to **RC** (R_{SHARED})

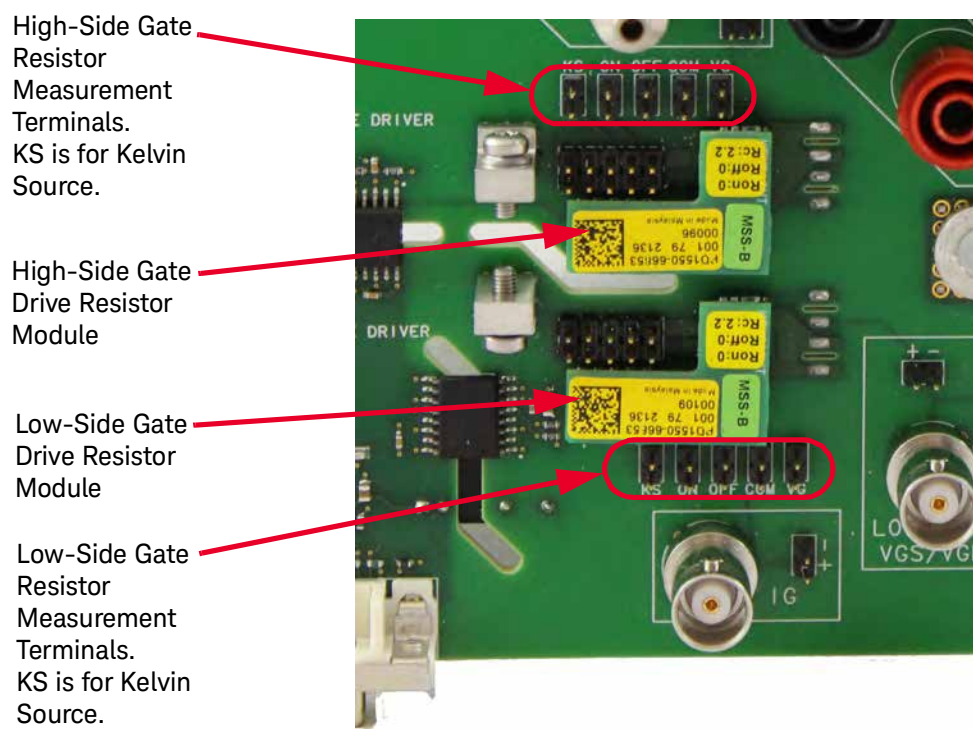


Figure 23 Measuring High-Side and Low-Side Gate Drive Resistor Values (**SHRD** is the same as **R_C**)

Install Gate Drive Resistor Modules on the Interface Module

Carefully align the two sockets on the resistor board with the two sets of pins on the Interface Module. Press the Gate Resistor Modules onto the pins.

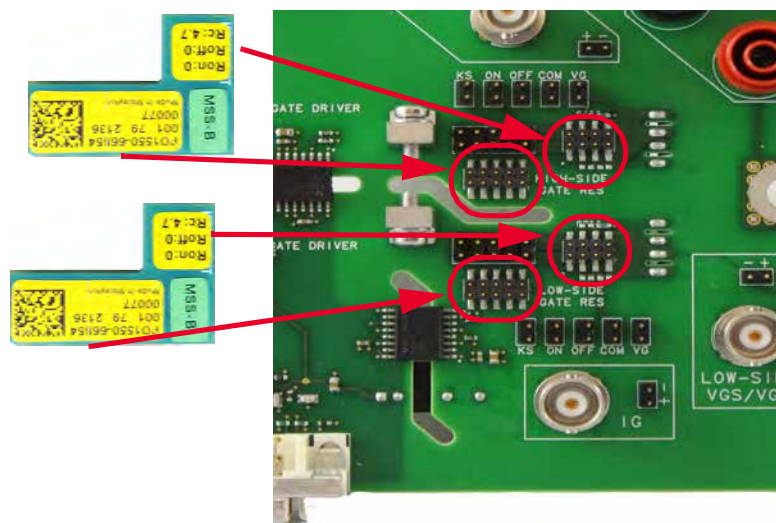


Figure 24 Install Gate Resistor Modules on Interface Module

Install Gate Drive Modules on the Interface Module

Remove the four screws (two for each module) from the Gate Drive Module mounting brackets.

Carefully align the High-Side Gate Drive Module with the pins on the Interface Module. Press the module onto the pins.

Carefully align the Low-Side Gate Drive Module with the pins on the Interface Module. Press the module onto the pins.

Optionally, use the T10 TORX screws to secure the Gate Drive Modules to the brackets on the Interface Module.

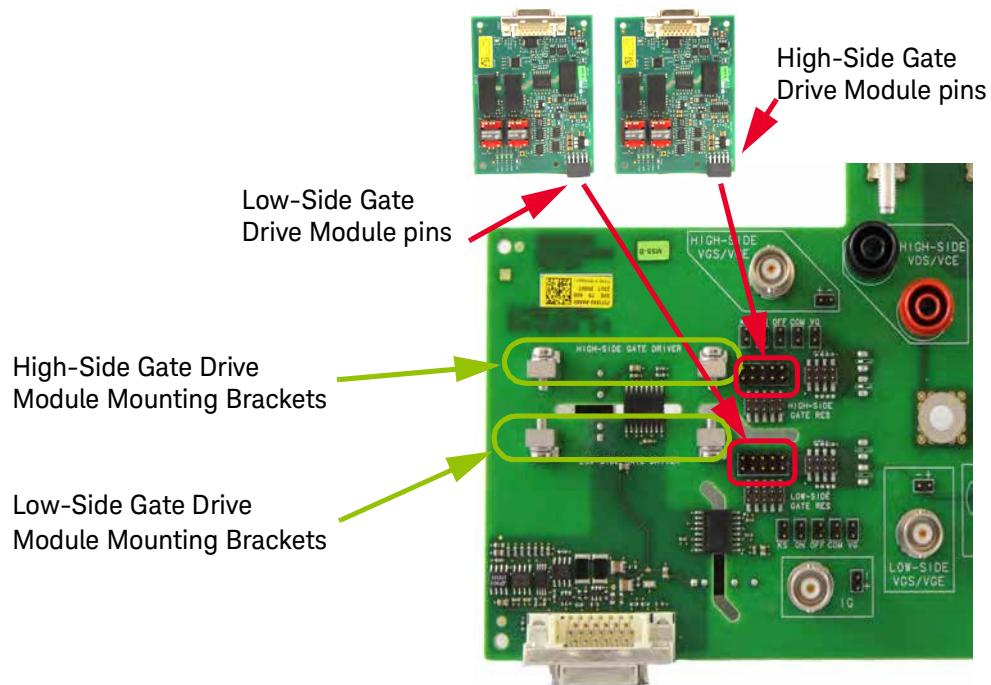


Figure 25 Install High- and Low-Side Gate Drive Modules (Gate Resistor modules not shown)

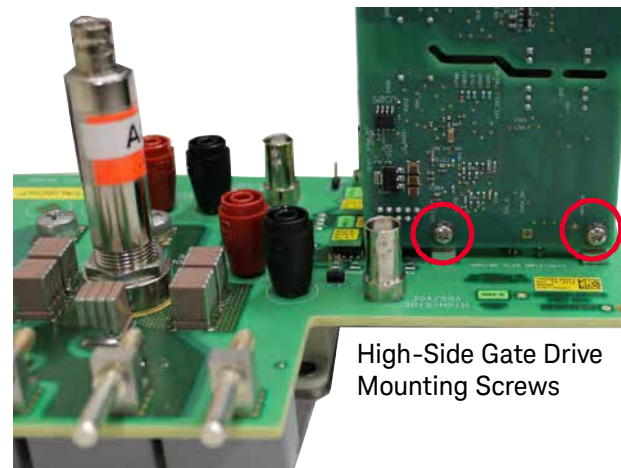
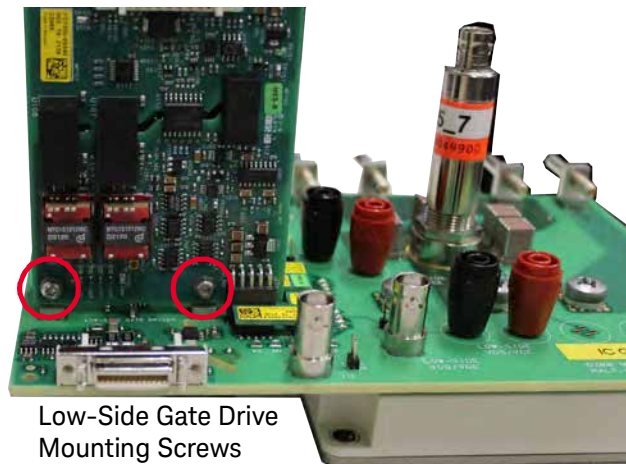


Figure 26 Optional Low-Side and High-Side Gate Drive Module Mounting Screws

Connect Interface Module to PD1550A Test System

If using the InTEST Thermal Plate, place it on the Lift Table first, then the DUT Module on top of the Thermal Plate.

If not using the InTEST Thermal Plate, place the module on the Lift table. Raise the lift table until the high voltage pins on the Interface Module align with the sockets on the Test Fixture. Push the Interface Module high voltage pins into the connectors on the Test Fixture.

CAUTION

The Interface Module must be perpendicular to Test System. It must not be either too high or too low.

Install UDI Cables to the Gate Drive and Interface Modules

Connect UDI cables to the connectors at the top of the High-Side and Low-Side Gate Drive Modules.

Connect a UDI cable to the Interface Module in front of the Gate Drive Modules.

NOTE

Any UDI cable may be connected to any UDI Connector and UDI port on the PD1550-020 Control Unit. Typically:

- UDI Port 1 connects to the Low-Side Gate Drive Module
 - UDI Port 2 connects to the High-Side Gate Drive Module
 - UDI Port 3 connects to the Interface Module in front of the Gate Drive Modules
-

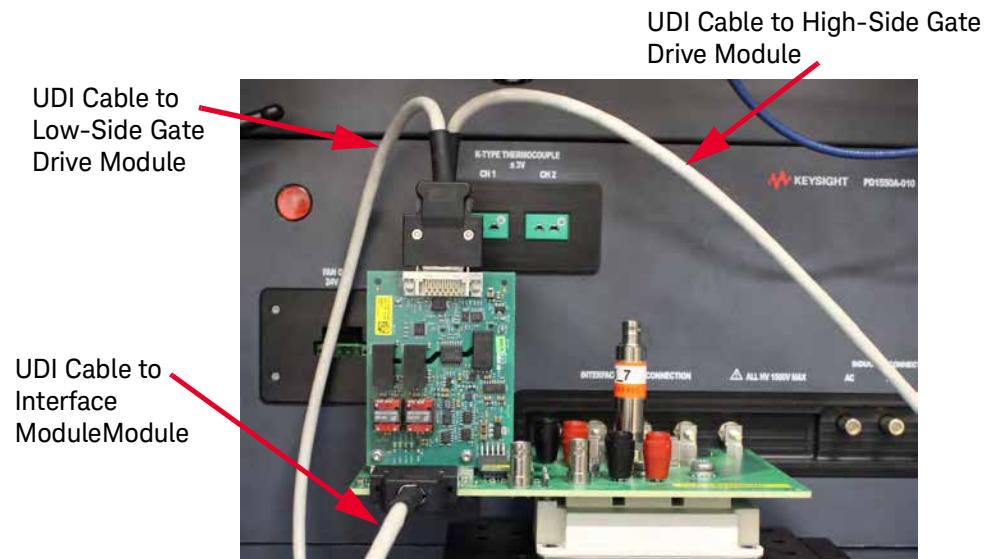


Figure 27 Install UDI Cables on Gate Drive and Interface Modules

Connect Probes to Oscilloscope

- 1 Attach the probe connector to the appropriate oscilloscope channel.
- 2 Connect the probe to the appropriate DPT Test Module.

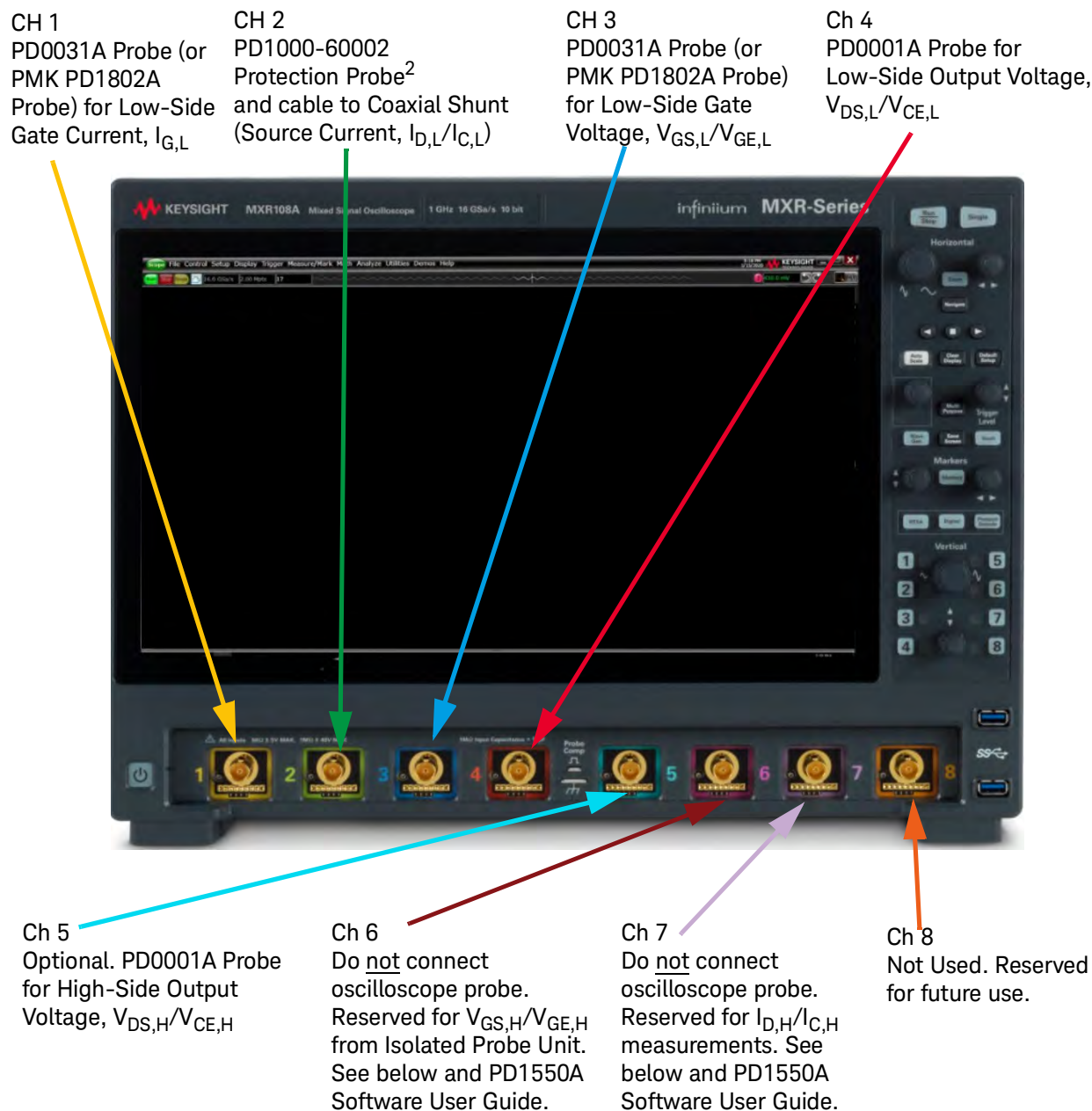


Figure 28 PD1550A Oscilloscope Probe Connections

Oscilloscope Channel	Color	Measures	Oscilloscope Probe
1	Yellow	Low-Side Gate Voltage: $V_{GS,L}/V_{GE,L}$ (LOW-SIDE VGS/VCE on Interface Module)	DP0031A Differential Probe ¹ (requires banana to BNC adapter)
2	Green	Low-Side Output Current: $I_{D,L}/I_{C,L}$ (LOW-SIDE ID/IC on Interface Module) ²	PD1000-60002 Protection Probe and cable to Coaxial Shunt ³
3	Blue	Low-Side Output Voltage: $V_{DS,L}/V_{CE,L}$ (LOW-SIDE VDS/VCE on Interface Module)	DP0031A Differential Probe ¹ (requires banana to BNC adapter)
4	Red	Low-Side Gate Current, $I_{G,L}$ (IG on Interface Module)	DP0001A High Voltage Differential Probe
5	Lt Blue	Optional. High-Side Output Voltage, $V_{DS,H}/V_{CE,H}$ (Interface Module HIGH_SIDE VDS/VCE)	DP0001A High Voltage Differential Probe
6	Dark Red	Do <u>not</u> connect oscilloscope probe. See “ Connect Probe for High-Side DUT Measurements ” below and PD1550A Software User Guide.	Reserved for $V_{GS,H}/V_{GE,H}$ from Isolated Probe Unit.
7	Purple	See “ Connect Probe for High-Side DUT Measurements ” below and PD1550A Software User Guide.	Reserved for $I_{D,H}/I_{C,H}$. See PD1550A Software User Guide.
8	Orange	Not used. Reserved for future use.	Not used. Reserved for future use.

1 Your system may have been provided with PMK PD1802A Differential Probes instead of the Keysight DP0031 probes. These probes are identical in performance.

2 Replace this cable with only the same Keysight part number. The length and type of this cable is assumed for correct Deskew.

3 Use the 0.56 N-m (5 lb-in) 5/16 in. SMA Break-over torque wrench (provided with the PD1550A system) to tighten the SMA cable connector to the PD1000-60002 Protection Probe. Failure to do so might cause extensive ringing in the DPT measurements. See appendix for details.

NOTE

The oscilloscope channels and colors shown above are recommended. You may choose different channels. All examples and screen captures shown in the DPT documentation use this configuration. The colors on the PD1000A Control Software screen match the oscilloscope probe channel number colors: i.e., Channel 1 - $V_{GS,L}/V_{GE,L}$ for Low-Side Gate Current is yellow, Channel 2 - $I_{D,L}/I_{C,L}$ for Low-Side Output Current is green, etc.

NOTE

Do not use a different cable for $I_{DS,L}$ or Isolated Probe Unit oscilloscope probes. The cables and oscilloscope probes supplied with your PD1550A provide correct probe deskew.

CAUTION

- Do not exceed maximum input voltage rating on oscilloscope.
 - The maximum input voltage for 50 Ω input impedance is ± 5 V.
 - The maximum input voltage for 1 M Ω input impedance setting is 30 V_{rms} or ± 40 V_{max} (DC + V_{peak}).
 - Probing technology allows for testing of higher voltages. No transient over voltage allowed.
-

CAUTION

When a probe, adapter, or cable is attached to the oscilloscope, the channel input circuits can be damaged by ESD. Avoid applying static discharges to anything connected to the oscilloscope. Ensure the oscilloscope is properly earth-grounded to prevent buildup of static charge. Wear a wrist strap or heel strap.

CAUTION

Loose cables can hold electrostatic charges. The free end of a cable touching a charged surface can cause oscilloscope input damage. Before connecting any cable to an oscilloscope input, short the center and outer conductors of the cable together to ground momentarily. Alternately, connect to a 50 Ω termination adapter to discharge the cables.

Connect Oscilloscope Probes to DUT Interface Module

NOTE

Important: This section and the following photographs apply only to the standard 62 mm Interface Module supplied with the PD1550A system. Your custom Interface Module may be different and require different connections.

Refer to Figure 29 below. Oscilloscope probes connect to the Test Interface Module as follows:

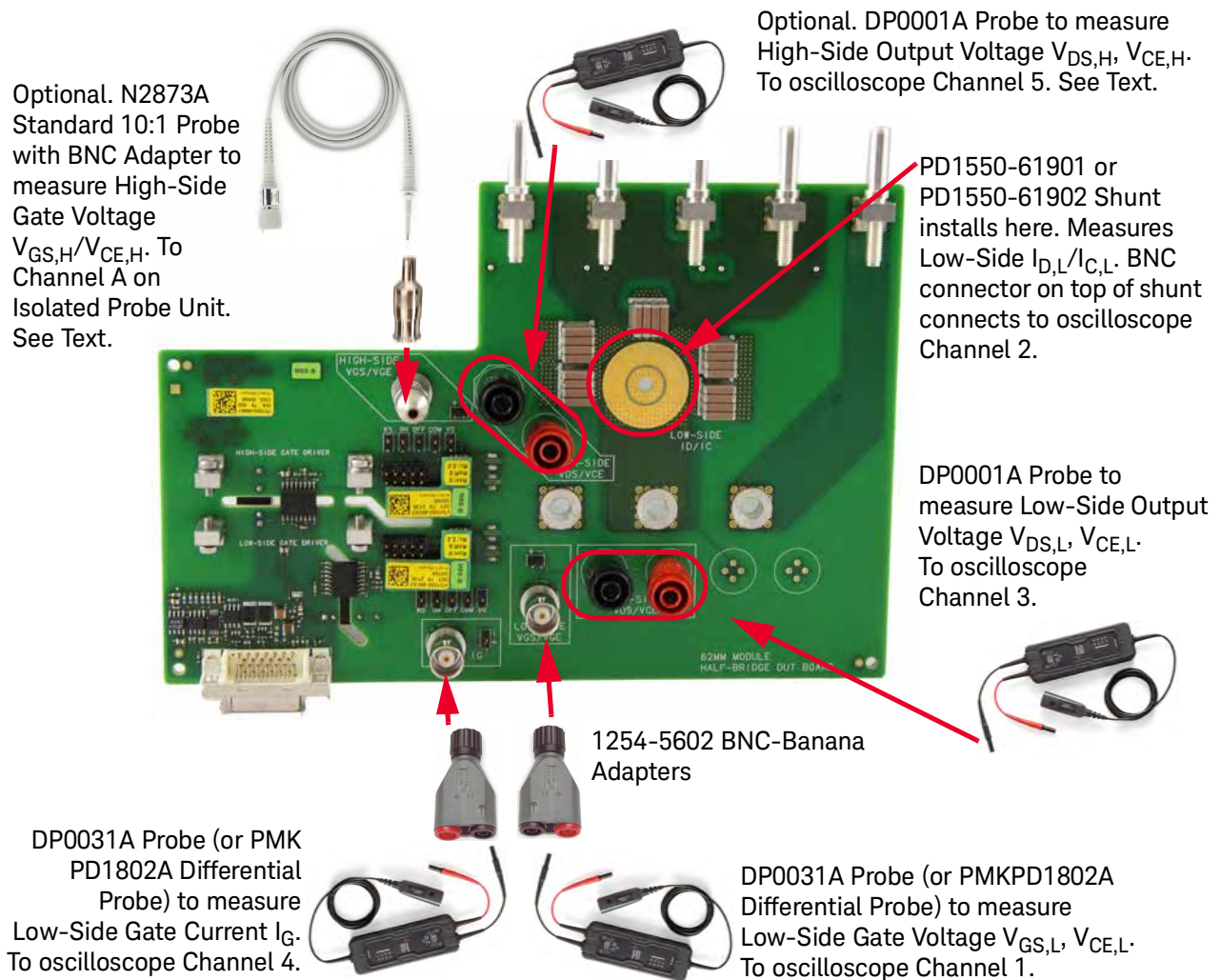


Figure 29 Oscilloscope Probe Connections to 62 mm Interface Module

NOTE: twist probe cables 2 times before connecting to Test Interface Module.

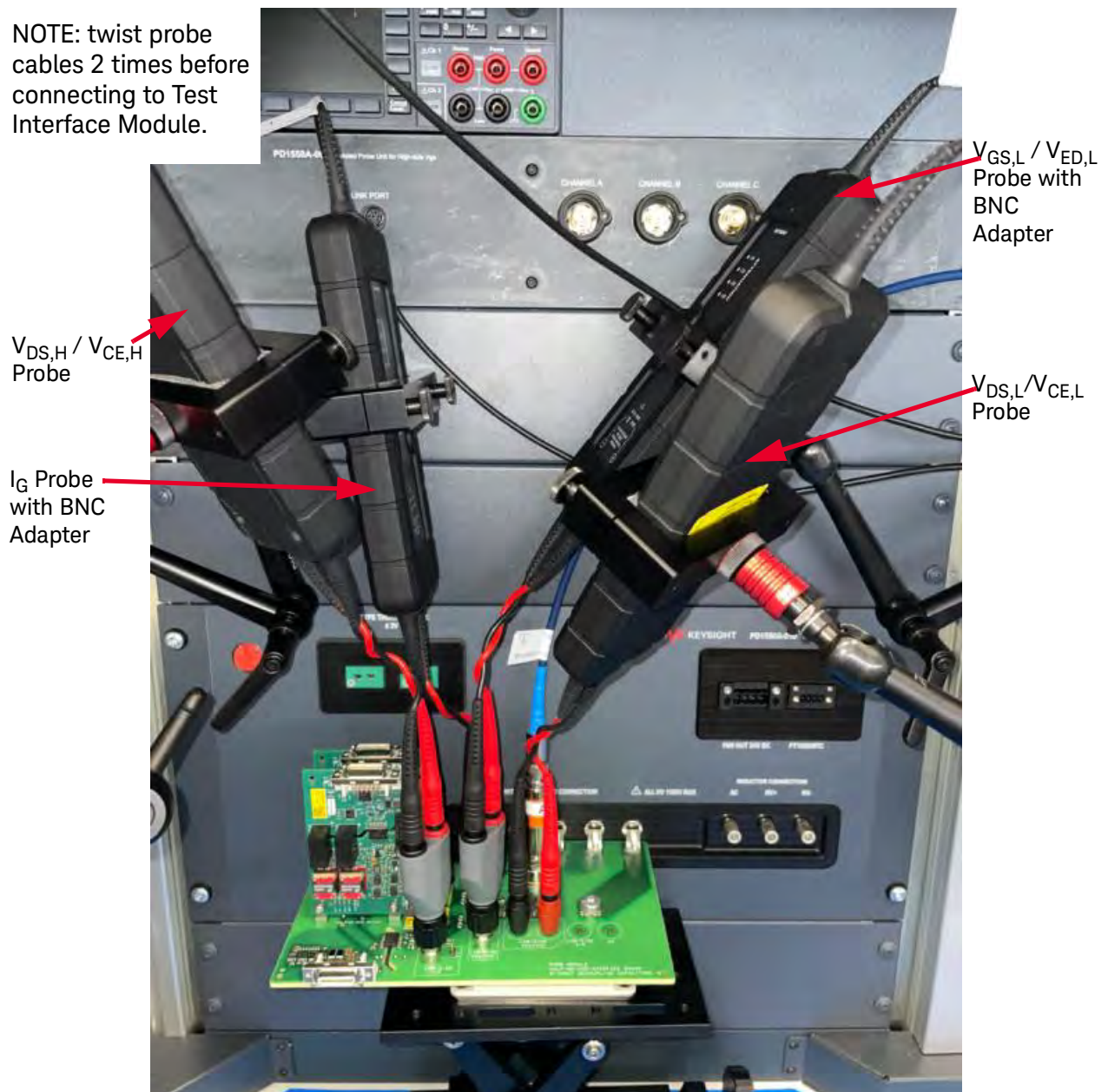


Figure 30 Connect Probes to Test Interface Module

Connect Probe for High-Side DUT Measurements

High-Side Gate Voltage

Keysight's Isolated Probe Unit is used for High-Side Gate Voltage, $V_{GS,H} / V_{GE,H}$, measurements only. Only Channel A is used at this time, the remaining channels are reserved for future use. A standard 10:1 oscilloscope probe connects the Isolated Probe Unit Channel 1 to the Keysight Interface Module.

Make certain that both **Gate Voltage $V_{GS,H}/V_{CE,H}$** and **Use Isolated Probe Unit for $V_{GS,H}/V_{CE,H}$** are selected in the **Settings > Hardware Configuration > Oscilloscope** tab are checked. Default condition is that these two are not checked.

High-Side Drain/Collector Current

For High-Side Drain or Collector current, $I_{D,H}/I_{C,H}$, measurements, a current shunt is not available for the Keysight 62 mm Interface Modules. However, for your custom Interface Modules you may design a place to install a shunt or a small Rogowski coil current probe. This should be connected to Channel 7 on the PD1550A oscilloscope.

Make certain that **Output Current $I_{D,H}/I_{C,H}$** is selected in the **Settings > Hardware Configuration > Oscilloscope** tab are checked. Default condition is that this is not checked.



Figure 31 N2873A Probe to High-Side Gate Voltage $V_{GS,H}/V_{CE,H}$ and Channel A on Isolated Probe Unit

Keysight Isolated Probe Unit

NOTE

The Link Port on the Keysight Isolated Probe Unit is not used.

All green LEDs next to individual channels should be green. There is also a green power LED and a red LED that indicates a trigger has occurred.

Apply Oscilloscope Probe Labels

A sheet of adhesive probe labels was provided with your PD1550A. For ease of reference, you can apply the probe labels to the PD0001A or PD0031A oscilloscope probes, to adapters, or anywhere to mark oscilloscope probe usage.



Figure 32 Sheet of Labels to Mark Oscilloscope Probes

Install UDI Cables

Universal Double-Pulse Interface (UDI) cables connect the PD1550A-020 Control Unit to other test units in the system. From the front panel, they connect to:

Connect from PD1550-68720 Control Unit to:

- PD1550-66840 Gate Drive Modules (both Low-Side and High-Side)
- PD1550-6686 Interface Module



Figure 33 UDI Cables Connected to Control Unit Front Panel

UDI cables may be connected to any UDI jack on the Control Unit. Typically:

- UDI Port 1 connects to the Interface Module in front of the Gate Drive Modules
- UDI Port 2 connects to the Low-Side Gate Drive Module
- UDI Port 3 connects to the High-Side Gate Drive Module

UDI jacks 4, 5, and 6 are generally not used and are reserved for future use.

NOTE

UDI jacks 7, 8, 9, 10, 11, and 12 are on the rear panel of the PD1550-020 Control Unit. UDI 11 connects to the rear of the PD1550-010 Test Fixture and UDI 12 connects to the rear of the PD1550-090 Inductor Unit. The remaining UDI jacks are not used and are reserved for possible future use.

Install Additional Test Fixture Accessories



Figure 34 PD1550A-010 Test Fixture Front Panel

External Loads

External Loads¹ (inductors) may be connected to the **AC** and **HV+** terminals on the Test Fixture front panel for Standard Double-Pulse tests

CAUTION

You must select **Inductor Selection > External** under **Output Current** in the main User Interface and specify the inductor value in the PD100A Control Software. See the PD1550A Software Guide for detailed information.

For the mating plugs, use pin connectors:

- 5 mm OD and maximum 18.5 mm long
- Keysight part number: 0363-0370
- Manufacturer (ODU²) Part Number: 181.212.000.301.000



The External Load sockets on the test fixture are rated for:

- Nominal Current: 90 A
- Continuous Current 155 A
- Surge Current 12 kA

¹ External resistive loads are not supported for this release of software.

² www.ODU.de

Range of External Inductors

The control software has limits that provide for a large range of inductors. Minimum is 1 μH ; maximum is 1000000 μH . You need to decide what first pulse length is appropriate for your DUT. Note that self heating and voltage drop in the capacitor bank's high range and switching speed limits the low range.

NTC Thermistor Connector

Negative Temperature Coefficient (NTC) thermistors are built-in to some power modules. Because of minimal self heating, the NTC thermistor remains at almost the same temperature as the power module die and is assumed to be close to the DUT heat sink temperature.

NOTE

Because of the slow response time of thermistors, they are not suitable to detect rapid changes in device temperature. An NTC thermistor cannot be used for short circuit or over current protection.

NOTE

For early releases of the PD1000A Control Software for the PD1550A, this jack and the device temperature are not used.

The PD1550A system uses an analog approach to measuring the temperature with the thermistor.

Reading the temperature(s) in the PD1000A Control Software

Select **NTC_Resistor** from the **Settings > Hardware Configuration > Fixture > Temp. Ref. Meas. Device** drop down menu. The device temperature measured from the thermistor is not displayed in the User Interface.

How to select the Thermistor resistance value

Select the value of the NTC Thermistor from the drop-down box. For early releases of the PD1000A Control Software for the PD1550A, this feature is not used.

Cable Requirements for the PT1000NTC Thermistor

Keysight does not provide a cable for the PTC1000NTC Thermistor for PD1000A Control Software version .



Figure 35 NTC Connector on Front of Test Fixture

Fan Out 24 VDC

An external fan is not available for PD1550A Initial Shipments.

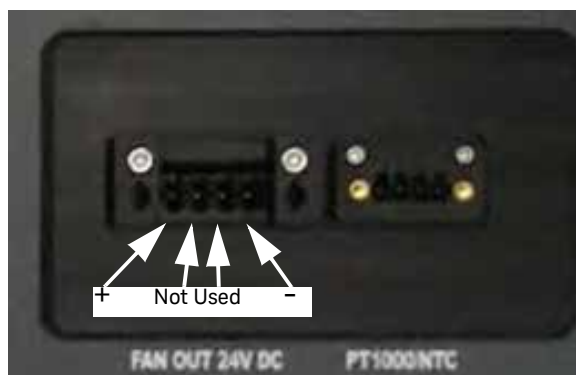


Figure 36 24 V DC Fan Out Connector on Test Fixture Front

NOTE

For early release versions of the PD1000A Control Software for the PD1550A, this jack is not supported.

Type K Thermocouples, CH1 and CH2

Two type K thermocouples may be attached to the DUT for monitoring the temperature during tests. How you create the thermocouples and attach them to the DUT is up to you. The following information provides some general guidelines.

Thermocouples are used to measure the surface temperature of devices. Be very careful, results obtained can be very different from actual test conditions if the thermocouples are not handled correctly.



Figure 37 Type K Thermocouple Jacks on Test Fixture Front

NOTE

For early release versions of the PD1000A Control Software for the PD1550A, these jacks and the device temperature are not supported.

Preparing the Thermocouple

The simplest method of preparing a thermocouple is to simply twist the wires together several times. However, the temperature is measured at the first point of contact with the device. The remaining section of the twisted pair becomes unnecessary and may be cut off. This could result in compromising the contact of the thermocouple wires resulting in unstable temperatures.

The best method is to spot weld the two thermocouple leads together.

Method of Securing the Thermocouple to a device

The easiest method is to tape the thermocouple to the device with polyimide (Kapton) tape. This allows easily securing and removing the thermocouple. However, this method also allows the tape and thermocouple to lift off the device during a test. The tape can also interfere with the heat radiation pattern.

A better method is to use a minimum amount of epoxy adhesive to secure the thermocouple to the DUT. The epoxy adhesive is not likely to peel off during the test and requires a much smaller area to secure the thermocouple to the DUT. This minimizes the effects on the measurements. Note that the epoxy must not get between the thermocouple and the DUT; the thermocouple must remain in direct contact with the DUT.

Recommendations for using a Thermocouple

- Use the shortest wire possible to minimize interference and noise.

For additional Thermocouple information, refer to the Keysight Application Note titled, "Practical *Temperature Measurements*".

Reading the temperature(s) in the PD1000A Control Software

Select either **Thermocouple1** or **Thermocouple2** from the **Settings > Hardware Configuration > Fixture > Temp. Ref. Meas. Device** drop down menu.

Install Optional InTEST Temperature Controller with Heating Plate

IMPORTANT: InTEST (Sigma Systems) Thermal Solutions¹ are not available from Keysight and must be purchased directly from InTEST Thermal Solutions.

Two pieces of equipment are required: the (Watlow) Heater Control Unit and a heating plate. Select from the list below and order directly from InTEST. The Controller and Heating plate are for heating the Device Under Test (DUT) only, it does not provide cooling. When running a series or loop of tests, remember that it takes a long time for the heating plate to cool down

InTEST (Sigma Systems) Part Number	Description
1.001.520-Controller EZ Zone	Heater Control unit only, no heater plate
1.001.561-HP61	Small Plate only (no controller), 6.9 cm x 8.9 cm ¹
1.001.486-HP168	Medium Plate only (no controller), 18.2cm x 9.2 cm ¹
1.001.562-HP448	Large Plate only, (no controller) 28 cm x 16 cm ¹
XHP61PMKEY01	Includes Heater Control unit and small plate
XHP168PMKEY01	Includes Heater Control unit and medium plate
XHP448PMKEY01	Includes Heater Control unit and large plate

¹ Size of heating plate alone, not the entire enclosure.



Figure 38 InTEST (Watlow) Controller Unit in Rack Panel and Heating Plate

¹ See <https://www.intestthermal.com/home>. Select **Product Brands**, then **Sigma Systems**, then **Platforms / Plates**.

NOTE

The Controller Unit comes prewired with the Failsafe switch and heating plate connector. For detailed display information for the Controller Unit, refer to the Watlow EZ-Zone User's Guide provided with the controller.

Install the InTEST Control Unit in the PD1550A Rack

- 1 Turn off the PD1550A system and unplug it from the ac source.
- 2 With a #2 Phillips screwdriver, remove the rack filler panel immediately under the PD1550A-010 Test Fixture.
- 3 Install the Control Unit Rack Panel just below the PD1550-010 Test Fixture.
- 4 With the set of rack keys provided with your PD1550A system, open both back doors on the rack.
- 5 With the supplied power cord, connect the Control Unit to the multiple outlet power distribution unit inside the PD1550A rack. Route the power cord down through the left slot on the rack surface.
- 6 With the supplied LAN cable, connect the Ethernet port on the Heater Controller to any port on the Ethernet Switch Number 2 in the PD1550A rack. Route the power cord down through the right slot on the rack surface.

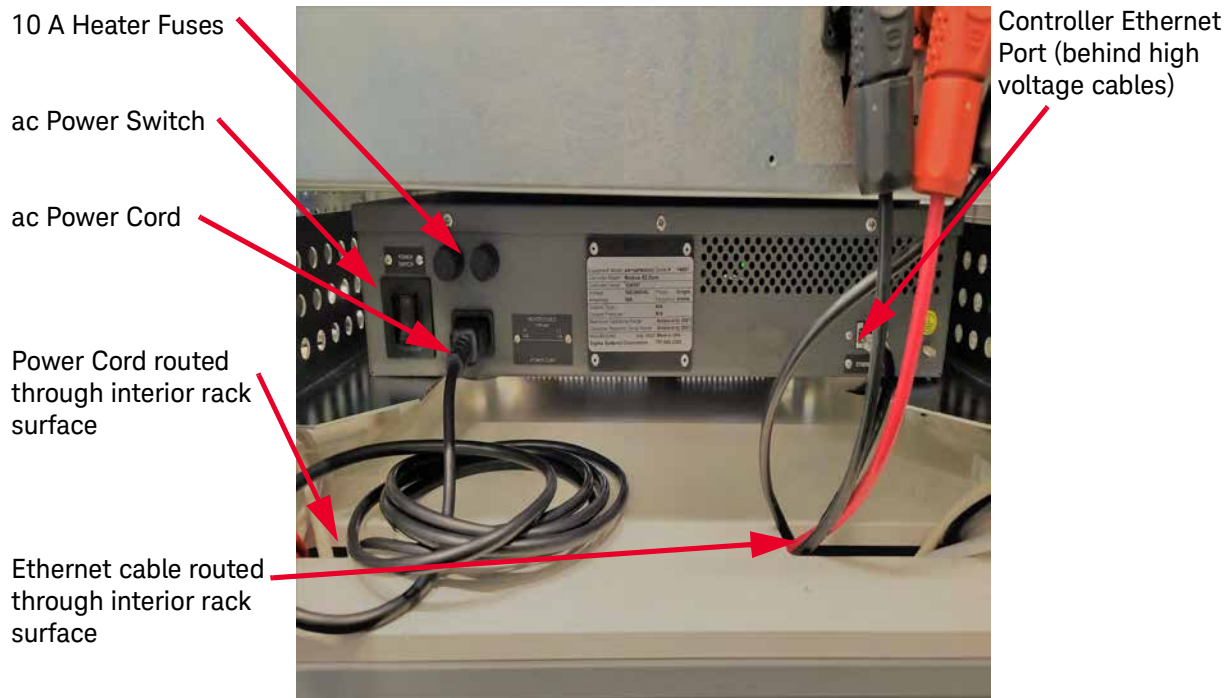


Figure 39 Rear Panel of the Heater Controller

NOTE

The PD1000 A Control Software manages initial setup and all communication with the Heater Control unit. The Watlow software is not used and may be discarded.

Refer to the Watlow EZ-ZONE Software Operators Guide to understand the controller display and messages.

- 7 Turn the Watlow EZ-ZONE control unit on. The switch is on the rear panel of the unit.
- 8 Close and lock the rear doors on the PD1550A rack.
- 9 Connect the heating plate to the multi-pin connector on the front of the control unit rack mount panel.
- 10 Place the heating plate on top of the lift table but under the DUT module.

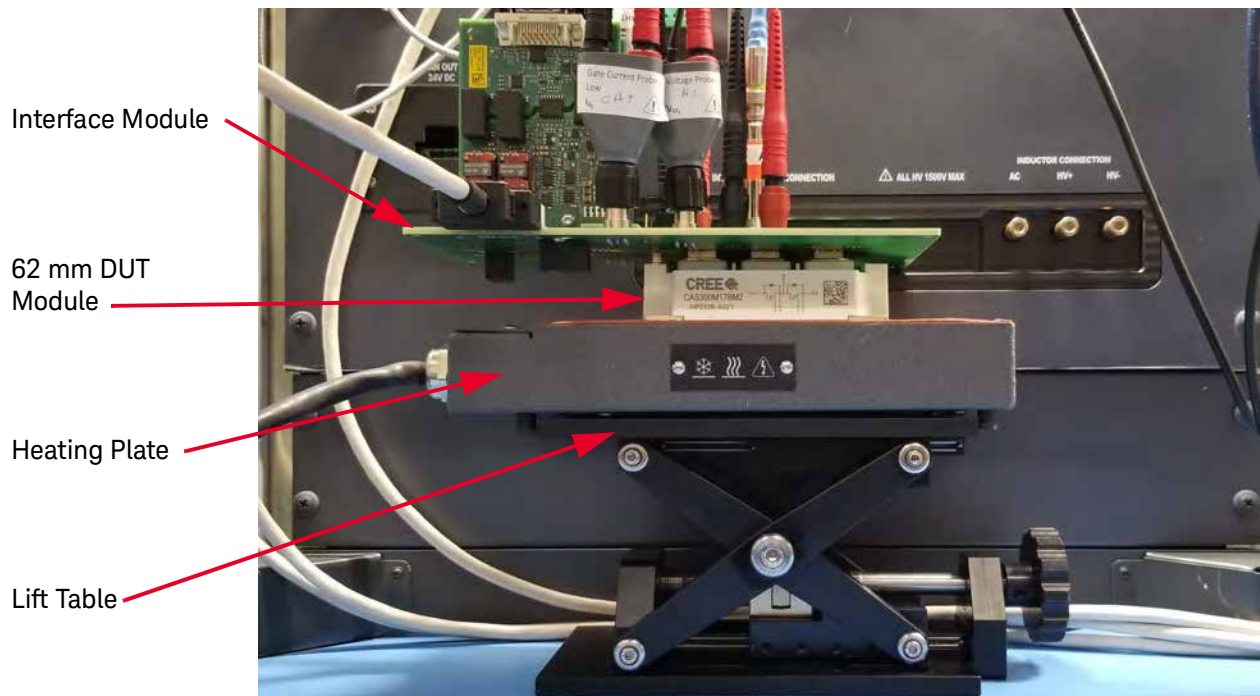


Figure 40 Heating Plate on the Lift Table Supporting the DUT Module.

- 11 Adjust the Lift Table to support the weight of the Heating Plate, the DUT module, and the Interface module.
- 12 Plug in the PD1550A system and turn it on. Press the **Reset** button on the front of the PD1550A system. The Watlow Control Unit should turn on. See Figure 41 on page 84.
- 13 Specify the desired test temperature and Temperature Control Settings in the PD1000A Control Software -- **NOT** on the Watlow EZ-Zone Controller.

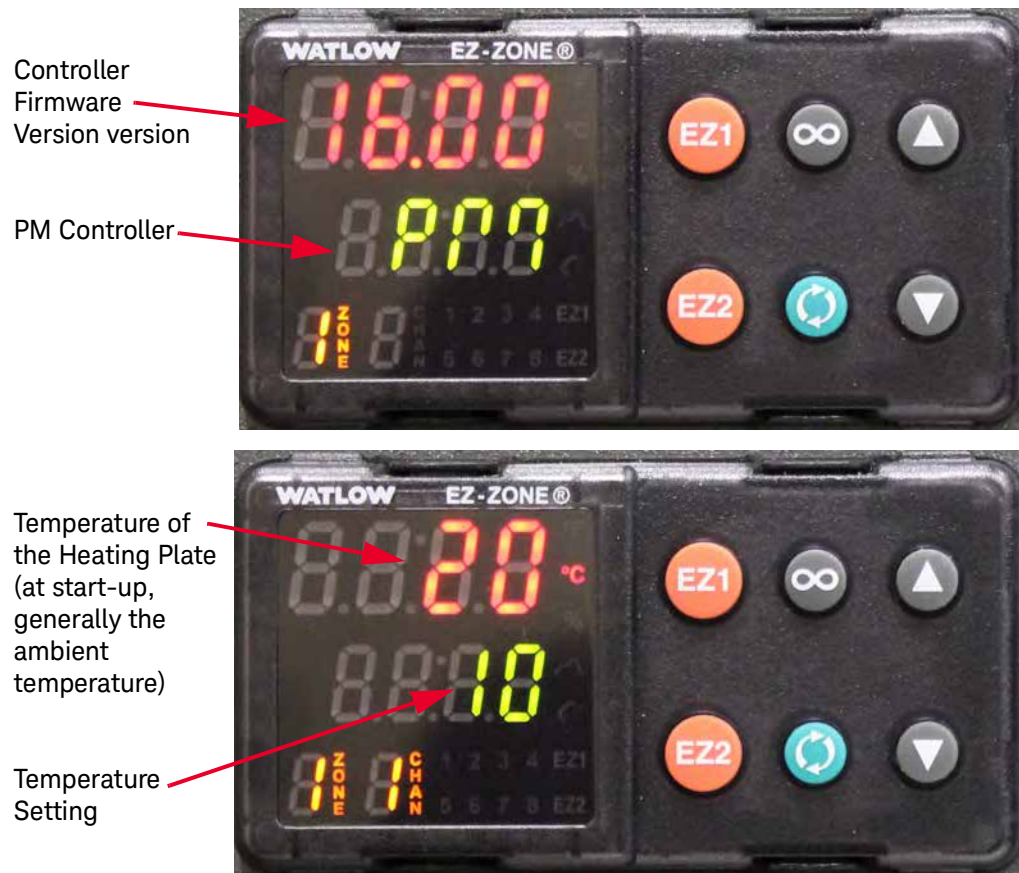


Figure 41 Watlow Controller Turn-on Sequence

NOTE

Set the test temperature(s) in the PD1000A Control Software. Do **Not** use the Watlow EZ-ZONE to set test temperatures, set points, alarms, etc.

Install Optional InTEST - Temptronic Thermostream Heater/Cooler System

IMPORTANT: InTEST Thermal Solutions are not available from Keysight and must be purchased directly from InTEST Thermal Solutions.

Only newer Thermostream units with the “Digital Thermal Sensing” feature may be used, older ones do not have the necessary digital interface.

Specific supported Thermostream units are:

- ATS-710-M
- ATS-730-M
- ATS-750-M
- ATS-770-M
- ECO-710-M

Because of the energy used in the PD1550A, Keysight does not allow any connection between the DUT and anything outside of the safety enclosure. In the following graphic, connections such as “Thermocouple A” or “Thermocouple B” are not allowed. To monitor the DUT temperature, the PD1550A uses a thermocouple connected to the Test Fixture. Temperature information is sent to the Thermostream through an isolated RS-232 connection.

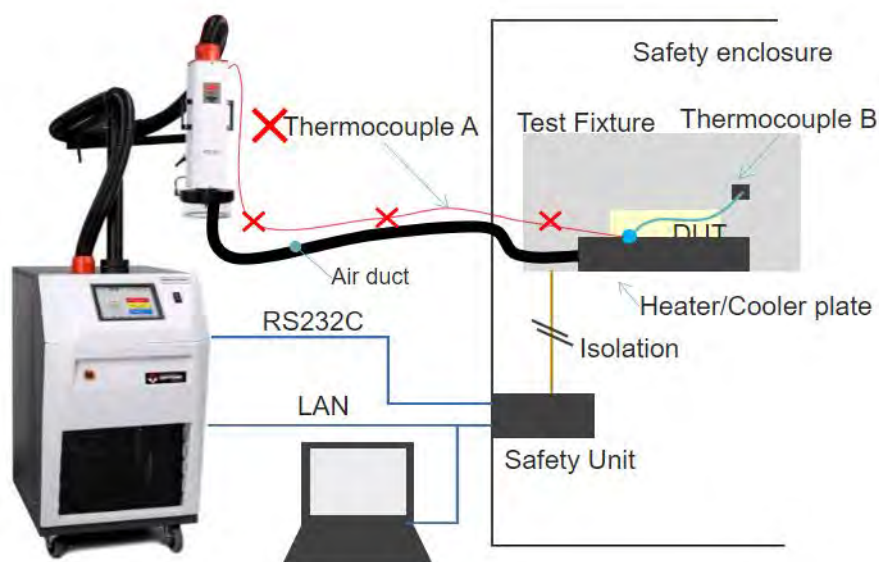


Figure 42

InTEST technicians will install their Thermostream unit on the left side of the PD1550A rack. They remove a left-side panel from the PD1550A rack and install a new side panel. The new, replacement side panel has an exhaust vent. Installation requires a LAN cable and an RS-232 cable (both supplied by InTEST) that connect to the PD1550A rack.

CAUTION

Do not obstruct the exhaust.

NOTE

It is not possible to avoid ice on heating/cooling plate. Additional dry air is not sufficient to avoid the frost or ice buildup on the plate. However, there should not be frost or ice buildup on the Interface Module or DUT module.

Thermostream Electrical Connections to the PD1550A Rack

Connect the Thermostream RS-232 and LAN cables to the left side of the PD1550A rack.



Figure 43 Thermostream RS-232 and LAN Connection on PD1550A Rack

Thermostream Compressed Air Requirements

For sustained low temperature operation and testing, clean dry air (CDA) must be provided¹:

- Filtered to 5 micron particulate contamination
- Oil content: <0.1 ppm by weight, filtered to 0.01 micron oil contaminant
- Dewpoint: <10 °C @ 6.2 BAR (90 PSI)
- Air supply pressure: 6.2 to 7.6 BAR 90 to 110 PSIG)
- Total airflow Rate Required: 7.1 to 14.2 l/s (15 - 30 scfm)
11.8 l/s (25 scfm) nominal
- Air Supply Temperature: + 20 °C to +25 °C; 22 °C Nominal

¹ These specifications are from the InTEST ATS-710-M and ECO-710-M Data Sheets. Different models may have different requirements. Refer to the InTEST model documentation for specific requirements.

4 Turn-on and Software Installation

After installing the Rack and Safety Enclosure, you need to Install and configure the PD1000A Control Software and then verify the installation:

In this Chapter:

- Step 1: Connect LAN and Power Cable to Rack [page 90](#)
- Step 2: Install System Software on Host PC [page 92](#)
 - Install IO Libraries Suite on Host PC [page 92](#)
 - Download PD1000A System Control Software [page 92](#)
 - Set AC Line Frequency and Date/Time on the B2902A [page 94](#)
- Step 3: Obtain and Install Coaxial Shunt Resistor De-Embedding File [page 95](#)
 - Obtain the Shunt De-embedding file [page 95](#)
 - Install the De-Embedding Transfer File on the Oscilloscope [page 97](#)

Step 1: Connect LAN and Power Cable to Rack

Before powering the system on, connect a LAN cable from the host computer to the side of the DPT Rack and Safety Enclosure. Connect the AC power cord to the rack.

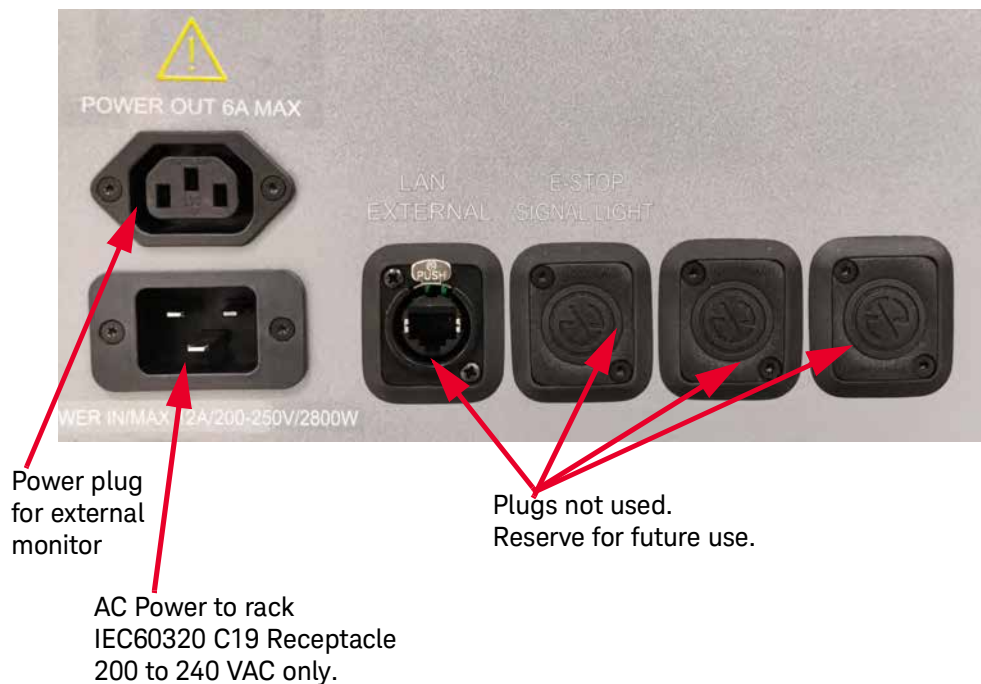


Figure 1 Right side of DPT Rack showing LAN and Power Connections

Double-Pulse Test System Turn-On and Turn-Off

With all of the test instruments and test fixture installed in the rack, it is time to turn on the system.

- 1 Connect the AC Power cable to the AC Jack on the side panel of the DPT Rack and Safety Enclosure.
- 2 Plug the other end of the cable in an appropriate AC outlet. See “Connect the Rack and Safety Enclosure to AC Mains” on page 20.
- 3 Ensure the **Emergency Stop** button is pulled out.
- 4 Turn the large round knob on the DPT Rack and Safety Enclosure to the left (horizontal position) to power on the system. The fans start but test instruments do not turn on. See the figure below.
- 5 Press the **Reset** button. Test instruments turn on. You should hear a few clicks as the safety relays energize. The system is now operational.
- 6 If the individual test instruments are not already turned on, turn them on now.

Turning the System Off

To shut down the test system, turn the power switch to the left (so that it is horizontal).

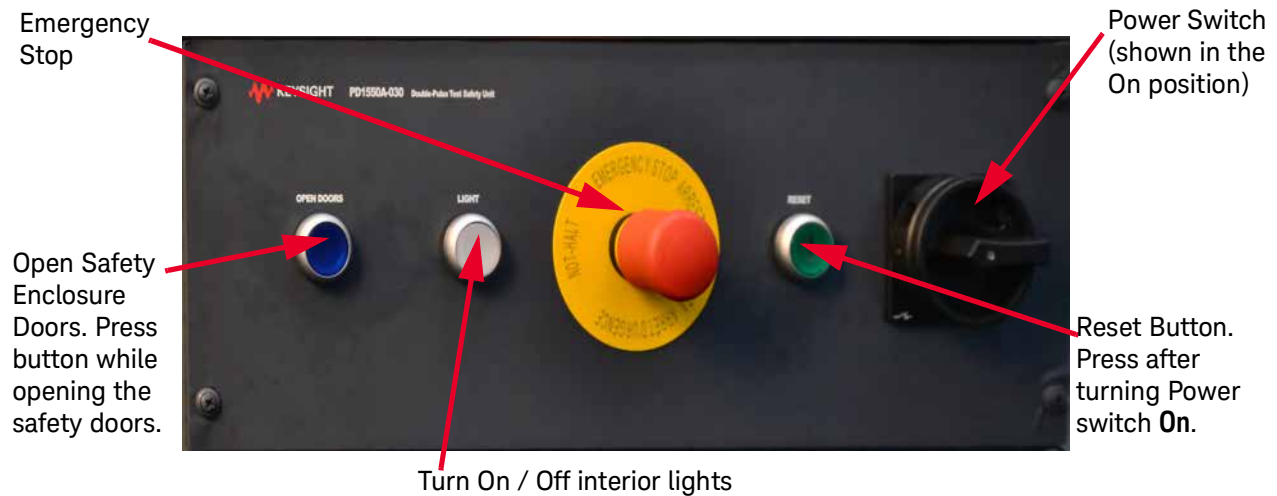


Figure 2 PD1550A-030 Safety Unit
(Power switch shown in the On position)

Light Tower on top of Rack

Green Light -- High voltage is off. It is safe to open the safety doors.

Amber Light -- Emergency Shut-down button has been pushed. Pull the **Emergency Off** button out and press the **RESET** button. Safety doors are locked.

Red Light -- Safety doors are locked and cannot be opened. High Voltage may be present. Safety doors are locked.

Blue Light -- Indicates a test is running. Safety doors are locked.

Emergency Off Functionality

The **Emergency Stop** button functionality works in two steps:

- When pressed, it interrupts the interlock of the high voltage source and unlocks the safety switch. If the Safety Doors are closed, It keeps the enclosure locked. After about 1 second the high voltage source shuts off by interrupting the main power line.
- To reset, pull out to release the **Emergency Off** button. Reset the Emergency Off circuit by pressing the **Quit** button.

Step 2: Install System Software on Host PC

To communicate with the PD1000A test equipment, Keysight I/O Libraries Suite must also be installed on your host computer. IO Libraries Suite is a collection of libraries and utilities that enable you to connect your instruments to the host computer and run programs on the computer that interact with the instruments. The IO Libraries Suite is used with all Keysight instruments

Install IO Libraries Suite on Host PC

Download the latest version from: www.keysight.com/find/iosuite. Always install IO Libraries Suite before installing any instrument driver or software. Use the latest version of the IO Libraries Suite.

NOTE

IO Libraries Suite Connection Expert may not find the B1506A until Easy EXPERT is running. Run EasyEXPERT before using Connection Expert.

Download PD1000A System Control Software

The PD1000A System Control Software may be downloaded from Keysight at any time. Download the software from the following website:

www.keysight.com/find/PD1000A

or

www.keysight.com/find/PD1550A

Set Oscilloscope VISA Address

To obtain the oscilloscope's IP Address:

- 1 Touch or click the **Utilities** soft key at the top of the oscilloscope display.
- 2 Touch or click the **Remote...** soft key. This opens the **Remote Setup** screen.

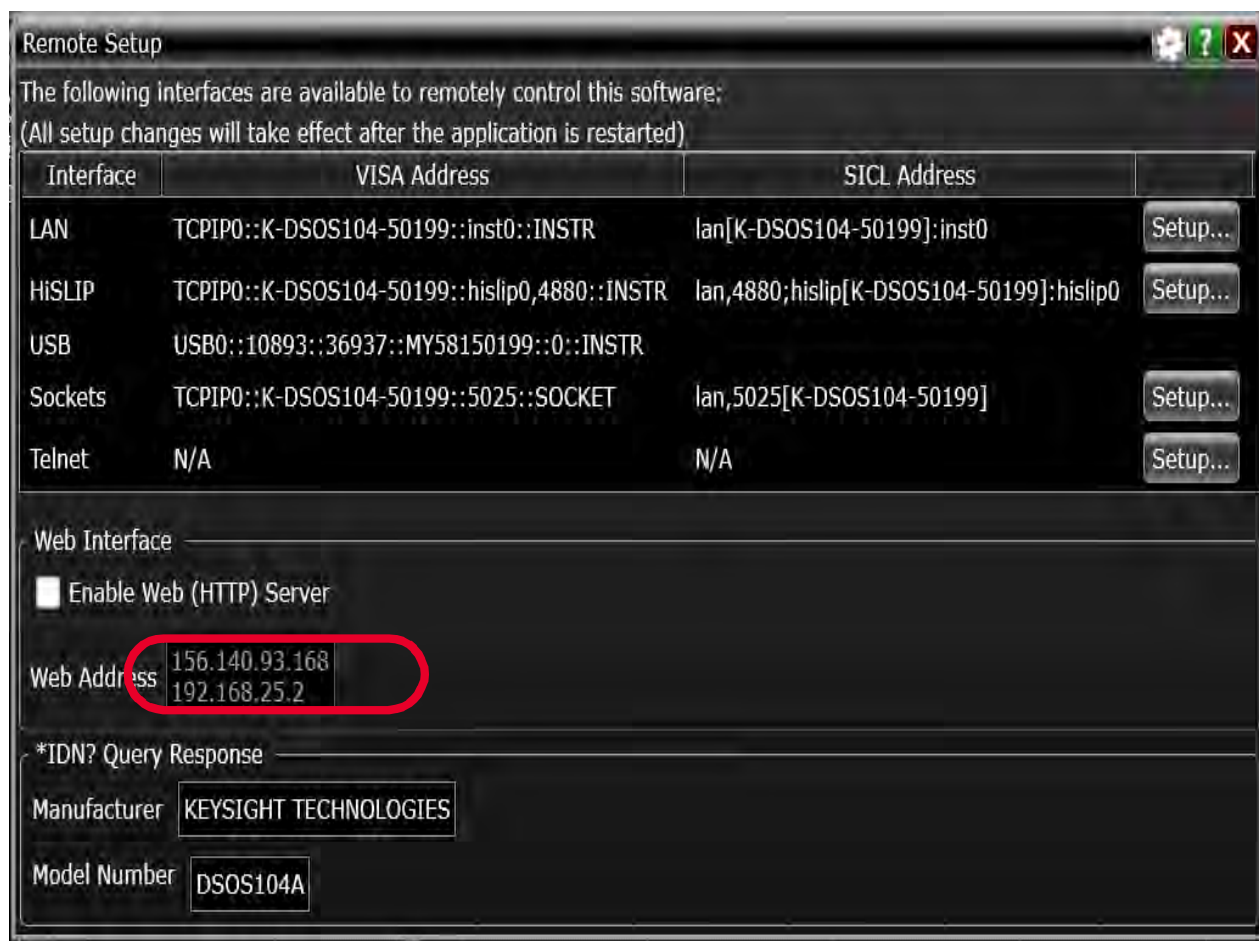


Figure 3 Remote Setup -- Web Interface

- 3 Locate the **Web Interface** field. In the example above, the correct web address to use is **156.140.93.168** for the Oscilloscope IP Address. This is the Oscilloscope IP address that you will use in the PD1000A Control Software **Settings > Hardware Configuration > DPT System Selection**. Do **NOT** use the 192.168.25.2 address.

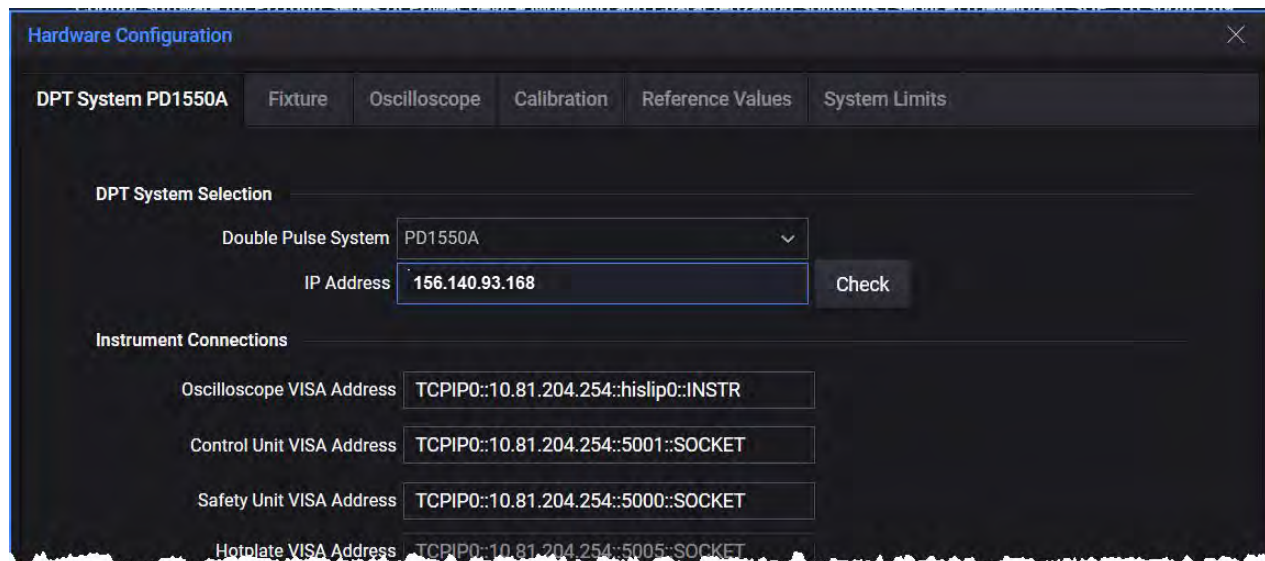


Figure 4 Oscilloscope IP Address in the **Settings > Hardware Configuration > DPT System Selection**.

For additional information, refer to the PD1550A Control Software Guide.

Set AC Line Frequency and Date/Time on the B2902A

The Keysight B2902A Source Measure Unit (SMU) is used only for the system calibration. Its factory default line frequency is set to 50 Hz and must be changed to 60 Hz in those countries with a 60 Hz line frequency. To change the line frequency from the instrument front panel, press the following keys:

- For setting to 50 Hz: **More > System > PLC > 50 Hz**
- For setting to 60 Hz: **More > System > PLC > 60 Hz**

Optional: To set the Date and Time press the following:

More > System > More > Info > Date/Time

More about IP Addresses and Dot Notation

Dot-notation addresses ("*nnn.nnn.nnn.nnn*" where "*nnn*" is a byte value from 0 to 255) must be expressed with care, as most PC web software interprets byte values with leading zeros as octal (base 8) numbers. For example, "192.168.020.011" is actually equivalent to decimal "192.168.16.9" because ".020" is interpreted as "16" expressed in octal, and ".011" as "9". To avoid confusion, use only decimal values from 0 to 255, with no leading zeros.

Step 3: Obtain and Install Coaxial Shunt Resistor De-Embedding File

For maximum DPT accuracy, the Coaxial Shunt Resistor's De-embedding File (also known as a Transfer File) must be installed in the oscilloscope. Recharacterization of the Coaxial Shunt should be performed annually and the updated De-embedding file installed in the oscilloscope. The Coaxial Shunt Resistor's De-Embedding file has to do with maximizing the Shunt Resistor's bandwidth and requires configuration on the oscilloscope.

Annual Characterization of the Coaxial Shunt

The Keysight PD1000-61901 Coaxial Shunt requires annual characterization; return the Shunt to a Keysight Sales and Service Office for characterization. A list of offices is available at: www.keysight.com/find/assist

After the shunt is characterized, Keysight will return the shunt to you. This provides the latest characterization .tf2 file. Download the file from the *Keysight Infoline* website and install it in the oscilloscope.

Obtain the Shunt De-embedding file

Whether the initial installation or installation of the de-embedding file after characterizing the shunt, the process is the same:

- 1 Locate the Coaxial Shunt Resistor Serial Number located on the side of the shunt resistor housing. The shunt's product number is: PD1000-61901¹ or PD1000-61902.
- 2 Go to Keysight Support Portal:
<https://support.keysight.com/s/service-and-warranty-status>.
- 3 Enter the shunt's product (model) number (PD1000-61901 or PD1000-61902) and its serial number (for example, MY58400001). Click **Search**.
- 4 Select **Calibration Documents** tab.
- 5 Select the Certificate Number (for example, PD1000-61901MY58400001)
- 6 Click the appropriate service document file, for example: **PD1000-61901MY58400001.zip**. It is a simple ASCII text file with a .tf2 file extension. This file contains the de-embedding information for the Coaxial Shunt Resistor with the specified serial number. The file name includes the shunt's serial number, for example: MY58400001.tf2.

¹ PD1000-61901 or PD1000-61902 are the Keysight part numbers for the shunt. If you need to order additional shunts, order Keysight part number PD1500-61901AU-SH1 or PD1500-61901AU-SH2. This includes a characterized shunt, mounting bushing, serial number, and installation instructions.

Install the De-Embedding Transfer File on the Oscilloscope

NOTE

For new PD1550A systems, the de-embedding file was installed in the oscilloscope at the factory with the file name:

MY5840xxxx.tf2

where xxx is the serial number labeled on the shunt itself.

- 1 From the temporary location where you unzipped the de-embedding file, copy the .tf2 file to the MXR108A Oscilloscope. Place it in the folder: **C:\Users\Public\Documents\Infiniium\Filters**.

NOTE

On the oscilloscope, the file path will show as:

C:\Users\Public\Public Documents\Infiniium\Filters. However, this is an alias path. Use the path: *C:\Users\Public\Documents\Infiniium\Filters* in the Shunt Settings De-embedding File path in the Control Software.

- 2 In the PD1000A Control Software, type the complete path and .tf2 file name into the **Double-Pulse Measurement Control > Settings > Instrument Configuration > De-embedding File** field. Refer to the *PD1550A Control Software Guide* for additional information.

NOTE

The oscilloscope channel you specify for the **Output Current** I_D/I_C in the *DPT Control Software Hardware Configuration* screen is the channel that the Coaxial Shunt De-embedding is applied to. Refer to the *PD1500A Control Software Guide* for detailed information.

5 PD1550A System Calibration- AutoCal

In this chapter:

Initiate Calibration & Compensation Procedures	page 101
1 Oscilloscope Probe Offset Compensation	page 102
PD1550A System Calibration (AutoCal)	page 106
2 Low-Side Gate Voltage Source Calibration -- $V_{GS,L}$ Output	page 108
3 Low-Side Common Resistor Calibration -- $R_{COM,L}$	page 109
4 Low-Side Gate Resistance Calibration -- $R_{GON,L}$	page 110
5 Low-Side Gate Resistance Calibration -- $R_{GOFF,L}$	page 111
6 High-Side Gate Voltage Source Calibration -- $V_{GS,H}$ Output	page 112
7 High-Side Common Resistor Calibration -- $R_{COM,H}$	page 113
8 High-Side Gate Resistance Calibration -- $R_{GON,H}$	page 114
9 High-Side Gate Resistance Calibration -- $R_{GOFF,H}$	page 115
10 Calibration Complete	page 116
Coaxial Shunt Resistor Characterization	page 117

NOTE

IMPORTANT: The calibration procedures in this chapter are for the Si/SiC DUT Interface Modules, Gate Drive modules, Gate Drive Resistor modules, and probes.

There are several calibration-related procedures that should be performed regularly. These procedures should be performed anytime the ambient temperature changes ± 5 °C, anytime the oscilloscope probes or anything in the test system are changed.

- **Oscilloscope Probe Compensation**
- **PD1550A System Calibration**
- **Coaxial Shunt Resistor Characterization & De-embedding.** Characterization should be performed annually. A De-embedding file will be available on Keysight InfoLine and should be installed in the oscilloscope immediately after characterization.

Additionally, a **Full Calibration** (also known as **Service Calibration**) is required annually for the oscilloscope, 33512B Waveform Generator, B2902A Precision Source/Measure Unit, and Heinzinger EVO Power Supply test instruments.

Initiate Calibration & Compensation Procedures

From the PD1000A Control Software, select the **Double-Pulse Test Control** tab. From the **Settings** drop-down menu, select **Calibration & Compensation**. Carefully follow all instructions.

The software reads the EEPROMS on the Gate Drive and Gate Drive Resistor Modules.

Refer to the PD1000 Control Software Online help file for additional calibration information.

If everything is installed, click the **Continue** button to start the calibration.



Figure 7 Instruction to Perform Oscilloscope Probe Compensation

The following PD1550A system calibration (AutoCal) steps are provided:

- 1 Oscilloscope Probe Offset Compensation page 102
- 2 Low-Side Gate Voltage Source Calibration -- $V_{GS,L}$
Output page 108
- 3 Low-Side Common Resistor Calibration -- $R_{COM,L}$ page 109
- 4 Low-Side Gate Resistance Calibration -- $R_{GON,L}$ page 110
- 5 Low-Side Gate Resistance Calibration -- $R_{GOFF,L}$ page 111
- 6 High-Side Gate Voltage Source Calibration -- $V_{GS,H}$
Output page 112
- 7 High-Side Common Resistor Calibration -- $R_{COM,H}$ page 113
- 8 High-Side Gate Resistance Calibration -- $R_{GON,H}$ page 114
- 9 High-Side Gate Resistance Calibration -- $R_{GOFF,H}$ page 115
- 10 Calibration Complete page 116

1 Oscilloscope Probe Offset Compensation

As the first step calibrating the Double-Pulse Test system, the oscilloscope probes must be adjusted for low frequency compensation. For this, the N2873A passive probes have built-in compensation RC divider networks. The Keysight N2873A probe is used only with the Isolated Probe Unit.

NOTE

Allow the oscilloscope and probes to warm up at ambient temperature for a minimum of 60 minutes (1 hour) before performing the adjustment.

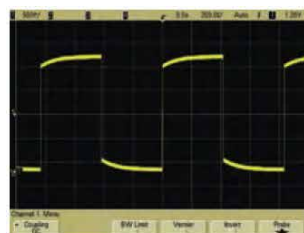
Required Equipment

- Spring hook and ground clips for passive oscilloscope probes.
- Low Frequency Compensation trimmer/adjustment tools (small non-metallic screwdriver).

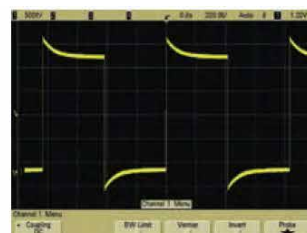
Low Frequency Compensation for the N2873A Probe

Keysight Infiniium oscilloscopes have a square wave reference signal available on the front panel to use for compensating the passive probes. Attach the spring hook and ground clip to the probe and then to the square wave terminals.

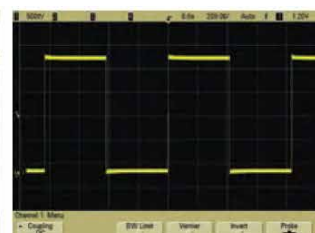
- 1 Refer to the [N2873A Probe User Guide](#) for instructions. A general description and procedure can also be found on page 5 (Hint #3) of the [Keysight 8 Hints for Better Scope Probing](#).
- 2 Connect the probe to the oscilloscope's front-panel square wave terminals.
- 3 Use the supplied trimmer tool to adjust the Low Frequency compensation to an optimum square wave response as shown below.
- 4 Adjust so that the square wave on the oscilloscope screen looks square.



Under Compensated



Over Compensated



Optimum

DP0001A Settings in the Oscilloscope User Interface

After making hardware connections, perform the following steps in the Infiniium oscilloscope software GUI to configure probe settings such as attenuation ratio and DC offset and gain calibration. These settings are required to get accurate measurement results.

Setting the Attenuation Mode

The probe supports four attenuation modes. An Infiniium oscilloscope automatically switches the attenuation mode for the probe to the value necessary to make the dynamic range of the probe greater than or equal to the level required to measure the current input signal.

The automatic switching of probe's attenuation also helps in preventing the overvoltage condition on the probe.

The Attenuation Setting LED on the probe indicates the currently set attenuation. You can also view the currently set attenuation in the Infiniium GUI's Probe Configuration dialog box as displayed below.

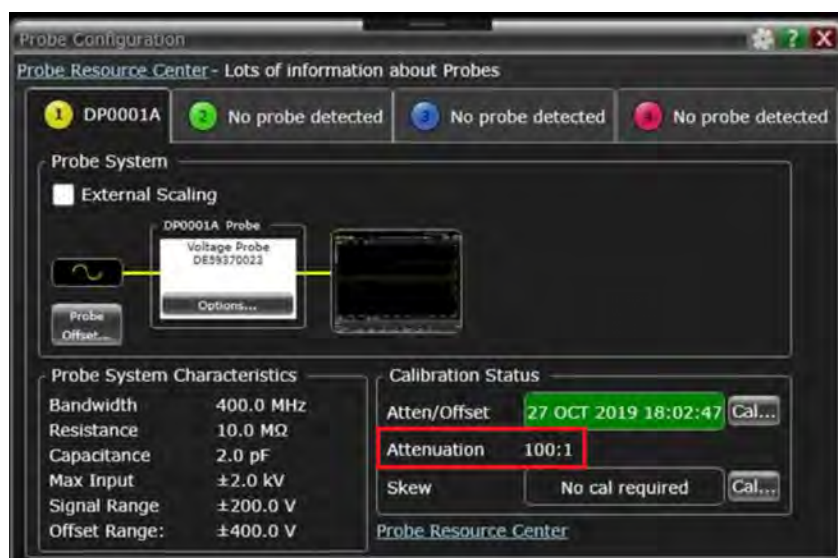
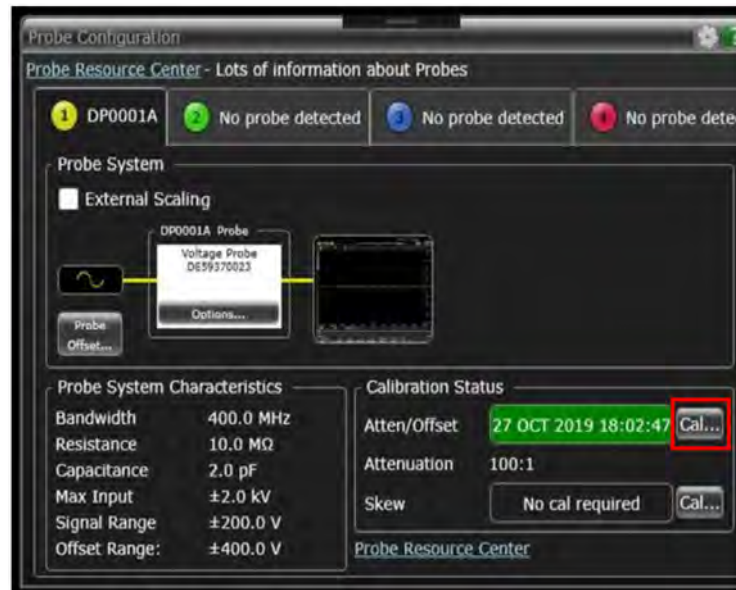


Figure 8 Setting PD0001A Probe Attenuation

Performing DC Offset and Gain Calibration

Probe gain (or attenuation ratio) correction adjusts the oscilloscope's scaling factors of the signal displayed on screen to properly match the correct DC values. Perform the DC offset and gain calibration to remove any DP0001A offset errors. The most common correction method for probes is the DC adjustment, which entails the adjustment of probe gain and probe offset.

- 1 In the **Probe Configuration** dialog box, click the **Cal...** button next to **Atten/Offset**.



The **Probe Calibration** dialog box displays:



- 2 Ensure that the probe is connected to the oscilloscope as illustrated in the **DC Offset/Gain Cal** dialog box.
- 3 Click the **Start Cal...** button to initiate calibration.
- 4 Follow the instructions displayed on the Infiniium GUI screens.

DP0031A Settings in the Oscilloscope User Interface

Not available, to be developed

PD1550A System Calibration (AutoCal)

Calibration requires the B2902 Precision Source/Measure Unit (SMU) and the following cables:

	Qty. 2 Black Test Patch Lead, 0.64 mm Square Pin Socket to 4 mm Stackable Banana Plug, 1 M.
	Qty. 2 Red Test Patch Lead, 0.64 mm Square Pin Socket to 4 mm Stackable Banana Plug, 1 M.

Requirements

- Perform the Oscilloscope Probe Offset Compensation first.
- Remove the DUT module from the Interface Module before calibration.

CAUTION

The DUT module must be removed before beginning System Calibration. The DUT module may be damaged if not removed.

- Remove both High-Side and Low-Side Gate Drive modules. Depending on the calibration step, you will be instructed to re-install either the Low-Side or the High-Side Gate Drive module.
- Install both High-Side and Low-Side Gate Resistor Modules that you want calibrated on the Interface module.
- The rack and Safety Enclosure doors may be left open for calibration.

NOTE

All test instruments must be warmed up for at least 60 minutes at ambient temperature before starting the calibration procedure. Failure to allow warm up may result in inaccurate calibration.

NOTE

IMPORTANT: The following descriptions and illustrations show the Keysight PD1550-66560 or PD1550-66561 Interface Modules. With customization for different DUTs, your Interface Module will be different. The basic instructions still apply.

NOTE

The Interface Module may remain unplugged from the Test Fixture for these calibration procedures.

CAUTION

Follow all on-screen instructions. Damage to the Test Module is possible if instructions are not followed.

Schematic for Gate Resistor Modules

The following schematic shows the calibration terminals on the Gate Resistor modules.

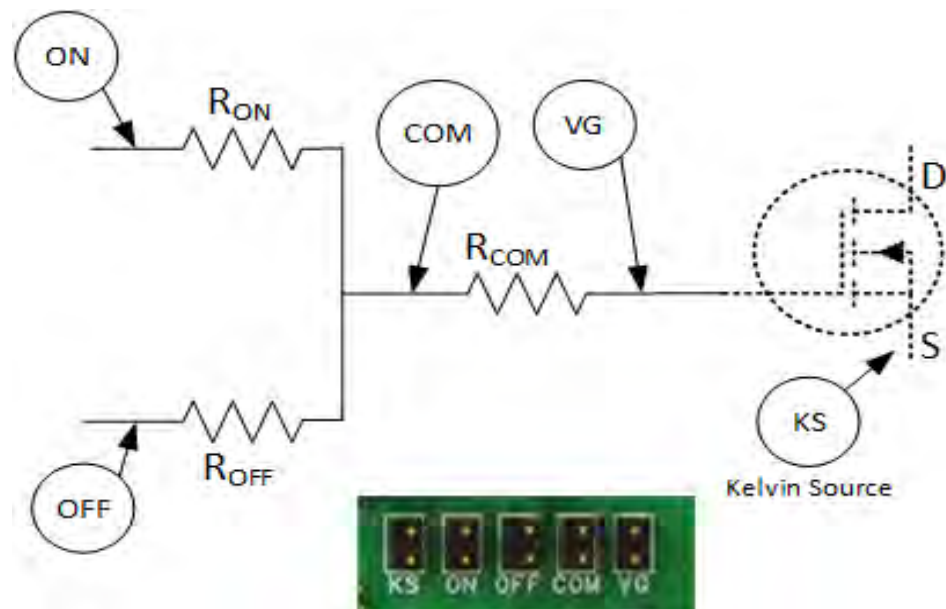


Figure 9

2 Low-Side Gate Voltage Source Calibration -- $V_{GS,L}$ Output

Calibrates voltage gain and offset for the Low-Side Gate Drive.

Hardware Setup:

- Remove the DUT module from the Interface Module before calibration.
- Install the Low-Side Gate Drive Module on the Interface Module.
- Install a low value resistance Low-Side Gate Resistance module (for example, $2.2\ \Omega$).
- Install UDI cables on the Low-Side Gate Drive Module and Interface Module.
- Use a red calibration cable to connect the SMU red Force terminal to either of the **VG** pins on the Low-Side of the Interface Module.
- Use a black calibration cable to connect the SMU black Force terminal to either of the **KS** pins on the Low-Side of the Interface Module.

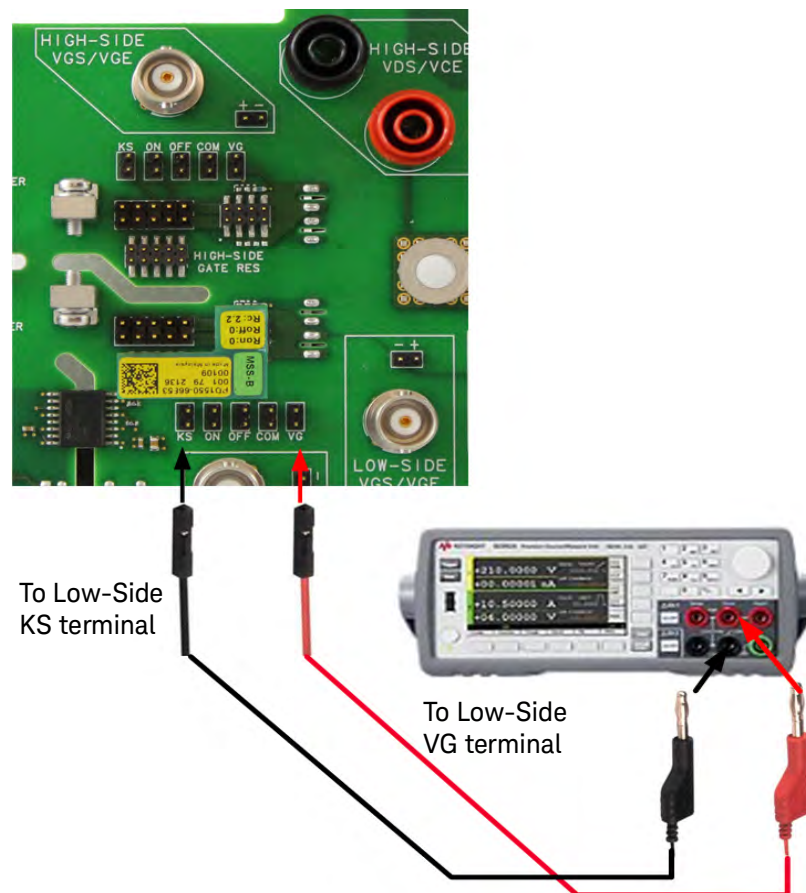


Figure 10 Low-Side Gate Voltage Source Calibration Connections

Procedure: Click **Start** to perform the calibration and continue to next step.

3 Low-Side Common Resistor Calibration -- $R_{COM,L}$

Hardware Setup:

- Remove the DUT module from the Interface Module before calibration.
- Remove the Low-Side Gate Drive Module from the Interface Module.
- Install the Low-Side Gate Resistor Module that you want calibrated.
- Install a UDI cable on the Interface Module.
- Use two sets of calibration cables for a four-wire resistance measurement as follows:
 - Red cable from SMU Force to Low-Side **COM** terminal.
 - Red cable from SMU Sense to Low-Side **COM** terminal.
 - Black cable from SMU Force to Low-Side **VG** terminal.
 - Black cable from SMU Sense to Low-Side **VG** terminal.

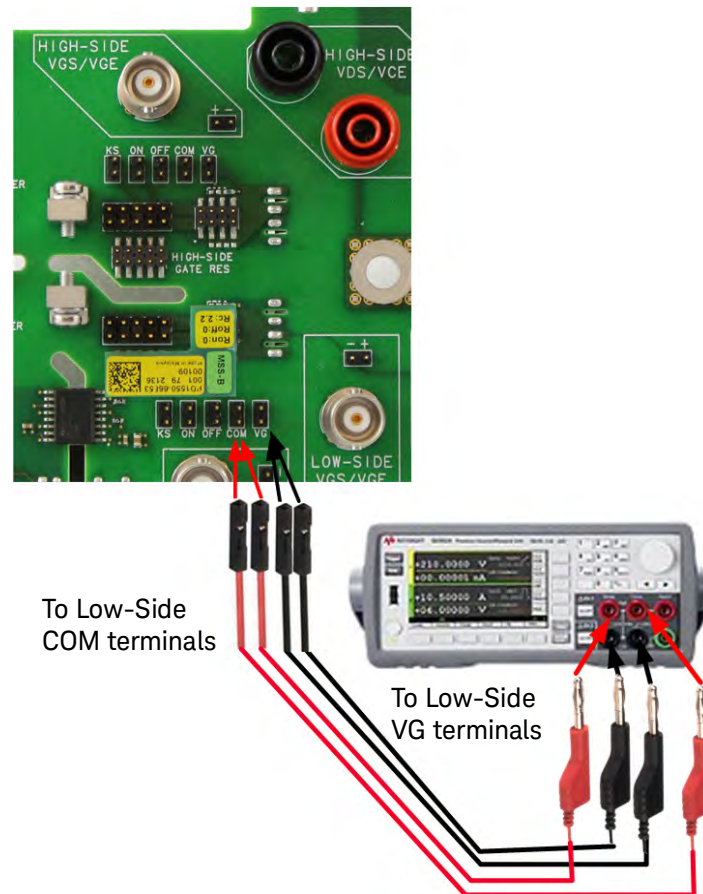


Figure 11 Low-Side R_{COM} Calibration Connections

Procedure: Click **Start** to perform the calibration and continue to next step.

4 Low-Side Gate Resistance Calibration -- $R_{GON,L}$

NOTE

IMPORTANT: Perform this calibration step only after performing:
3 Low-Side Common Resistor Calibration -- $R_{COM,L}$

Hardware Setup:

- Remove the DUT module from the Interface Module before calibration.
- Remove both High-Side and Low-Side Gate Drive Modules from the Interface Module.
- Install the Low-Side Gate Resistor Module that you want calibrated.
- Install UDI cables on the Low-Side Gate Drive Module and Interface Module.
- Use two sets of calibration cables for a four-wire resistance measurement :
 - Red cable from SMU Force to Low-Side **ON** terminal.
 - Red cable from SMU Sense to Low-Side **ON** terminal.
 - Black cable from SMU Force to Low-Side **VG** terminal.
 - Black cable from SMU Sense to Low-Side **VG** terminal.

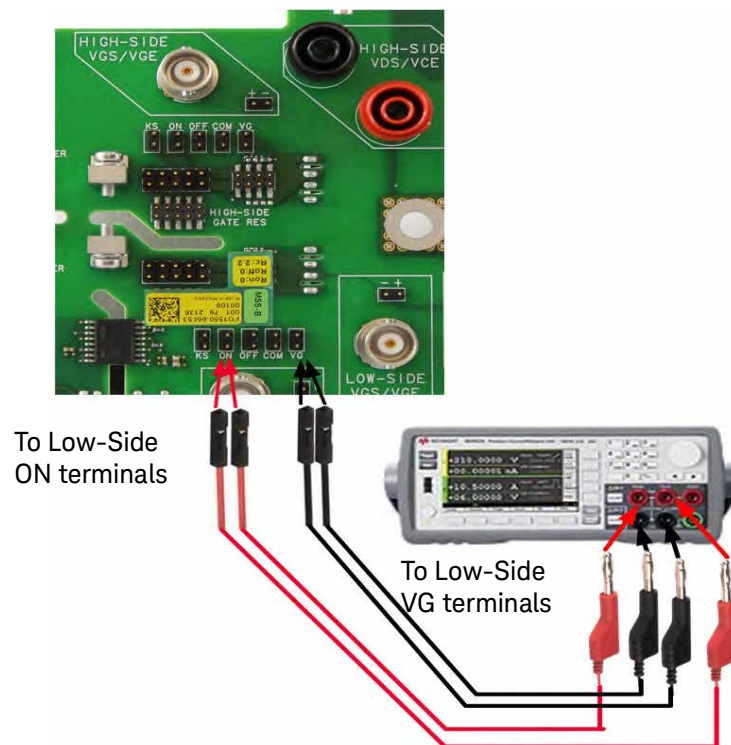


Figure 12 Low-Side $R_{G,ON}$ Calibration Connections

Procedure: Click **Start** to perform the calibration and continue to next step.

5 Low-Side Gate Resistance Calibration -- $R_{G,OFF,L}$ **NOTE**

IMPORTANT: Perform this calibration step only after performing:
3 Low-Side Common Resistor Calibration -- $R_{COM,L}$

Hardware Setup:

- Remove the DUT module from the Interface Module before calibration.
- Remove both High-Side and Low-Side Gate Drive Modules from the Interface Module.
- Install the Low-Side Gate Resistor Module that you want calibrated.
- Install UDI cables on the Low-Side Gate Drive Module and Interface Module.
- Use two sets of calibration cables for a four-wire resistance measurement:
 - Red cable from SMU Force to Low-Side **OFF** terminal.
 - Red cable from SMU Sense to Low-Side **OFF** terminal.
 - Black cable from SMU Force to Low-Side **VG** terminal.
 - Black cable from SMU Sense to Low-Side **VG** terminal.

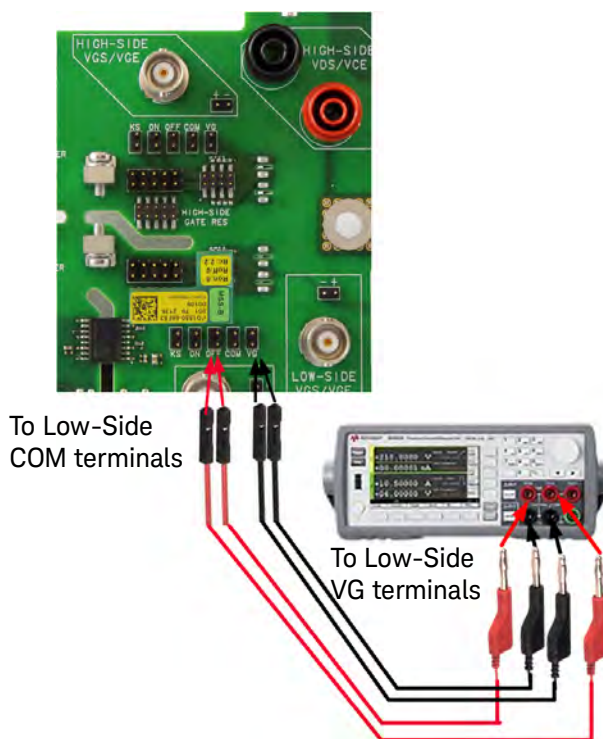


Figure 13 Low-Side $R_{G,OFF}$ Calibration Connections

Procedure: Click **Start** to perform the calibration and continue to next step.

6 High-Side Gate Voltage Source Calibration -- $V_{GS,H}$ Output

Calibrates voltage gain and offset for the High-Side Gate Drive.

Hardware Setup:

- Remove the DUT module from the Interface Module before calibration.
- Install the High-Side Gate Drive Module.
- Install a High-Side Gate Resistance Module with a low resistance (for example, $2.2\ \Omega$).
- Install UDI cables on the Low-Side Gate Drive Module and Interface Module.
- Use a red calibration cable to connect the SMU red Force terminal to either of the **VG** pins on the High-Side of the Interface Module.
- Use a black calibration cable to connect the SMU black Force terminal to either of the **KS** pins on the High-Side of the Interface Module.

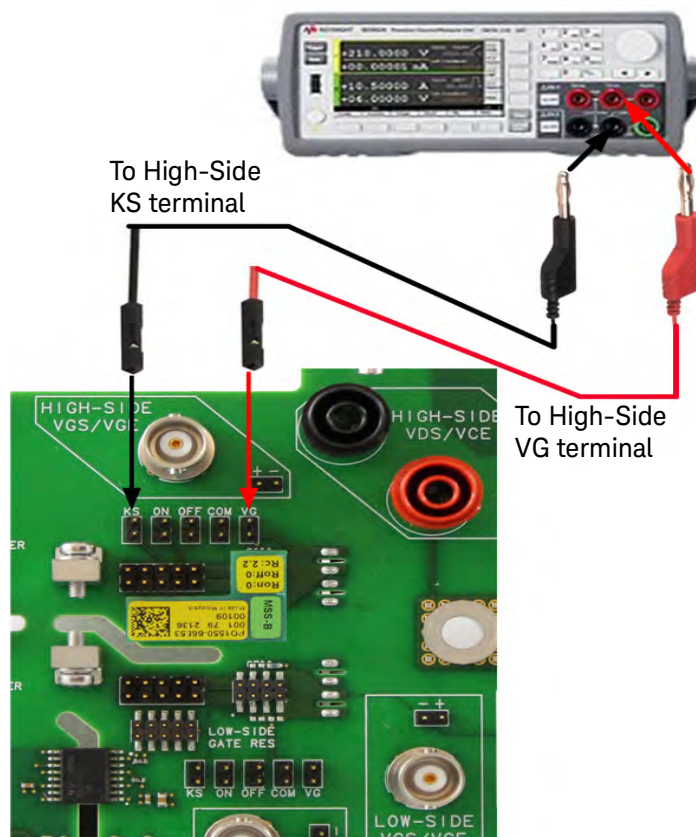


Figure 14 High-Side Gate Voltage Source Calibration Connections

Procedure: Click **Start** to perform the calibration and continue to next step.

7 High-Side Common Resistor Calibration -- $R_{COM,H}$

Hardware Setup:

- Remove the DUT module from the Interface Module before calibration.
- Remove the High-Side Gate Drive Module from the Interface Module.
- Install the High-Side Gate Resistor Module that you want calibrated.
- Install a UDI cable on the Interface Module.
- Use two sets of calibration cables for a four-wire resistance measurement as follows:
 - Red cable from SMU Force to High-Side **COM** terminal.
 - Red cable from SMU Sense to High-Side **COM** terminal.
 - Black cable from SMU Force to High-Side **VG** terminal.
 - Black cable from SMU Sense to High-Side **VG** terminal.

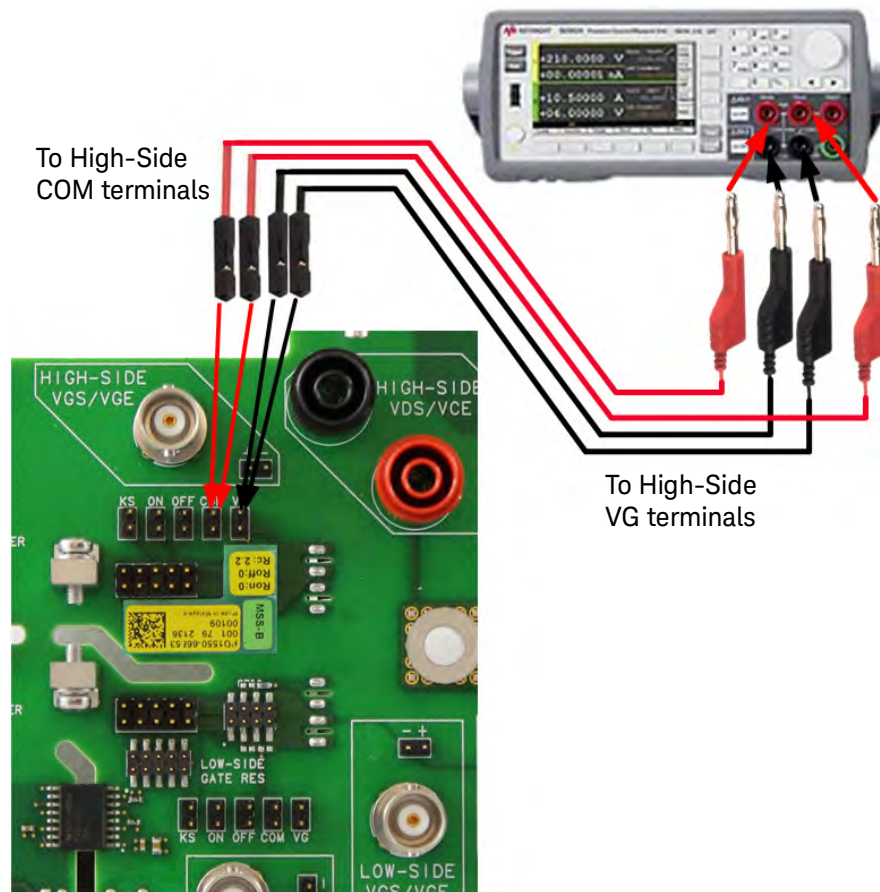


Figure 15 High-Side R_{COM} Calibration Connections

Procedure: Click **Start** to perform the calibration and continue to next step.

8 High-Side Gate Resistance Calibration -- $R_{GON,H}$

NOTE

IMPORTANT: Perform this calibration step only after performing:
7 High-Side Common Resistor Calibration -- $R_{COM,H}$

Hardware Setup:

- Remove the DUT module from the Interface Module before calibration.
- Remove both High-Side and Low-Side Gate Drive Modules from the Interface Module.
- Install the High-Side Gate Resistor Module that you want calibrated.
- Install UDI cables on the Low-Side Gate Drive Module and Interface Module.
- Use two sets of calibration cables for a four-wire resistance measurement:
 - Red cable from SMU Force to High-Side **ON** terminal.
 - Red cable from SMU Sense to High-Side **ON** terminal.
 - Black cable from SMU Force to High-Side **VG** terminal.
 - Black cable from SMU Sense to High-Side **VG** terminal.

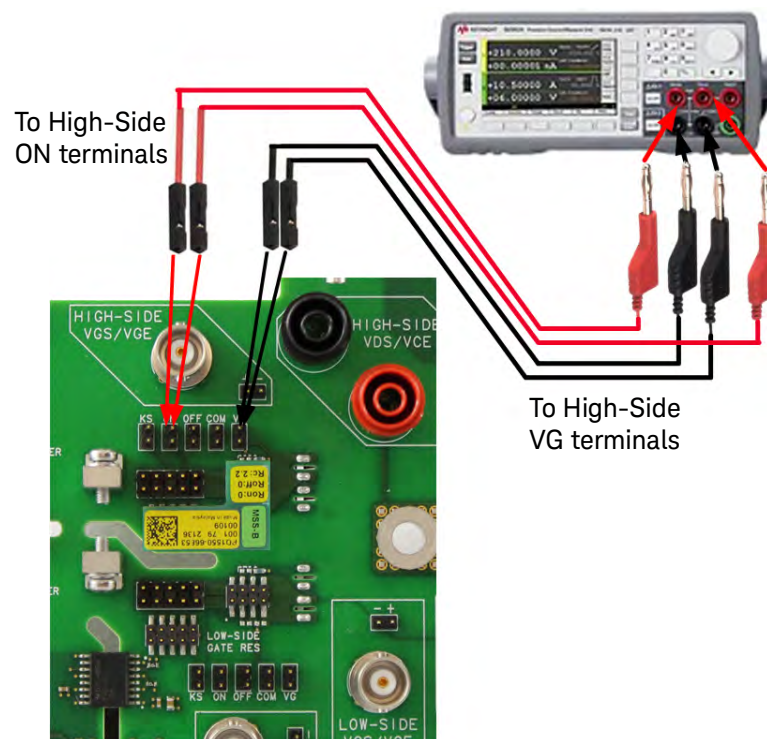


Figure 16 High-Side $R_{G,ON}$ Calibration Connections

Procedure: Click **Start** to perform the calibration and continue to next step.

9 High-Side Gate Resistance Calibration -- $R_{G,OFF,H}$ **NOTE**

IMPORTANT: Perform this calibration step only after performing:
7 High-Side Common Resistor Calibration -- $R_{COM,H}$

Hardware Setup:

- Remove the DUT module from the Interface Module before calibration.
- Remove both High-Side and Low-Side Gate Drive Modules from the Interface Module.
- Install the High-Side Gate Resistor Module that you want calibrated.
- Install UDI cables on the Low-Side Gate Drive Module and Interface Module.
- Use two sets of calibration cables for a four-wire resistance measurement:
 - Red cable from SMU Force to High-Side **OFF** terminal.
 - Red cable from SMU Sense to High-Side **OFF** terminal.
 - Black cable from SMU Force to High-Side **VG** terminal.
 - Black cable from SMU Sense to High-Side **VG** terminal.

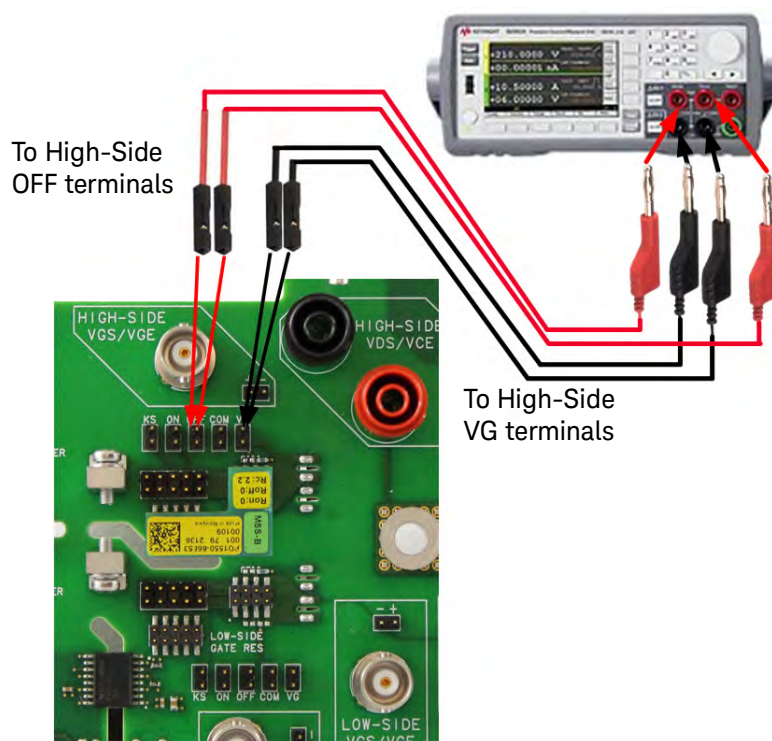


Figure 17 High-Side $R_{G,OFF}$ Calibration Connections

Procedure: Click **Start** to perform the calibration and continue to next step.

10 Calibration Complete

Click **Exit** to complete the **Calibration & Compensation** process.

After Calibration, remove all test cables from the Interface Module and reconnect all oscilloscope probes to the Interface Module.

Coaxial Shunt Resistor Characterization

There is no separate calibration for the PD1550-61901 50 m Ω and the PD1550-61902 5 m Ω Coaxial Shunt Resistors. The De-embedding characterization file installed in the Oscilloscope provides the necessary accuracy.

NOTE

The PD1550-61901 and PD1550-61902 Coaxial Shunts should be removed from the DUT Test Module and shipped to a Keysight Service Center for characterization. This should be done annually.

This creates the latest characterization .tf2 file. After the shunt is characterized, Keysight returns the shunt to you. Download the file from the [Keysight Service Portal](#) website and install it in the oscilloscope.

Install the De-Embedding Transfer File on the Oscilloscope

- 1 From the temporary location where you unzipped the de-embedding file, copy the .tf2 file to the Oscilloscope. Place it in the folder:
C:\Users\Public\Documents\Infiniium\Filters.

NOTE

On the Oscilloscope, the file path will show as:
C:\Users\Public\Public Documents\Infiniium\Filters. However, this is an alias path. Use the path: *C:\Users\Public\Documents\Infiniium\Filters* in the Shunt Settings De-embedding File path in the Control Software.

- 2 In the PD1000A Control Software, type the .tf2 file name into the **Double-Pulse Measurement Control > Settings > Instrument Configuration > De-embedding File** field. For new PD1550A systems, the de-embedding file was installed in the oscilloscope at the factory with the file name:
MY5840xxxx.tf2

where xxxx is the serial number labeled on the shunt itself.

NOTE

The oscilloscope channel you specify for the **Output Current I_D/I_C** in the DPT Control Software Hardware Configuration screen is the channel that the Coaxial Shunt De-embedding is applied to.

A Selecting Gate Drive Resistors

Figure 18 below shows a basic N-channel FET drive circuit. R_G is the external Gate Drive Resistor. Its value affects the switching speed and therefore switching loss of the FET. The drive voltage (V_G) must be sufficiently larger than the FET's threshold voltage (V_{TH}) to turn on the FET and sufficiently low enough to fully turn off the FET. The gate drive must have capability to sufficiently charge the FET input capacitance.

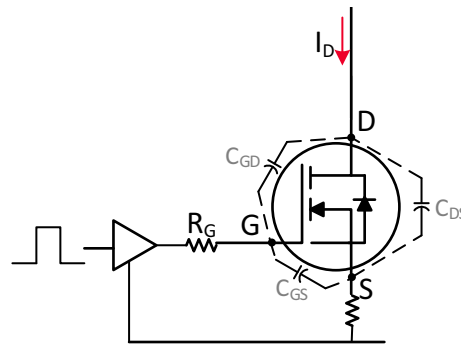


Figure 18 Basic N-channel FET Drive Circuit

Proper selection of a gate drive resistor affect the following three things:

- drive current
- gate-drive power dissipation
- rise and fall times.

Small Gate Resistor Values

Small gate resistor values increase the switching speed of a FET making it susceptible to voltage surge and oscillation and ultimately device failure. Too small of a gate drive resistor results in overshoot in the gate drive voltage (V_{GS}). At $R_G = 0 \Omega$, there may unwanted ringing in the gate-source waveform; the internal device resistance is insufficient to dampen oscillation. transient voltage spikes or excessive gate drive voltage and could puncture the gate-source oxide destroying the device.

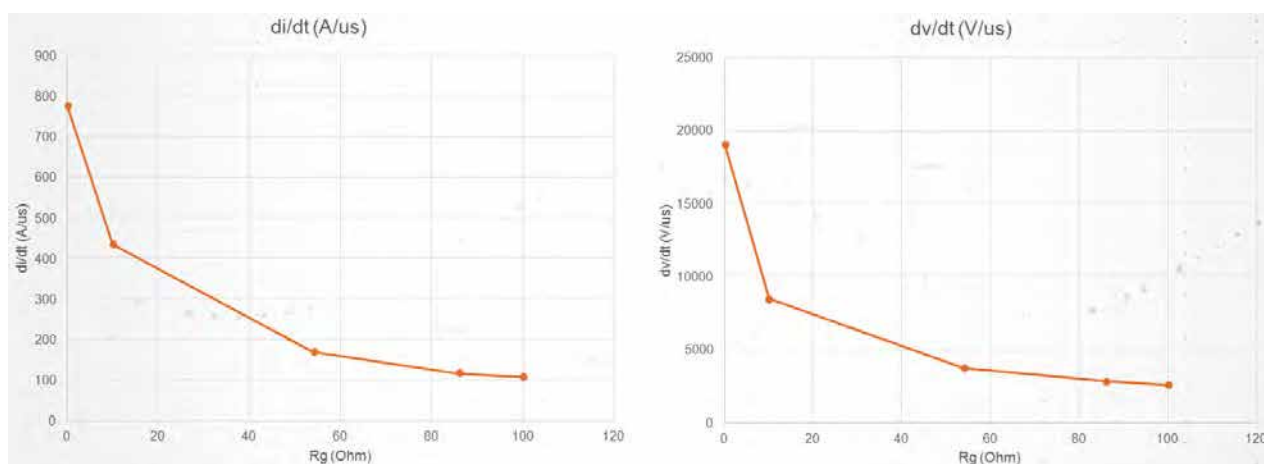
Large Gate Resistor Values

Large gate resistor values decrease switching speed of the device resulting in increased power loss, a reduction in performance, and potential heat issues. Too high of a value over-damps the oscillation and extends the switching times.

Optimal Gate Resistor Value

As described above, increasing the gate resistor value reduces the ringing but also reduces switching speed and therefore increases switching loss. This is because the gate resistor value and gate voltage restrict the gate charge current. Reducing the gate resistor value increases switching speed at the expense of increased ringing.

Figure 19 and Figure 20 illustrate how di/dt and dv/dt change with different values of Gate resistors.



$V_{GS} = 0 \text{ to } 18 \text{ V}$
 $V_{DS} = 400 \text{ V}$
 $I_{DS} = 10 \text{ A}$

R_G (in Ohms)	di/dt (A/ μ s)	t_d (ns)	t_f (ns)	t_{off} (ns)	dv/dt (V/ μ s)	E_{ON} (μ J)	E_{OFF} (μ J)
100	108.8	262	156.6	418.6	2632.7	737	325
86	118.2	234.7	141.2	375.9	2870	674	287
54	171	156	103.6	259.6	3779	503	174
10	437	61.4	43.5	104.9	8524	253	52
0	778	15	31	46	19112	20	20

Figure 19 Gate Resistor vs. Switching Speed at Turn-On

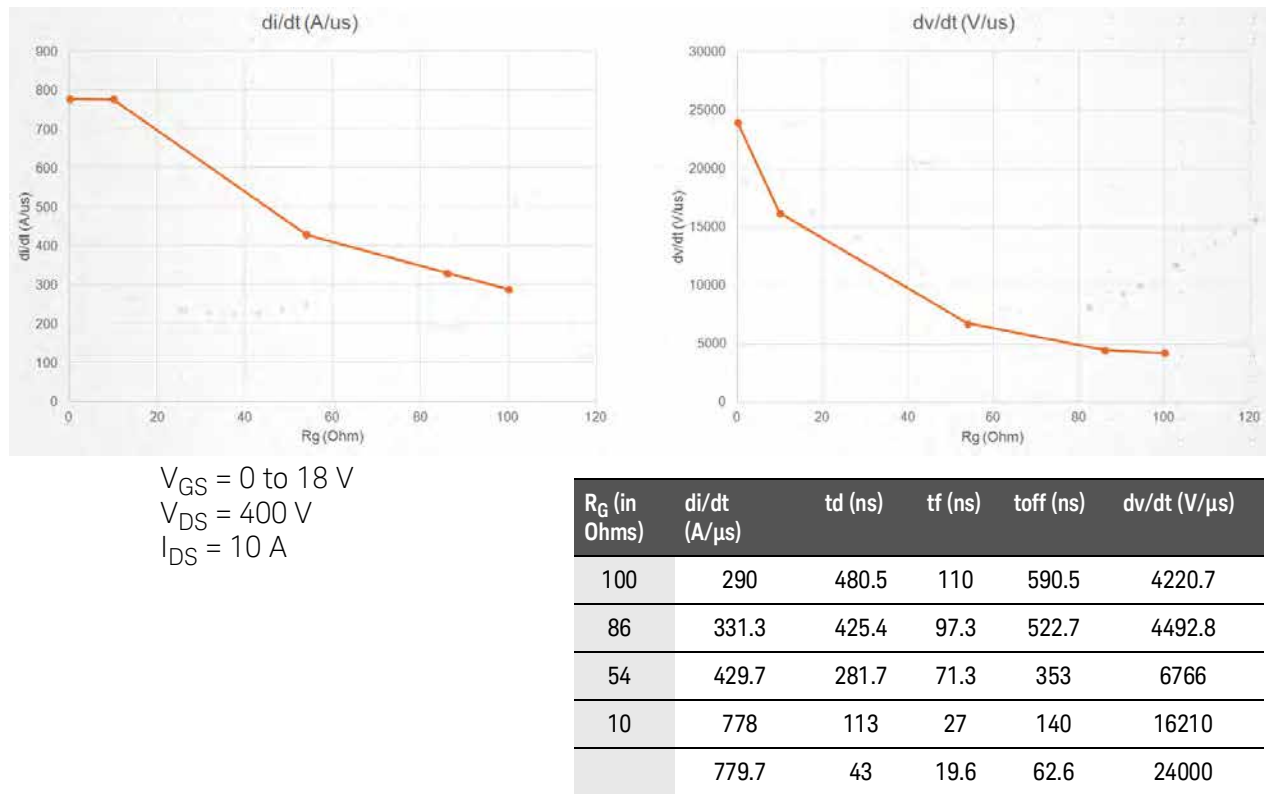


Figure 20 Gate Resistor vs. Switching Speed at Turn-Off

Additional factors to consider:

- For general modeling purposes, a larger gate drive resistor is good. The PD1550A makes high power IV derivations. It requires a clean curve for both V_{GS} and I_{DS} .
- For Gate Charge measurements having a plateau is important. Whether the V_{GS} display shows the plateau depends on the device being tested (DUT) as well as voltage and current settings. A 100 Ω R_G should give a better plateau than the 10 Ω R_G .

NOTE

Always use High-Side and Low-Side Gate Drive Modules with the same value resistors. Using a 100 Ω Gate Resistor on the High-Side transistor and a 0 Ω resistor on the Low-Side transistor, could cause false turn-on of the non-switching transistor due to high dv/dt and the weakly-driven gate. A 0 Ω resistor on the transistor that is not being switched is generally okay.

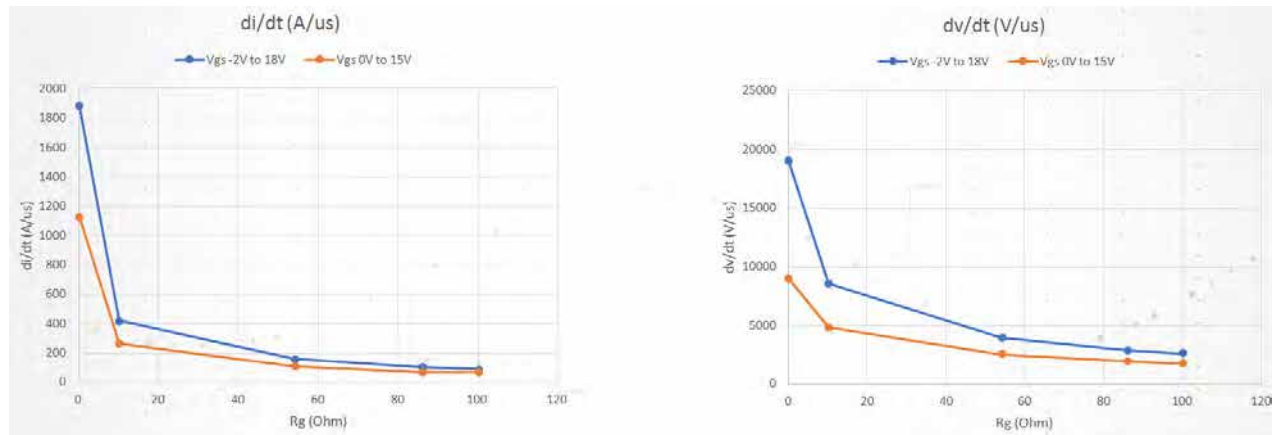
NOTE

Switching characteristics of the DUT are influenced by the Gate resistor value. A small resistor value allows for faster switching but it increasing the ringing. A large gate resistor value slows down the turn-on of the device but allows for a more accurate gate charge measurement.

NOTE

A $0\ \Omega$ R_G cannot be used for Gate Charge measurements because the gate current cannot be measured.

- In some cases, di/dt is defined in device data sheets for reverse recovery measurements. Using 0, 10 and 100 Ohm Gate Drive Resistors (R_G), draw a graph like the one shown in Figure 21, it is easier to find the appropriate R_G . For example, in Figure 21, if the defined di/dt is 200 A/ μ s for a condition (400V/10A with V_{GS} 0V to 18V which corresponds to orange curve), the R_G value should be in between 10 Ω and 20 Ω .



Measured data for
blue plot

R_G (in Ohms)	di/dt (A/ μ s)	t_d (ns)	t_f (ns)	t_{off} (ns)	dv/dt (V/ μ s)
100	91	1.7	163	218	2649
86	105	1.8	178	196	2892
54	160	2.5	205	140	4000
10	422	4.3	138	62.6	8587
	1891	8.5	134	33.7	19090

Measured data for
orange plot

R_G (in Ohms)	di/dt (A/ μ s)	t_d (ns)	t_f (ns)	t_{off} (ns)	dv/dt (V/ μ s)
100	68	1.3	164	313	1768
86	68	1.4	158	260	1946
54	109	1.7	154	169	2567
10	265	2.9	124	109	4861
	1132	4	114	58.9	9033

Figure 21 Gate Resistor vs. di/dt for Reverse Recovery

- When measuring Reverse Recovery, R_G on the High-Side module plays an important role. For switching characterization, use an R_G value similar to the R_G in your final design. If you have a specific R_G , you can use the PD1000-66550 Gate Drive resistor modules and install your own resistors.
- To see the fastest di/dt and dv/dt for your circuit design, use the $0\ \Omega$ R_G . However, remember that the $0\ \Omega$ R_G cannot be used for measuring gate charge or gate current.

B Installing Surface-Mount Devices

For installing surface-mount gate resistors on the PD1000-66550 Gate Drive Resistor Modules, a very small-tipped soldering iron may be used. However, you may find it easier to use a hot air solder reflow tool.

For the custom Gate Drive resistors, use the correct size of SMD resistors. Because of the tight spacing and small size of the resistors, it is best to use a hot air type solder reflow tool and push the SMD resistors in place. Gate Drive Resistors are an imperial size 0603 ($L = 0.6 \text{ mm}$, $W = 0.3 \text{ mm}$).

Use Anti-static procedures when soldering the devices to the Test Module.

NOTE

These Keysight printed circuit assemblies (PCAs) are RoHS compliant. To ensure a reliable connection when installing surface mount devices or custom gate resistors, you must use a lead-free soldering process.

NOTE

For detailed information on soldering devices to the printed circuit assembly, refer to the latest IPC 610 standard.

CAUTION

Do not use solder paste that contains a toxic substance (lead). Use extreme caution when handling and using the paste. Follow all manufacturers warning and guidelines.

WARNING

All soldering involves temperatures that may exceed 500°C . These temperatures may burn skin, eyes, clothing, etc. Always use eye protection when soldering.

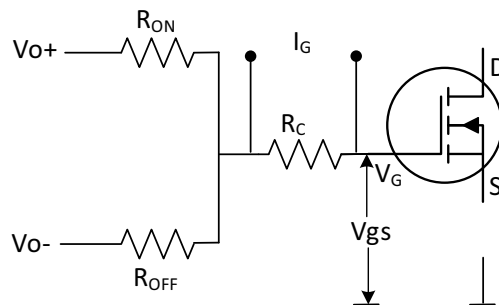


Figure 22 Schematic of Gate Drive Resistors

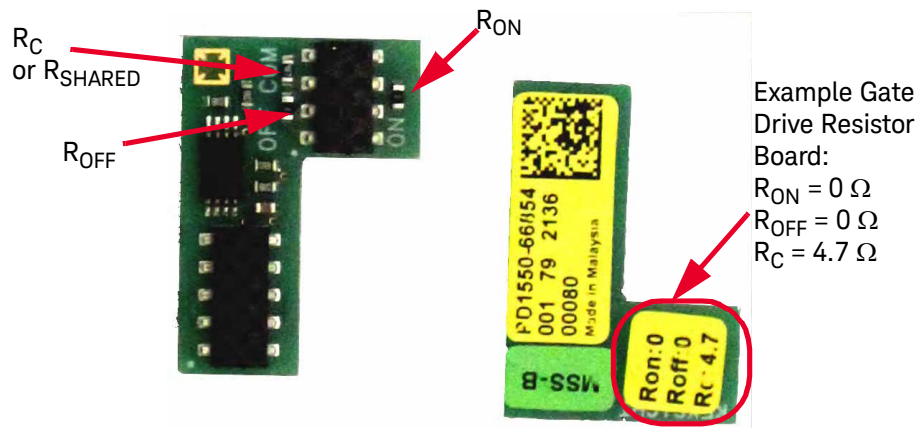


Figure 23 PD1550A Gate Drive Resistor Modules

Using a Hot Air Solder Reflow Tool

- 1 Start by applying flux to the pads on the test module. The flux cleans the pad and makes it easier for the solder to adhere properly.
- 2 Apply a small amount of solder paste on the all the pads of the component you want to solder.
- 3 Using bent-nose tweezers or pointed probe, place the component in its correct position and hold it there.
- 4 Use the hot air solder reflow toll to melt the solder tool to melt the solder. Remove the hot air tool as soon as the solder melts.
- 5 Your device should now be soldered to the Test Module. Inspect the solder joints with a microscope to ensure solder joints are good and that there are no solder bridges. Use solder braid to remove excess solder if necessary.

Using a Small-tip Soldering Iron

Use a small pencil type 10-15 watt soldering iron. A sharp, pointed tip is essential when soldering surface mount components. Keep the tip of the iron clean and well tinned at all times. Many areas on the printed circuit board are close together and care must be given not to form solder bridges. Solder bridges may occur if you accidentally touch an adjacent foil, particularly a previously soldered connection, using too much solder, or dragging the iron across adjacent foils. If a solder short occurs, remove it with your hot iron. Use only lead-free rosin core solder. For a good soldering job, the areas being soldered must be heated sufficiently so that the solder flows freely.

Use small diameter solder, (e.g., 0.05 or 0.031 inch diameter).

- 1** Start by applying a small amount of flux to all pads on the module. The flux cleans the pad and makes it easier for the solder to adhere properly.
- 2** Apply a small amount of solder paste from a syringe to each pad.
- 3** Carefully place the device(s) on the pads. Bent-nose tweezers are useful when positioning the resistors.
- 4** Place the tip of the soldering iron onto each of the pads so that the solder melts and makes good connection between the component and the module.
- 5** Remove the soldering iron and allow the solder joint to cool.
- 6** Inspect the solder joints with a microscope to ensure solder joints are good and that there are no solder bridges. Use solder braid to remove excess solder if necessary.

C SMA Connector Care & Connection

Good connections are essential for accurate calibrations and measurements and require a skilled operator. The most common cause of measurement error is poor connections. The following information is for use when connecting the two Waveform Generator cables to the DPT Test Fixture and when connecting the BNC-SMA cable to the PD1000-60002 Protection Probe. **IMPORTANT:** proper connection can help prevent ringing during a DPT test.

SMA connectors mate with 2.92 and 3.5 mm connectors. However, a damaged SMA connector, or a used SMA connector with a slightly bent pin can destroy a 2.92 or 3.5 mm connector. In SMA connectors, the center pin connects first, before the threads. If an SMA pin is bent or off-center for any reason, then the pin will make contact with the 2.92/3.5 mm female contacts which are unsupported as an air dielectric is used, and the female contact may be pushed out of place.

- 1 Ground yourself and all devices. Wear a grounded wrist strap and work on a grounded, conductive table mat.
- 2 Visually inspect the connectors. If necessary, clean the connectors.
- 3 Carefully align the connectors. As you make the actual connection, be sure the connectors align perfectly.
- 4 Push the connectors straight together. Do not twist or screw the connectors together.
- 5 Engage the connector nut (of the connector with the retracted sleeve) over the threads of the other connector (the connector with the extended sleeve). Turn only the connector nut. Let the connector nut pull the two connectors straight together.
- 6 Do not over tighten this connection. A connection in which the outer conductors make gentle contact at all points on both mating surfaces is sufficient. Very light finger pressure is enough to accomplish this.
- 7 Make sure the connectors are properly supported. Relieve any side pressure on the connection from long or heavy devices or cables.
- 8 Torque the connection according to the procedures described below.

Final Connection Using a Torque Wrench

Using a torque wrench guarantees the connection is not too tight, preventing possible connector damage. It also guarantees that all connections are equally tight. Prevent the rotation of anything other than the connector nut that you are tightening.

Use a Keysight 8710-1582, 0.56N-m (5 lb-in) 5/16 inch break-over torque wrench to make a final connection. A Torque wrench is supplied as part of the PD1550A Accessory Kit.



Figure 24 Keysight 8710-1582 SMA Torque Wrench

NOTE

The Keysight 8710-1582, 5 lb-in Torque Wrench is a precision instrument and should be treated and maintained like a measuring instrument.

- 1 Turn the connector nut. This may be possible to do by hand if one of the connectors is fixed (as on a test port). However, it is recommended that you use a second open-end wrench to keep the body of the device from turning.
- 2 Position both wrenches within 90 degrees of each other before applying force. Wrenches opposing each other (greater than 90 degrees apart) will cause a lifting action that can misalign and stress the connections of the device involved. This is especially true when several devices are connected together. Refer to the following figure.

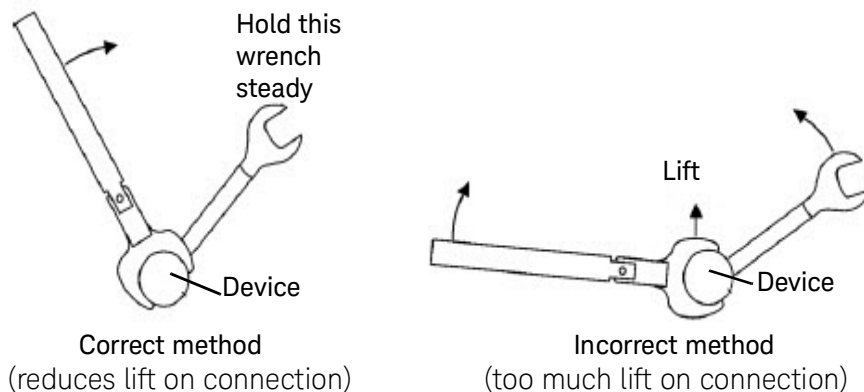


Figure 25 Wrench Positions

- 3 Hold the torque wrench lightly, at the end of the handle only (beyond the groove). See the following figure.

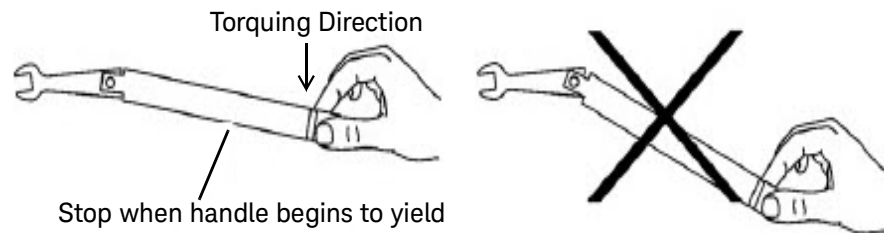


Figure 26 Using the Torque Wrench

- 4 Apply force downward to the wrench handle. This applies torque to the connection through the wrench. Do not hold the wrench so tightly that you push the handle straight down along its length rather than pivoting it, otherwise you apply an unknown amount of torque.

CAUTION

You don't have to fully break the handle of the torque wrench to reach the specified torque; doing so can cause the handle to kick back and loosen the connection. Any give at all in the handle is sufficient torque.

- 5 Tighten the connection just to the torque wrench break point. The wrench handle gives way at its internal pivot point. Do not tighten the connection further.

Separating Connections

To avoid lateral (bending) force on the connector mating plane surfaces, always support the devices and connections.

CAUTION

Do not turn the device body. Only turn the connector nut. Damage to the center conductor can occur if the device body is twisted.

- 1 Use an open-end wrench or spanner wrench to prevent the device body from turning.
- 2 Use another open-end wrench or the torque wrench to loosen the connector nut.
- 3 Complete the separation by hand, turning only the connector nut.
- 4 Pull the connectors straight apart without twisting, rocking, or bending.

Inspect and Clean Connectors

Clean connector interfaces prolong connector life and produce more accurate and repeatable measurements. When using SMA female connectors, pay special attention to the contact fingers on the female center conductor. These can be bent or broken, and damage to them is not always easy to see. A connector with damaged contact fingers will not make good electrical contact and must be repaired or replaced.

Inspect each connector to make sure that no particles or residue are present.

Connector Cleaning

WARNING

Always use protective eye-wear when using compressed air or nitrogen.

WARNING

Keep isopropyl alcohol away from heat, sparks, and flame. Store in a tightly closed container. Isopropyl alcohol is extremely flammable. In case of fire, use alcohol foam, dry chemical, or carbon dioxide; water may be ineffective.

Use isopropyl alcohol with adequate ventilation and avoid contact with eyes, skin, and clothing. It causes skin irritation, may cause eye damage, and is harmful if swallowed or inhaled. It may be harmful if absorbed through the skin.

Wash thoroughly after handling. In case of spill, soak up with sand or earth. Flush spill area with water.

Dispose of isopropyl alcohol in accordance with all applicable federal, state, and local environmental regulation.

- Use compressed air to loosen particles on the connector mating plane surfaces.
- Apply a small amount of isopropyl alcohol to a lint-free swab. Clean the connector threads. Let the alcohol evaporate, then blow the threads dry with a gentle stream of clean, low-pressure compressed air or nitrogen. Always completely dry a connector before you reassemble or use it.

D Simplified System Wiring Diagrams

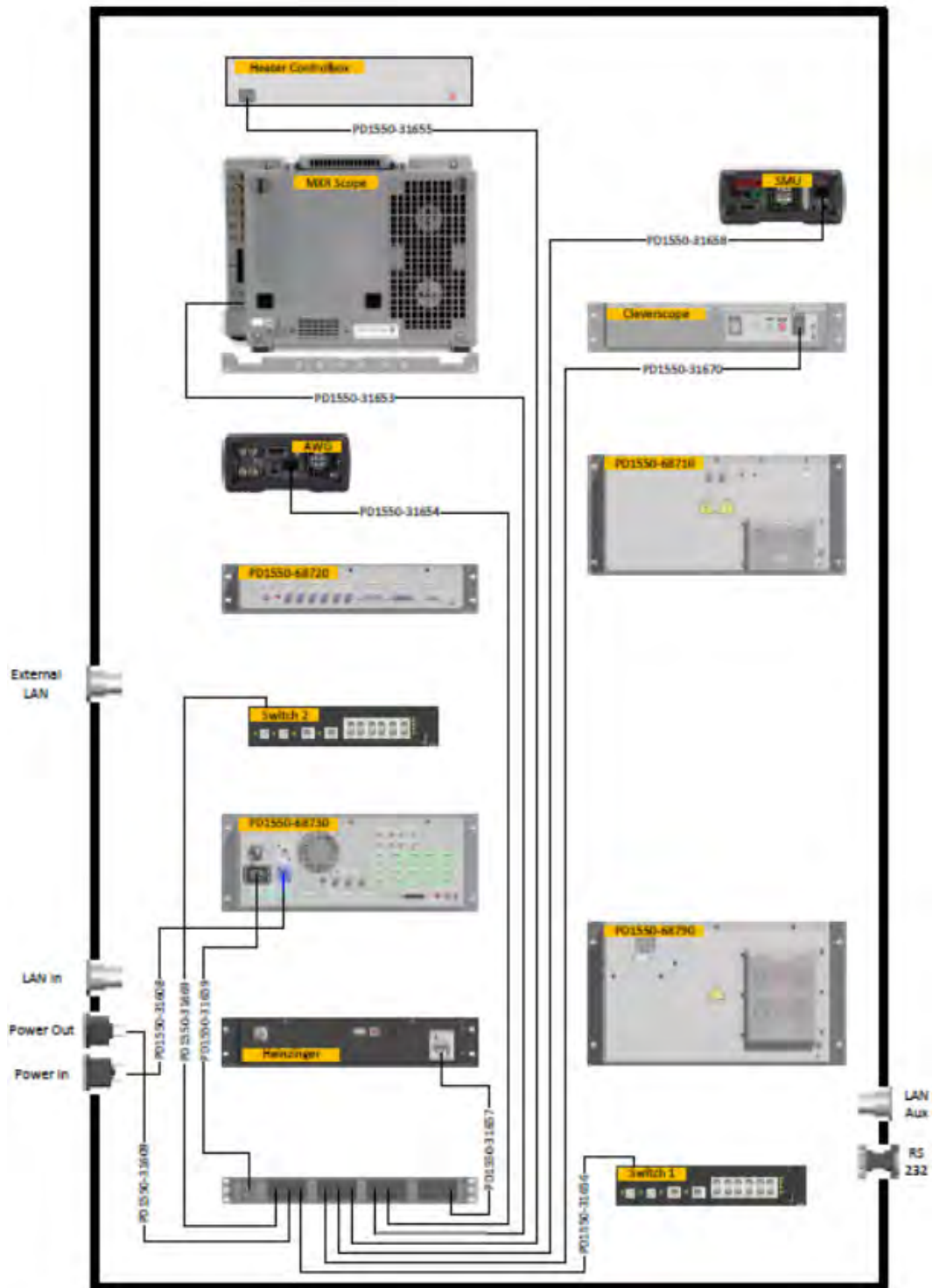
This appendix shows simplified wiring diagrams for the DPT system.

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PD1550A Ethernet Wiring	page 136
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Figure 27 PD1550A High Voltage Wiring

PD1550A Power Wiring

**Figure 28** PD1550A Power Wiring

PD1550A Ethernet Wiring

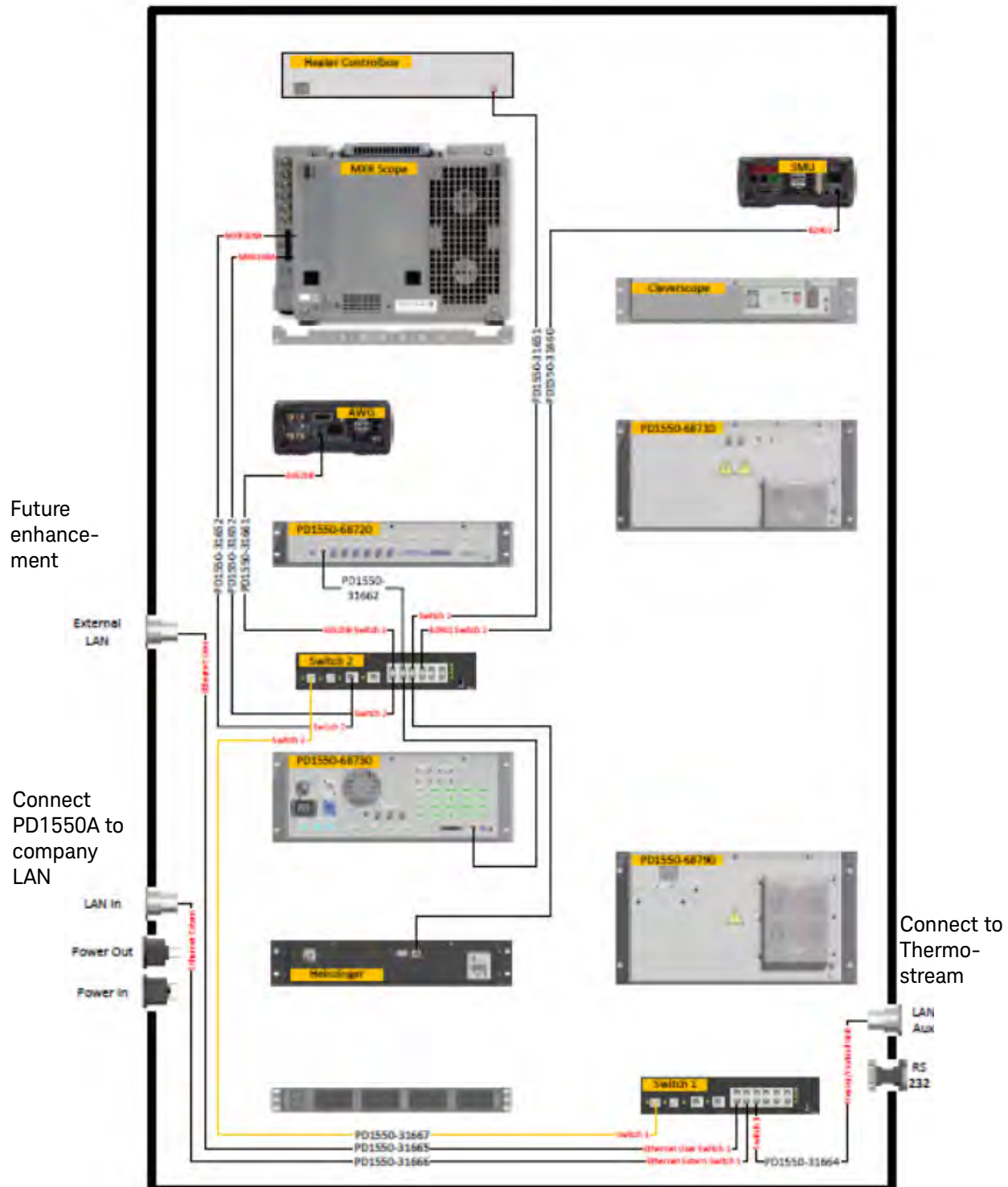
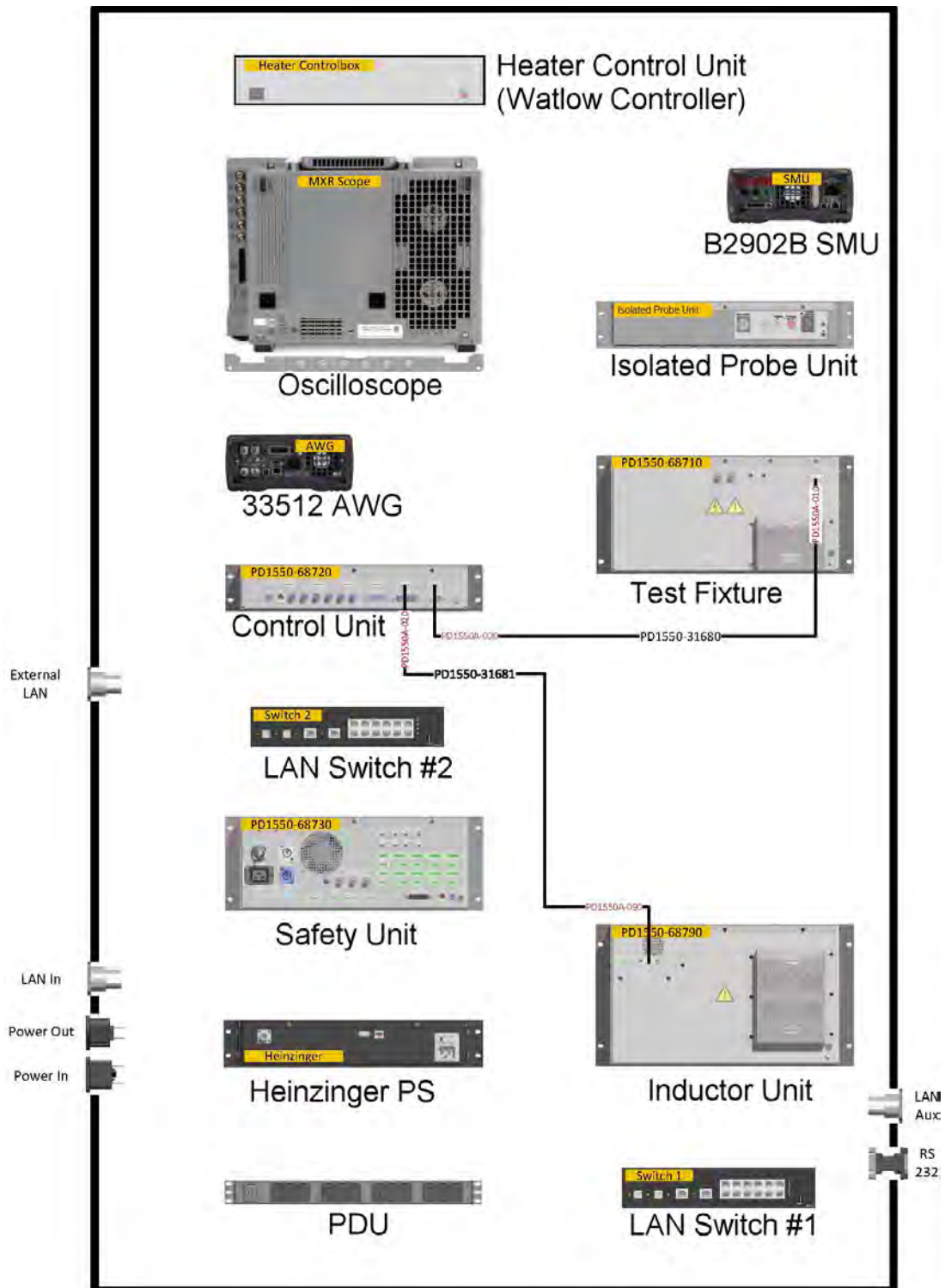


Figure 29 PD1550A Ethernet Wiring

PD1550A Internal UDI Wiring

**Figure 30** PD1550A Internal UDI Wiring

PD1550A BNC Wiring

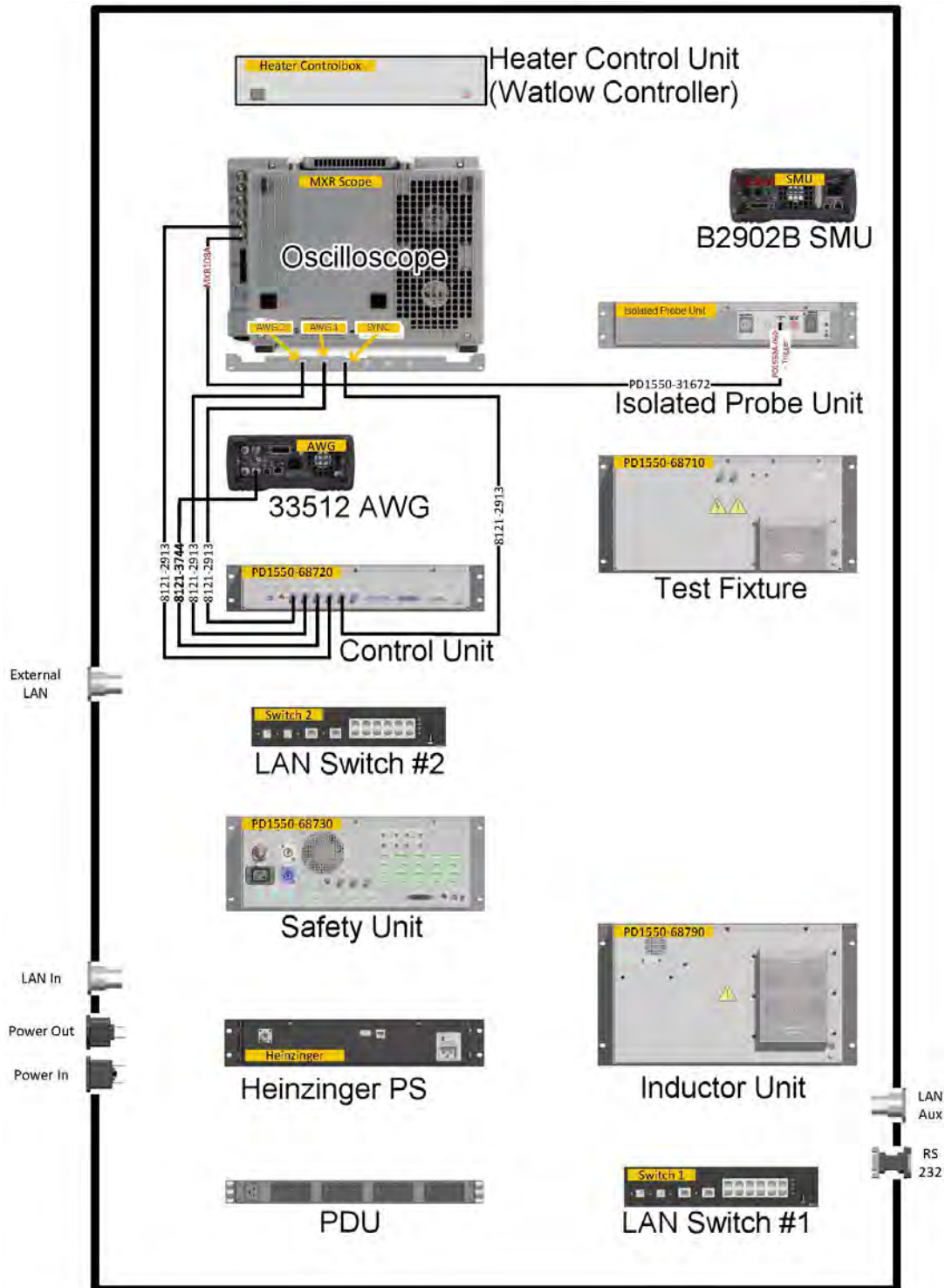
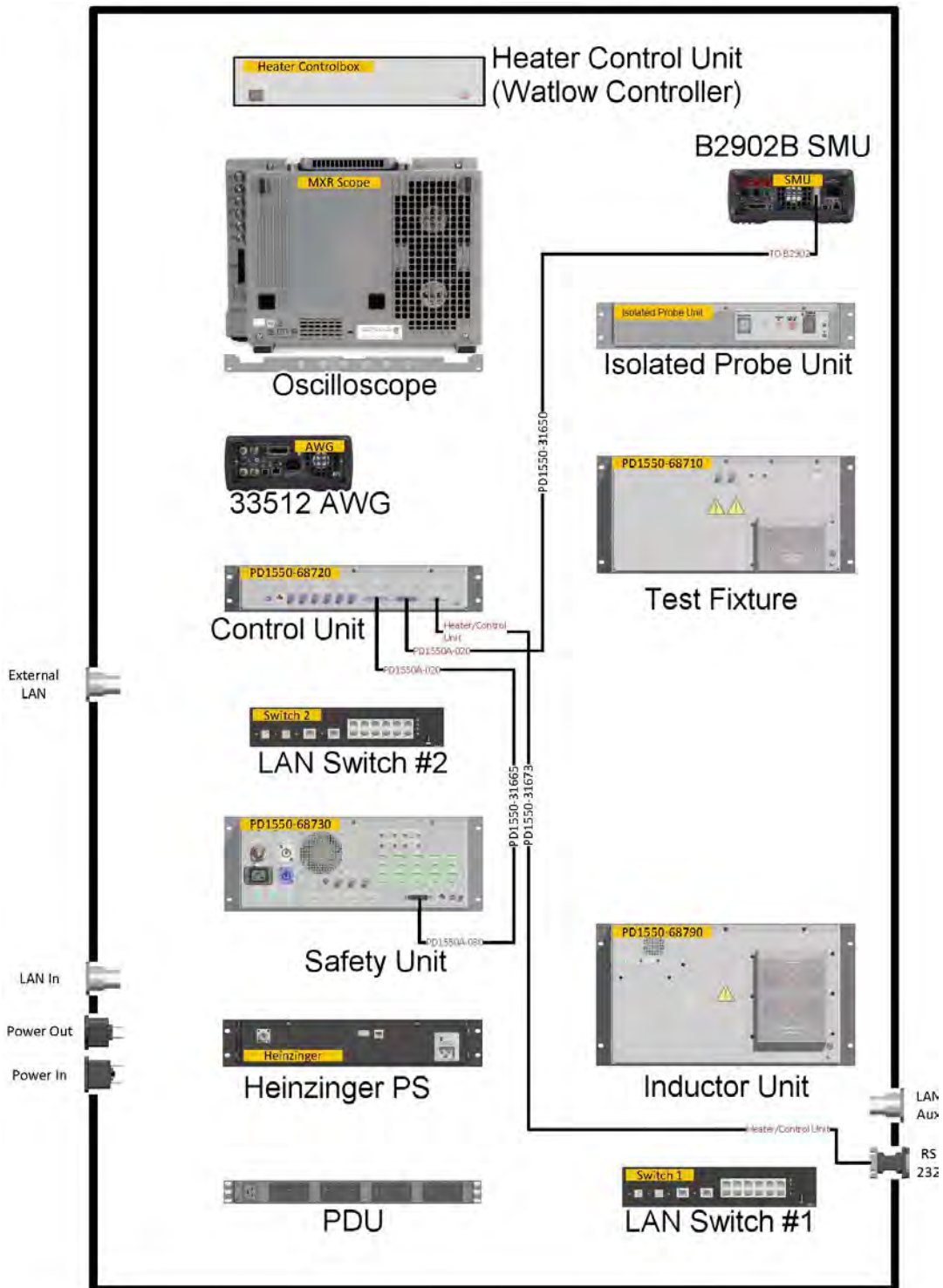


Figure 31 PD1550A BNC Wiring (Internal to the Rack)

PD1550A D-Sub Connector Wiring

**Figure 32** PD1550A D-Sub Connector Wiring (Internal to the Rack)

PD1550A Connect Probes to Oscilloscope

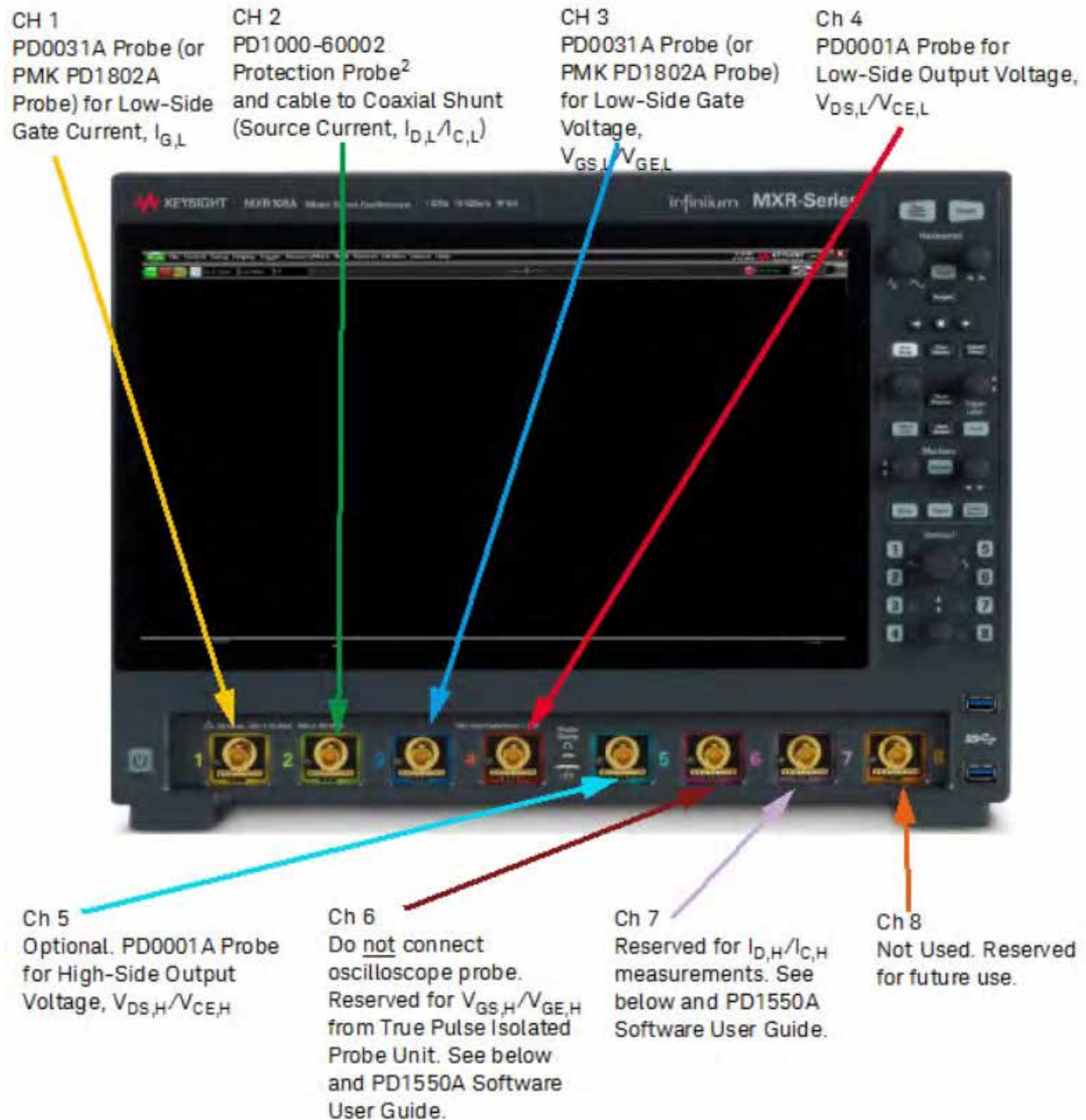


Figure 33 Standard (default) Oscilloscope Probe Connections

Oscilloscope Channel	Color	Measures	Oscilloscope Probe
1	Yellow	Low-Side Gate Voltage: $V_{GS,L}/V_{GE,L}$ (LOW-SIDE VGS/VCE on Interface Module)	DP0031A Differential Probe ¹ (requires banana to BNC adapter)
2	Green	Low-Side Output Current: $I_{D,L}/I_{C,L}$ (LOW-SIDE ID/IC on Interface Module)	PD1000-60002 Protection Probe and cable to Coaxial Shunt ²
3	Blue	Low-Side Output Voltage: $V_{DS,L}/V_{CE,L}$ (LOW-SIDE VDS/VCE on Interface Module)	DP0031A Differential Probe ¹ (requires banana to BNC adapter)
4	Red	Low-Side Gate Current, $I_{G,L}$ (IG on Interface Module)	DP0001A High Voltage Differential Probe
5	Lt Blue	Optional. High-Side Output Voltage, $V_{DS,H}/V_{CE,H}$ (Interface Module HIGH_SIDE VDS/VCE)	DP0001A High Voltage Differential Probe
6	Dark Red	Do <u>not</u> connect oscilloscope probe. See “ Connect Probes for High-Side DUT Measurements ” and PD1550A Software User Guide.	Reserved for $V_{GS,H}/V_{GE,H}$ from Isolated Probe Unit Isolated Probe Unit.
7	Purple	See “ Connect Probes for High-Side DUT Measurements ” and PD1550A Software User Guide.	Reserved for $I_{D,H}/I_{C,H}$. See PD1550A Software User Guide.
8	Orange	Not used. Reserved for future use.	Not used. Reserved for future use.

¹ Your system may have been provided with PMK PD1802A Differential Probes instead of the Keysight DP0031 probes. These probes are identical in performance.

² Use the 0.56 N-m (5 lb-in) 5/16 in. SMA Break-over torque wrench (provided with the PD1550A system) to tighten the SMA cable connector to the PD1000-60002 Protection Probe. Failure to do so might cause extensive ringing in the DPT measurements. See appendix for details.

NOTE

The oscilloscope channels and colors shown above are recommended. You may choose different channels. All examples and screen captures shown in the DPT documentation use this configuration. The colors on the PD1000A Control Software screen match the DSOS104 Oscilloscope probe channel number colors: i.e., Channel 1 - $V_{GS,L}/V_{GE,L}$ for Low-Side Gate Current is yellow, Channel 2 - $I_{d,L}/I_{C,L}$ for Low-Side Output Current is green, etc.

NOTE

Do not use a different cable for $I_{DS,L}$ or Isolated Probe Unit oscilloscope probes. The cables and oscilloscope probes supplied with your PD1550A provide correct probe deskew.

Connect Probes for High-Side DUT Measurements

High-Side Gate Voltage

Keysight's Isolated Probe Unit is used for High-Side Gate Voltage, $V_{GS,H}$ / $V_{GE,H}$, measurements only. Only Channel A is used at this time, the remaining channels are reserved for future use. A standard 10:1 oscilloscope probe connects the Isolated Probe Unit Channel 1 to the Keysight Interface Module.

Make certain that both **Gate Voltage $V_{GS,H}/V_{CE,H}$** and **Use Isolated Probe Unit for $V_{GS,H}/V_{CE,H}$** are selected in the **Settings > Hardware Configuration > Oscilloscope** tab are checked. Default condition is that these two are not checked.

High-Side Drain/Collector Current

For High-Side Drain or Collector current, $I_{D,H}/I_{C,H}$, measurements, a current shunt is not available for the Keysight 62 mm Interface Modules. However, for your custom Interface Modules you may design a place to install a small Rogowski coil current probe. This should be connected to Channel 7 on the PD1550A oscilloscope.

Make certain that **Output Current $I_{D,H}/I_{C,H}$** is selected in the **Settings > Hardware Configuration > Oscilloscope** tab are checked. Default condition is that this is not checked.

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Printed in Malaysia

Edition 1, May 2023



PD1550-90002

www.keysight.com

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Manual Part Number
PD1550-90002

Edition

First Edition, May 2023

Published by

Keysight Technologies, Inc.
900 S. Taft Ave.
Loveland, CO 80537 USA

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WARNING



HIGH VOLTAGE

is used in the operation of this equipment.

LETHAL VOLTAGE on CONTACT

may be present at measurement terminals if you fail to implement all safety precautions.

- When the **RED** light is on in the light tower Double-Pulse Test Rack and Safety Enclosure, lethal voltage may appear at measurement terminals.
- Never attempt to defeat the safety interlock function of the safety doors.
- Do not operate the system unless another person is around the work space who is familiar with system operation and hazards for administering first aid.
- Potential voltages less than ± 500 V may cause death under certain conditions. Therefore, adequate preventive measures must be taken at all times!

Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this system. Failure to comply with these precautions or with specific warnings elsewhere in this manual may impair the protections provided by the system. In addition, it violates safety standards of design, manufacture, and intended use of the system. Keysight assumes no liability for customer's failure to comply with these requirements.

Product manuals are available on the Web. Go to www.keysight.com/find/PD1550A for all documentation.

WARNING



Hazardous voltage: System maximum output voltage may appear at the measurement terminals inside the safety enclosure. Never attempt to bypass the safety interlock and features of the PD1550A Double-Pulse Test system safety enclosure. To avoid contact with extremely high voltages, the rack cabinet must be operated with all side, front, and rear panels in place and the safety enclosure must remain closed. There are no user-serviceable parts inside.

Do not intentionally modify the interlock function of the safety enclosure. While the high voltage indicator is lit, dangerous voltage or residual charge may appear on the measurement terminals.

CAUTION

Some of the material in the safety enclosure can generate static electricity. Take care if you are using ESD sensitive devices in its vicinity.

NOTE

Do not use this system in any manner not specified by the manufacturer. The protective features of this system may be impaired if it is used in a manner not specified in the operation instructions. This system is an INDOOR USE product only.

This system complies with INSTALLATION CATEGORY II for mains input and INSTALLATION CATEGORY I for measurement input terminals, and POLLUTION DEGREE 2 defined in IEC 61010-1.

If an system is marked CAT I (IEC Measurement Category I), or it is not marked with a measurement category, its measurement terminals must not be connected to line-voltage mains.

Safety of any system incorporating the equipment is the responsibility of the assembler of the system.

DANGEROUS PROCEDURE WARNINGS

- Warnings shall be complied. Procedures throughout in this manual prevent you from potential hazardous situations. The instructions contained in the warnings must be followed.

BEFORE APPLYING POWER

- Verify that all safety precautions are taken. Make all connections to the system before applying power. Note the system's external markings described under "Safety and Regulatory Symbols".

GROUND THE RACK

- This is Safety Class I system. To minimize shock hazard, the Rack and Safety Enclosure must be connected to an electrical ground. The power terminal and the power cable must meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

- Do not operate the system in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

DO NOT REMOVE COVERS

- No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock do not remove covers.

IN CASE OF DAMAGE

- Instruments, probes or cables that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel. Return the product to a Keysight sales or service office for service and repair to ensure that safety features are maintained.

USE ONLY THE SPECIFIC ACCESSORIES

- Specified accessories satisfy the requirements for specific characteristics for using the instruments and the Rack and Safety Enclosure.

CLEANING

- Disconnect the power from the rack before cleaning the Rack and Safety Enclosure. Use only a damp cloth to clean the surfaces of the Rack and Safety Enclosure.

Safety Information

The following general safety precautions must be observed during all phases of operation of these instruments. Failure to comply with these precautions or with specific warnings or operating instructions in the product manuals violates safety standards of design, manufacture, and intended use of the instruments. Keysight Technologies assumes no liability for the customer's failure to comply with these requirements.

General

Do not use these instruments in any manner not specified by the manufacturer. The protective features of these instruments must not be impaired if it is used in a manner specified in the operation instructions.

Before Applying Power

Verify that all safety precautions are taken. Make all connections to the instruments before applying power. Note the external markings described under "Safety Symbols".

Ground the Instrument

Keysight instruments are provided with a grounding-type power plug. The instruments must be connected to an electrical ground to minimize shock hazard. The ground pin must be firmly connected to an electrical ground (safety ground) terminal at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

Unless otherwise noted in the specifications, these instruments or system is intended for indoor use in an installation category II, pollution degree 2 environment per IEC 61010-1 and 664 respectively. They are designed to operate at a maximum relative humidity of 50% to 80% at 30 °C or less (non-condensing). These instruments or system are designed to operate at altitudes up to 3000 meters, and at temperatures between 20 and 30 °C.

Do Not Operate in an Explosive Atmosphere Do not operate in the presence of flammable gases or fumes.

Do Not Operate Near Flammable Liquids

Do not operate the instruments in the presence of flammable liquids or near containers of such liquids.

Cleaning

Clean the outside of the Keysight instruments with a soft, lint-free, slightly dampened cloth. Do not use detergent or chemical solvents.

Do Not Remove Instrument Cover

Only qualified, service-trained personnel who are aware of the hazards involved should remove instrument covers. Always disconnect the power cable and any external circuits before removing the instrument cover.

Keep away from live circuits

Operating personnel must not remove equipment covers or shields. Procedures involving the removal of covers and shields are for use by service-trained personnel only. Under certain conditions, dangerous voltages may exist even with the equipment switched off. To avoid dangerous electrical shock, DO NOT perform procedures involving cover or shield removal unless you are qualified to do so.

DO NOT operate damaged equipment

Whenever it is possible that the safety protection features built into these instruments have been impaired, either through physical damage, excessive moisture, or any other reason, REMOVE POWER and do not use the instrument until safe operation can be verified by service-trained personnel. If necessary, return the product to a Keysight Technologies Sales and Service Office for service and repair to ensure the safety features are maintained.

DO NOT block the primary disconnect

The primary disconnect device is the appliance connector/power cord when an instrument used by itself, but when installed into a rack or system the disconnect may be impaired and must be considered part of the installation.

Do Not Modify the Instrument

Do not install substitute parts or perform any unauthorized modification to the product. Return the product to a Keysight Sales and Service Office to ensure that safety features are maintained.

In Case of Damage

Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

Measurement Limits

The Truevolt Series DMMs provide protection circuitry to prevent damage to the instrument and to protect against the danger of electric shock, provided the Measurement Limits are not exceeded. To ensure safe operation of the instrument, do not exceed the Measurement Limits shown on the front and rear panel.

The DMMs comply with EN/IEC 61326-2-1, for sensitive test and measurement equipment.

When subjected to transient radiated and/or conducted electromagnetic phenomena, the DMMs may have temporary loss of function or performance which is self-recovering. Recovery may take longer than 10 seconds.

When subjected to continuously present electromagnetic phenomena, some degradation of performance may occur.

Safety and Regulatory Symbols

CAUTION

A CAUTION denotes a hazard. It calls attention to an operating procedure or practice that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

WARNING

A WARNING denotes a hazard. It calls attention to an operating procedure or practice, that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Products display the following:



CAUTION. Refer to documentation for safety information.



Earth Ground.



Chassis Ground.



Alternating Current (AC).



Direct Current (DC).



Standby Power. Unit is not completely disconnected from AC mains when power switch is in standby position



Indicates that antistatic precautions should be taken.



DANGER: Hazardous voltage, potential for electric shock. Do not touch terminals.



Cold Surface, avoid contact. Low temperature or freezing conditions. Surfaces are cold and may cause personal injury.



Hot Surface, avoid contact. Surface is hot and may cause personal injury.



The CE marking is a registered trademark of the European Community (if accompanied by a year, it is the year when the design was proven). It indicates that the product complies with all relevant EU directives.



The Regulatory Compliance Mark (RCM) is a registered trademark of the Australian Communications and Media Authority.



The CSA mark is a registered trademark of the Canadian Standards Association and indicates compliance to the standards laid out by them. Refer to the product Declaration of Conformity for details.



This symbol represents the time period during which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use. Forty years is the expected useful life of this product.



Universal recycling symbol. This symbol indicates compliance with the China standard GB 18455-2001 as required by the China RoHS regulations for paper/fiberboard packaging.



R-R-Kst-SP21786

South Korean Certification (KC) mark. It includes the marking's identifier code.

A 급 기기 (업무용 방송통신기자재)
이 기기는 업무용 (A 급) 전자파적합기
기로서 판 매자 또는 사용자는 이 점을 주
의하시기 바라 며 , 가정외의 지역에서
사용하는 것을 목적으 로 합니다.



Waste Electrical and Electronic Equipment (WEEE)

The crossed-out wheeled bin symbol indicates that separate collection for Waste Electric And Electronic Equipment (WEEE) is required, as obligated by the EU DIRECTIVE and other National legislation.

Please refer to [keysight.com/go/takeback](https://www.keysight.com/go/takeback) to understand your trade-in options with Keysight in addition to takeback instructions.

Traditional Chinese

根據歐盟指令和其他國家的法律規定，帶有X標誌的帶輪垃圾桶圖案，表示該產品屬於需要進行單獨回收的電子電器產品。

請參考 [keysight.com/go/takeback](https://www.keysight.com/go/takeback)，了解產品回收說明以及Keysight的以舊換新方式。

Simplified Chinese

根据欧盟指令和其他国家的法律规定，带有X标志的带轮垃圾桶图案，表示该产品属于需要进行单独回收的电子电器产品。

请参考 [keysight.com/go/takeback](https://www.keysight.com/go/takeback)，了解产品回收说明以及Keysight的以旧换新方式。

Japanese

車輪付きゴミ箱に×マークは、EU DIRECTIVEやその他の国の法律で義務付けられている廃電気・電子機器（WEEE）の分別回収が必要であることを示しています。

[keysight.com/go/takeback](https://www.keysight.com/go/takeback) では、製品のテイクバック方法に加えて、Keysight の下取りオプションについてもご紹介しています。

Korean

바퀴달린 쓰레기통의 X 표시는 EU 지침 및 기타 국가 법률에 따라 전기 및 전자 장비 폐기물(WEEE)에 대한 별도 수거가 필요함을 나타냅니다.

제품 회수 지침과 함께 Keysight를 통한 보상 판매 옵션을 이해하려면 [keysight.com/go/takeback](https://www.keysight.com/go/takeback) 을 참조하십시오.

German

Das Symbol der durchgestrichenen Mülltonne auf Rädern weist darauf hin, dass eine getrennte Sammlung von Elektro- und Elektronik-Altgeräten (WEEE) gemäß der EU-RICHTLINIE und anderer nationaler Gesetze erforderlich ist.

Bitte informieren Sie sich unter [key-sight.com/go/takeback](https://www.keysight.com/go/takeback) über Ihre Rücknahmeoptionen bei Keysight sowie über die Anweisungen zur Produktrücknahme.

French

Le pictogramme de la poubelle barrée indique que la collecte séparée des déchets d'équipements électriques et électroniques (DEEE) est requise, comme l'oblige la directive européenne et d'autres législations nationales.

Veuillez vous référer à [keysight.com/go/takeback](https://www.keysight.com/go/takeback) pour obtenir les options d'échange Keysight en plus des instructions de reprise de produit.

Italian

Il simbolo del bidone barrato indica che è richiesta la raccolta separata dei rifiuti di apparecchiature elettriche ed elettroniche (RAEE), come previsto dalla DIRETTIVA UE e da altre legislazioni nazionali.

Si prega di fare riferimento al sito [key-sight.com/go/takeback](https://www.keysight.com/go/takeback) per comprendere le opzioni di Commercializzazione con Keysight oltre alle istruzioni per il ritiro del prodotto.

Spanish

El símbolo del contenedor de basura tachado indica la obligación de recogida selectiva de los residuos de aparatos eléctricos y electrónicos (RAEE), tal y como lo establece la DIRECTIVA de la UE y otras legislaciones nacionales.

Acceda a nuestra página [key-sight.com/go/takeback](https://www.keysight.com/go/takeback) para obtener información sobre las opciones de recuperación que ofrece Keysight, y las instrucciones de recuperación del producto.

Portuguese

O símbolo da lata de lixo riscada indica que a necessidade da coleta seletiva dos resíduos de equipamentos eléctricos e electrónicos (REEE) é obrigatória, em consonância com a DIRETIVA da União Europeia (WEEE) e outras legislações nacionais.

Consulte [keysight.com/go/takeback](https://www.keysight.com/go/takeback) para verificar suas opções de "trade in" com o escritório Keysight local, ou para receber as instruções de reciclagem do produto.

Russian

Символ перечеркнутого мусорного контейнера на колесиках указывает на необходимость раздельного сбора отходов электрического и электронного оборудования (WEEE) в соответствии с требованиями ДИРЕКТИВЫ ЕС и других национальных законодательств.

Пожалуйста, обратитесь к сайту [keysight.com/go/takeback](https://www.keysight.com/go/takeback), чтобы узнать о возможностях торговли с компанией Keysight, а также об инструкциях по возврату продукции.

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E Index

1 Site Preparation

IMPORTANT

Keysight recommends that a trained Keysight Application Engineer install and setup the Double-Pulse Test Rack and Safety Enclosure. The instructions in this guide are written for the trained Application Engineer.

End users should have the installation site prepared before beginning installation. See “Customer Responsibilities” on page 16.

This System Installation Guide provides step-by-step instructions to install the PD1550A Dynamic Power Device Analyzer/Double-Pulse Tester and connect accessories. Note that the PD1550A is part of the overall PD1000A Power Device Measurement System for Advanced Modeling.

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Customer Responsibilities

The final location at customer site must meet the following requirements prior to the installation.

☐	Receive the PD1550A Double-Pulse Test System.
☐	Uncrating – You should remove the PD1550A system the shipping crate. You may inventory the shipment using the enclosed packing list. See Chapter 2.
☐	Site Preparation and Maintenance – Ensure the operating environment (space, noise, etc.) is suitable.
☐	Electrical and environmental requirements are met. Wiring primary power to the system is your responsibility, as is installing communications cabling to the system. The actual power connection to the system will be made after the Keysight representative has removed the system from the pallet and moved it to the desired location.
☐	Host Computer requirements are met.
☐	All necessary software licenses and software are installed on the host computer.
☐	Additional supplies including but limited to host computer, LAN cable, etc. These are not included with the PD1550A.

Keysight's PD1550A Rack and Safety Enclosure is a free-standing rack with test instruments installed and a Safety Enclosure on top. Consider your anticipated location and requirements to ensure safety and optimize access to test and control instrumentation.

Rack and Safety Enclosure Dimensions and Weight



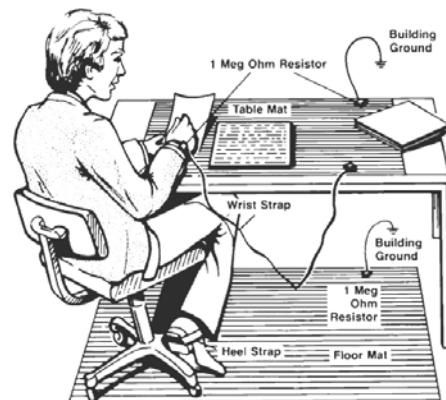
	Weight	Height	Depth	Width
Shipping Crate (with DPT Rack and Safety Enclosure inside)	~ 567 kg (~ 1250 lbs)	2.1 M (83 in)	1.27 M (50 in)	1.5 M (59 in)
Rack and Safety Enclosure (all test equipment and fixtures installed)	~ 234 kg (~715 lbs)	2.0 M (78 in.)	1.1 M (42 in.)	1.27 M (50 in.)

Static-safe Handling Procedures

Electrostatic discharge (ESD) can damage or destroy electronic components. Use a static-safe work station to perform at work on electronic assemblies. This figure shows a static-safe work station using two types of ESD protection:

- Conductive table-mat and wrist-strap
- Conductive floor-mat and heel-strap

Both types, when used together, provide a significant level of ESD protection. Of the two, only the table-mat and wrist-strap combination provides adequate ESD protection when used alone. To ensure user safety, the static-safe accessories must provide at least 1 M Ω of isolation from ground.



CAUTION

Some of the material in the safety enclosure can generate static electricity. Take care if you are using ESD sensitive devices in its vicinity.

Power Module Test Rack and Safety Enclosure Location

The Rack and Safety Enclosure is a free-standing rack with test instruments installed. It is the customer's responsibility to consider the anticipated location and requirements to ensure safety and optimize access to instrumentation.

The following figure shows Rack and Safety Enclosure dimensions (doors closed). You should allow a minimum one meter of space in front of the rack for operator access, one meter behind the system for service and one meter on each side of the rack for opening rack doors and sufficient air flow for cooling and ventilation.



NOTE

The Air Intake fans on the Test Rack and Safety Enclosure sides and top are temperature controlled. They turn on only when the temperature in the lower portion of the rack exceeds approximately 35°C.

Rack Ventilation

The Rack and Safety Enclosure has six air intake fans and eight exhaust fans. See the graphic below.

CAUTION

For proper air flow through the Rack and Safety Enclosure, do not block air vents or rack cooling fans. Allow a minimum of 1 M on each side, above the rack, and on the rear of the Rack and Safety Enclosure for ventilation.

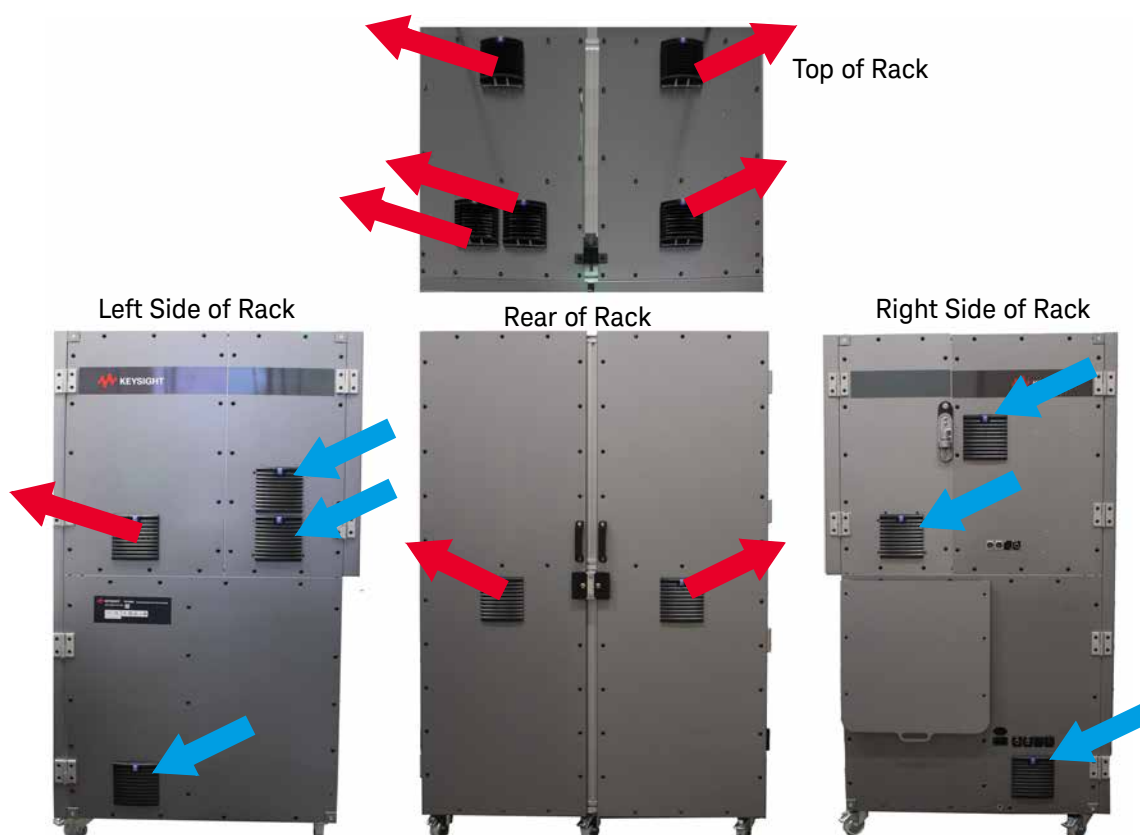


Figure 1 Air Flow through the DPT Rack and Safety Enclosure (Blue arrows are fresh air in / Red arrows are hot air exhaust)

Connect the Rack and Safety Enclosure to AC Mains

WARNING

AC wiring and the Mains Disconnect are subject to local and regional electrical codes. A licensed electrician must determine and install the appropriate Mains Disconnect.

Copper wire must be used in the power drop. A licensed electrician must determine the wire size for the power drop according to local and regional electrical codes. The wires must be sized to ensure that the voltage at the system does not drop below 90% of the nominal voltage.

AC Power Cord

A country-specific mains power cord (2.5 m [98 inches] long, 3 conductor, IEC-60320 C19 socket on one end) is available with the PD1550A Rack and Safety Enclosure.

WARNING

LEAKAGE CURRENT! Due to the types of instruments installed in this cabinet, there is a risk of leakage current (> 3.5 mA). Reliable ground circuit continuity is required for safe operation of this product. To reduce the risk of electrical shock, an earth (ground) connection is essential before connecting the AC power mains. Never operate the system with the ground connector disconnected. Use a permanent safety ground connection (recommended) or a plug meeting the IEC 60309 (CEE plug) requirements.

Connection of the PD1550A to the AC Mains

WARNING

AC wiring and the Mains Disconnect are subject to local and regional electrical codes. A licensed electrician must determine and install the appropriate Mains Disconnect.

Copper wire must be used in the power drop. A licensed electrician must determine the wire size for the power drop according to local and regional electrical codes. The wires must be sized to ensure that the voltage at the system does not drop below 90% of the nominal voltage.

Mains Disconnect

A mains disconnect – providing over-current and short circuit protection – must be provided. It disconnects the mains circuits from the mains supply. It may be a switch disconnect or a circuit breaker. The DPT Rack and Safety Enclosure front panel switch is only a standby switch and is not a LINE switch (disconnecting device). The disconnect must:

- Comply with UL 489/CSA C22.2 No.5 standard; rated current 20 A or below.
- Open all line conductors and neutral conductors where local code applies, but does not open the protective earth conductor.
- Be marked “System Mains Disconnect” or the equivalent in your language.
- Be marked with a “I” for the “On” position and a “O” for “Off.”
- Be capable of being locked in the “**Off**” position but not in the “**On**” position.
- Be installed within three meters of the DPT Rack, where it can be easily reached by the system operator without requiring the system to be moved.

Convenience outlets should be installed near the system for external equipment. Locate the outlets within one meter (three feet) of the rear of the system.

Circuit Breakers

Circuit breakers must comply with either UL489 or, CSA C22.2 No.5 or, IEC 60947 part 2. Permanently connected systems need to test the Earth connection integrity by testing with current twice the rated current of branch circuit breaker.

Optional Safety Ground Connection

This DPT Rack must be grounded properly for proper operation and safety. The rack connects to AC mains by a plug/socket with ground connection; a permanent earth ground connection is not necessary but one is provided.

Receiving the PD1550A

Your DPT Rack and Safety Enclosure shipment arrives in multiple shipping containers – a large wood shipping crate for the rack and one or more boxes with the accessories. Before uncrating the Rack and Safety Enclosure or unpacking any accessories, carefully inspect the shipping containers for any damage that may have occurred during shipment such as:

- dents
- scratches
- cuts
- water damage

If any damage is discovered, leave the instruments in the shipping containers. Report any damage to the shipping agent immediately and request an inspection. Shipping damage is not covered by the Keysight warranty.

IMPORTANT: Make sure that all doors, elevators, and passageways in route to the site are large enough to accommodate the rack and are capable of carrying the weight.

The packaged physical specifications for the racks are listed in the “Rack and Safety Enclosure Dimensions and Weight” on page 16. Floor elevators and lifting equipment must be of sufficient capacity. If the rack or other instrument shipping crate is damaged upon receipt, request that the carrier's agent be present when the protective covering is removed. Inspect the rack and instruments for damage (scratches, dents, bent pieces, etc.). If the rack or any instrument is damaged, notify the carrier and the nearest Keysight Sales and Service office immediately.

Moving the Rack and Safety Enclosure

On initial receipt, the Rack and Safety Enclosure plus shipping crate exceeds 560 kg (1,290 lbs). Use a mechanical lift to lift the shipping crate.

The rack has six casters for moving it around on a level floor.

When transporting the Rack and Safety Enclosure for long distances or outside of a building always make sure that the environmental conditions like humidity, temperature and air pollution never exceed the related instrument specification. The temperature should not exceed -20 °C to +60 °C.

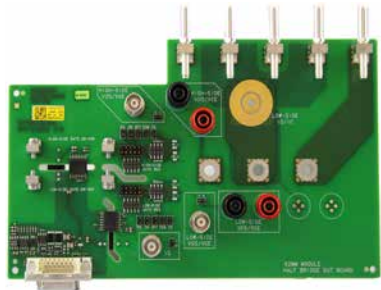
Inventory the Shipment

The DPT Rack and Safety Enclosure comes in at least two shipping containers - a wood crate for the PD1550A (all test instruments are factory installed) and one or more cardboard box for all accessories. Use the packing list that comes with your system to ensure you received all pieces of the system.

Your shipment should include the following:

- PD1550A DPT Rack and Safety Enclosure (the following test instruments are pre-installed in the PD1550A system rack):
 - Keysight MXR108A 8-Channel Oscilloscope
 - Keysight 33512B Waveform Generator
 - Keysight B2902B Precision Source/Measurement Unit
 - Heinzinger EVO High Voltage Power Supply, (PD1080A-FG for repair and Cal services)
 - PD1550A-010 Dynamic Test Fixture (standard, 1000 A, PD1550-68710)
 - PD1550A-020 Dynamic Test Control Unit
 - PD1550A-030 Dynamic Test Safety Unit
 - PD1550A-090 Dynamic Test Inductor Unit
 - PD1550A-080 Isolated Probe Technology Unit (for measuring $V_{GS,H}$), (PD1550-68760, PD1081A-FG for repair and Cal services)
- Country-specific Power Cord

Accessories included with the PD1550A

Description and Keysight Part Number	Quantity	Graphic
PD1550-67601 Red/Yellow/Green/Blue tower light, (to be installed at customer site on top of rack)	1	
PD1550-66560 DPT Test Interface Board for 62 mm Modules <u>without</u> decoupling capacitors. Note: This Interface Module is suitable for testing the PD1550A system or commissioning the system. It is <u>not</u> the best option for testing 62 mm DUT modules, it will exhibit excessive ringing on the oscilloscope.	1	

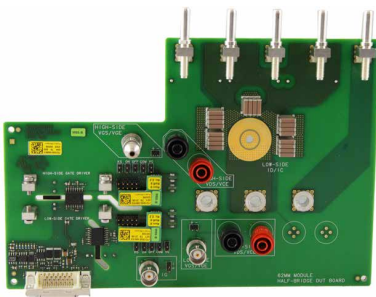
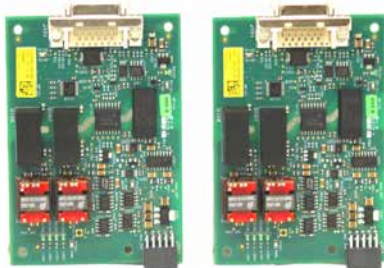
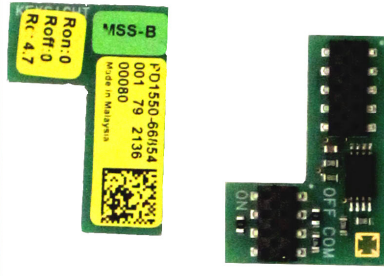
Description and Keysight Part Number	Quantity	Graphic
1854-2245 62 mm IGBT Half-Bridge Test Module (Infineon FF500R17KE4 or equivalent)	1	
1855-3111 62 mm MOSFET Half-Bridge Test Module (CREE [Wolfspeed] CAS300M17BM2 or equivalent)	1	
PD1550-61901 0.05 Ω (50 m Ω) Shunt , (PD1072A-FG for repair and Cal services)	1	
PD1550-61902 0.005 Ω (5 m Ω) Shunt, (PD1073A-FG for repair and Cal services)	1	
PD1550-61602 UDI Cables	3	
DP0001A 400 MHz High Voltage Differential Probe	2	
PD1550-61203 Probe Holder for DP0001A	2	

Description and Keysight Part Number	Quantity	Graphic
DP0031A 200 MHz High Voltage Differential Probe NOTE: Your system may have been provided with PMK PD1802A Differential Probes instead of the Keysight DP0031 probes, These probes are identical in performance.	2	
PD1550-61204 Probe Holder for DP0031A	2	
1254-5602 Probe Adapter, BNC Male to Dual 4 mm Banana Jacks	2	
N2873-60001 10:1, 500 MHz Passive Probe includes Oscilloscope Probe to BNC Adapter (used with Keysight Isolated Probe Technology for High-Side V_{GS}/V_{GE} measurements only)	1	
PD1000-60002 Protection Probe (one supplied standard, additional are optional)	1	
54609-61611, Cable Assembly - 50 Ohm, BNC to SMA, for $I_{D,L}$ Goes from PD1000-60002 Protection Probe to Shunt on DUT Interface Board IMPORTANT: Replace this cable only with same Keysight PN. This is required to maintain deskew in the system.	1	
PD1550-60003, Standard Lift Table 180 mm x 100 mm	1	

Description and Keysight Part Number	Quantity	Graphic
Holdit Pro-Set Probe Holders (no Keysight part number)	5	
Ferrite-core Inductor (9170-1792) One core for the N2873A Oscilloscope Probe. The remaining three are not used.	4	
PD1550-00010 Sheet of 14 probe labels for Probe Adapters	1	
Keys -- 4 for the rear doors of the rack and 2 for the Safety Interlocks on the front doors. One key is in the rear panel of the PD1550-030 Safety Unit. DO NOT REMOVE THIS KEY!!! ! No replacement keys or KEY part numbers are available.		
Tool kit	1 kit	Shipped in accessories box
Power Cord, country dependent with C19 Latching Socket, 3-Conductor, 250VAC	N/A	

PD1550A Accessories (not included)

The following accessories are used in the PD1550A but you must specify the quantity in the product order.

Description and Keysight Part Number	Quantity	Graphic
PD1550-66561 DPT Interface Board for 62 mm DUT modules <u>with</u> decoupling capacitors. Note: This optional Interface Module is the best choice for testing 62 mm DUT modules. It will not exhibit the ringing (oscillations) that the PD1550-66560 has.	1	
PD1550-66540 ± 28 V Gate Drive Modules Calibrated and tested (Option GD1)	Minimum 2 required, (1 for High-Side and 1 for Low-Side, they are identical)	
Gate Drive Resistor modules PD1000-66550 No installed Gate Resistor ¹ (Opt. G01) PD1000-66551 0,0,0 Ω Gate Resistor ² (Opt. G02) PD1000-66552 0,0,1.0 Ω Gate Resistor ² (Opt. G03) PD1000-66553 0,0,2.2 Ω Gate Resistor ² (Opt. G04) PD1000-66554 0,0,4.7 Ω Gate Resistor ² (Opt. G05) PD1000-66555 0,0,10.0 Ω Gate Resistor ² (Opt. G06) PD1000-66556 0,0,22.0 Ω Gate Resistor ² (Opt. G07) PD1000-66557 0,0,100 Ω Gate Resistor ² (Opt. G08) PD1000-66558 0,0,400 Ω Gate Resistor ² (Opt. G09)	Two modules are provided with each part number. Two of same resistance value are required for PD1550A	

¹ See Appendix A for instructions on selecting gate resistors (R_G). See Appendix B for instructions on installing custom gate resistors on PD1000-66550 Gate resistor modules. After installation, module requires calibration.

² For Gate Resistor value, the first two 0's are the $R_{G,ON}$ and $R_{G,OFF}$ values. The third value (e.g., 1.0, 2.2, etc.) is the shared resistor value. These Gate Resistor modules are tested and programmed.

Optional (not required) PD1550A Accessories

The following accessories are used in the PD1550A but not required.

Description and Part Number	Quantity	Graphic
PD1550-60004 (Opt. LT2) Heavy Duty Lift Table 300 mm x 150 mm (for larger DUT modules)	1	

The following cables are included with the PD1550A and are used only for the AutoCalibration procedure:

Description	Quantity	Graphic
Black Test Patch Lead, 0.64 mm Square Pin Socket to 4 mm Stackable Banana Plug, 1 M	2	
Red Test Patch Lead, 0.64 mm Square Pin Socket to 4 mm Stackable Banana Plug, 1 M	2	

What is Not Supplied with the Rack and Safety Enclosure

- Dedicated host computer. See **Host Computer System Requirements** below.
- Standard CAT5e LAN cable (to go from host computer to the DPT Rack and Safety Enclosure). This cable should be less than 3 M long.
- A qualified electrician must provide AC Power connection.

Host Computer Requirements

Operating System	Windows 10
OS versions:	64-bit.
Processor Speed:	1 GHz 32-bit (x86), 1 GHz 64-bit (x64), Itanium64 not supported
Computer memory:	1 GB minimum
Available hard disk space ¹ :	1.5 GB available hard disk space, includes: 1 GB available for Microsoft .NET Framework 4.5.2 100 MB for Keysight IO Libraries Suite
Video:	Screen resolution -- Full HD (1920x1080) at 100%. Support for DirectX 9 graphics, 128 MB graphics memory
1. Less memory may be required for operation than is required for installation.	

PD1550A Documentation

Keysight test instruments comes complete with its own documentation. Country-specific power cords and other cables or accessories may be discarded. All necessary power cords and cables are included in the DPT system Rack and Safety Enclosure.

- **PD1550A Control Software Guide:** Provides detailed information to install, configure, and use the PD1000A Control Software for the PD1550A DPT system. PN: PD1550-90001
- **PD1550A Operation and General Maintenance Guide:** Provides detailed information to operate and maintain the PD1550A Test Rack and Safety Enclosure. PN: PD1550-90003
- **PD1550A System Installation Guide:** Provides detailed information for Keysight personnel to install the Double-Pulse Rack and Safety Enclosure at a customer's site. PN: PD1550-90002
- **PD1000A Control Software Help File:** Provides the same information as this Software Guide plus additional information for using the PD1000A Control Software.

Documentation and software are available at: www.keysight.com/find/PD1550A

For detailed information about any of the test instruments, refer to the documentation provided with the instrument. Instrument documentation, data sheets, firmware updates, software updates, specifications, and more can be found on the product web pages listed below.

www.keysight.com/find/PD1000A (for Control Software, and PD1000A general information)

www.keysight.com/find/MXR108A 8-Channel Oscilloscope

www.keysight.com/find/33512B Waveform Generator, 2-Ch with ARB

www.keysight.com/find/B2902B Precision Source/Measurement Unit

www.Heinzinger.com High Voltage Power Supply Model EVO

NOTE

Adobe Reader is required to view PDF files. It is available free at: <https://get.adobe.com/reader>.

Simplified System Diagrams

Refer to “Simplified System Wiring Diagrams” on page 133 for diagrams. These diagrams illustrate the overall system wiring.

NOTE

The test instruments, Power Distribution Unit, instrument power cords, LAN cables, and all of the Safety Electronics are pre-installed in the PD1550A Rack and Safety Enclosure for your convenience.

2 Uncrate the PD1550A Rack and Safety Enclosure

The Double-Pulse Test (DPT) Rack and Safety Enclosure is the largest of the two shipping container shipped for the system. This chapter describes how to uncrate the DPT Rack and Safety Enclosure.

In this chapter:

Tools Required for Uncrating the PD1550A Rack	page 33
Uncrate the Rack and Safety Enclosure	page 34
Moving the Rack and Safety Enclosure	page 41
Re-crating the Rack and Safety Enclosure for Shipping	page 42

CAUTION

To avoid possible injury, at least two people are required to uncrate the PD1550A Rack and Safety Enclosure.

NOTE

IMPORTANT: A minimum of 3 meters (9 ft) of clearance is required all the way around and above the shipping crate to enable removing of the packing material.

Tools Required for Uncrating the PD1550A Rack

- T40 Torx screwdriver
- Optional: pry bar to remove crate clamps

Uncrate the Rack and Safety Enclosure

Use the following procedure to remove the rack from the shipping crate. Keysight recommends using two people to uncrate the Rack and Safety Enclosure. Wear work gloves to protect against splinters.

- 1 Make certain you have adequate room to uncrate the Rack and Safety Enclosure. A minimum of 4 M (12 ft) is required in front of the crate (ramp+ Rack and Safety Enclosure), 2 M (6 feet) behind the crate, and 1 M (3 feet) above the crate. See Figure 2 below.

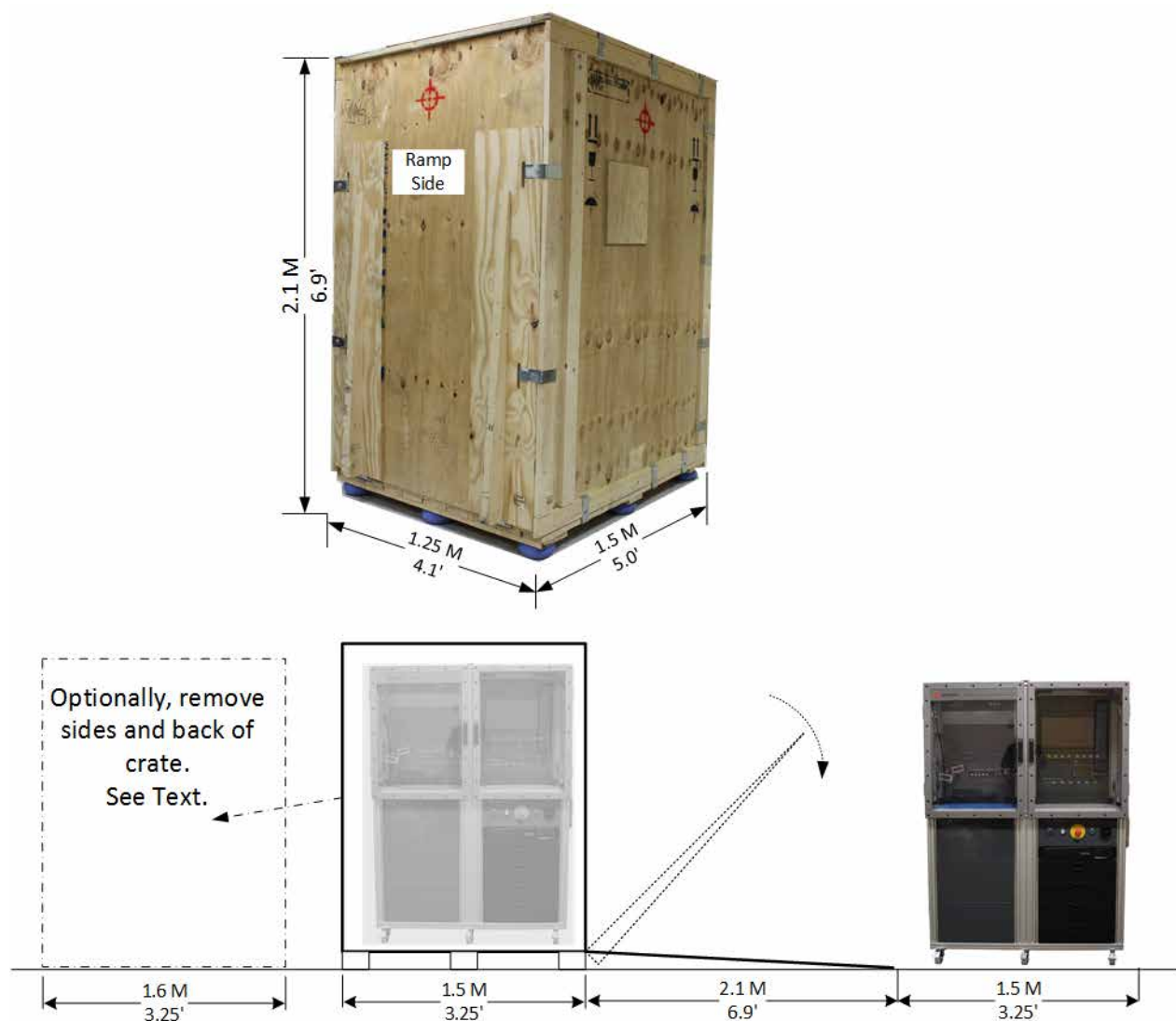


Figure 2 PD1550A Rack and Safety Enclosure Shipping Crate

- 2 Remove the TORX T40 screws and four clamps securing the ramp to the sides of the shipping crate.

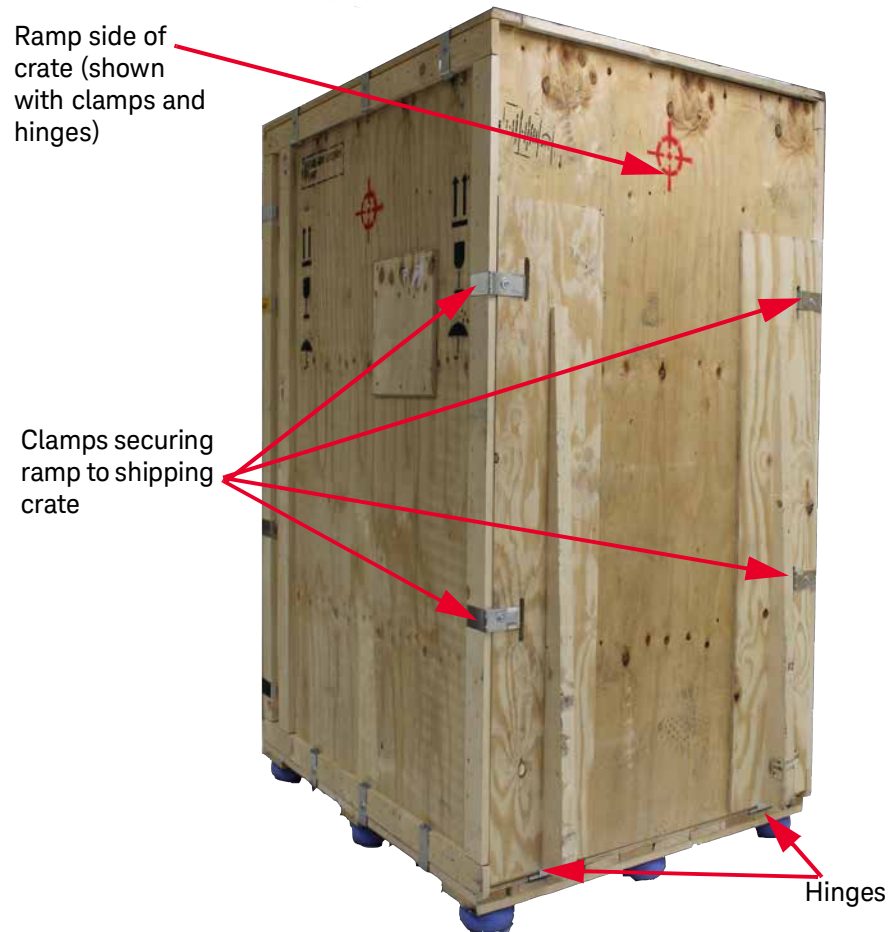


Figure 3 Remove screws and clamps from ramp

NOTE

The ramp is secured to the pallet by hinges.

- 3 Carefully unfold the ramp down to the floor.



Figure 4 Carefully open the ramp

- 4 Remove the top braces from inside the shipping crate.

Remove 8 lag bolts from sides of the shipping crate -
4 on each side of crate

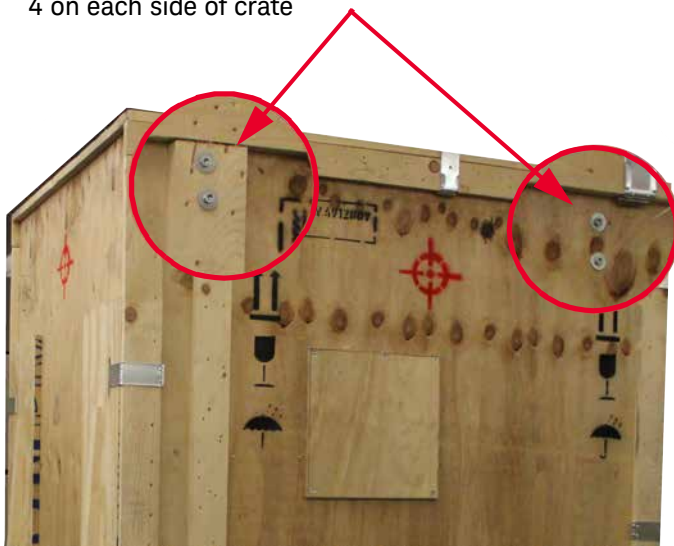


Figure 5 Remove Top Braces (Rack packing materials not shown)

NOTE

Although it is possible to remove the PD1550A Rack and Safety Enclosure from the shipping crate without removing the sides and back of the crate, Keysight recommends removing crate from the pallet. This is because the casters on the bottom of the rack must rotate freely. It is possible for the caster locking mechanism to dig into the bottom braces in the crate and not allow the casters to rotate properly.

- 5 Remove the screws and clamps that secure the crate to the pallet. Do **not** remove the screws and clamps from the sides of the crate.

Do **NOT** remove the clamps from the sides of the shipping crate

Remove the clamps from the bottom of the crate that secures it to the pallet



Figure 6 Remove clamps securing crate to pallet

- 6 Carefully slide the crate body (sides, back and top) of the shipping crate away from the shipping pallet. Set crate body on the floor behind the pallet.

CAUTION

Important: Two people are required for this step.



Figure 7 Remove crate body from the pallet (Rack packing material not shown)

- 7 Remove the front, side and rear braces from the pallet.

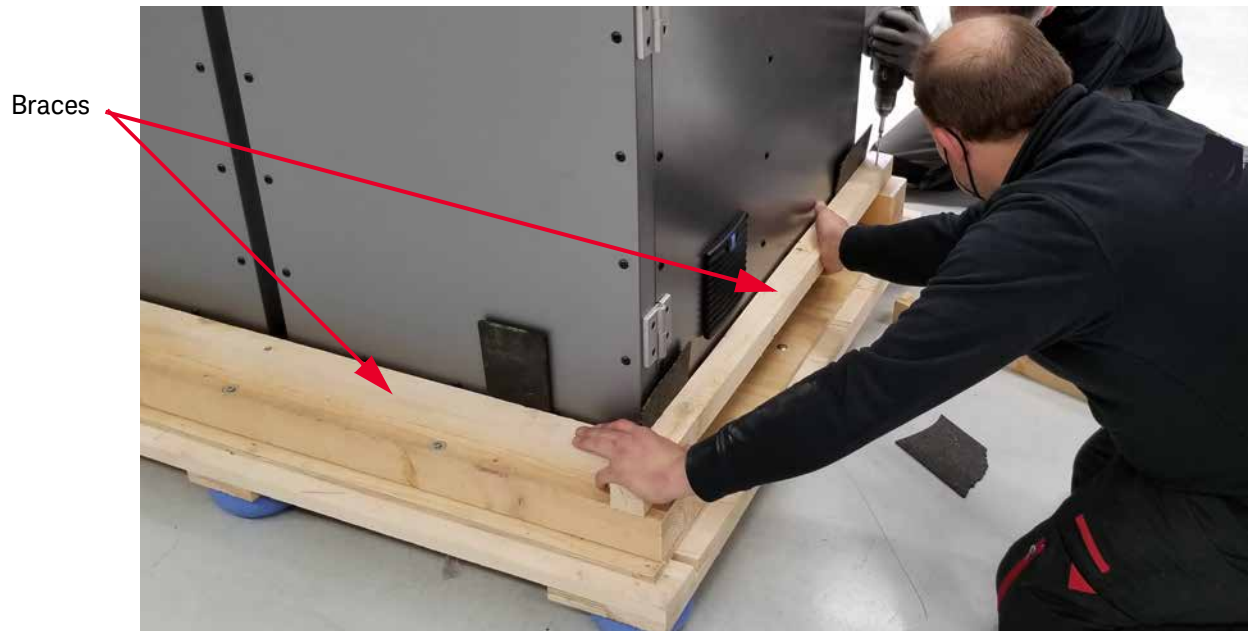


Figure 8 Remove the Braces from the Pallet (Rack packing materials not shown)

- 8 Remove packing materials from the Rack and Safety Enclosure.



CAUTION

Make sure that the casters on the bottom of the rack are unlocked before you roll the rack down the ramp.



Caster Locked



Caster Unlocked

- 9 Carefully roll the test rack and safety enclosure down the ramp.

CAUTION

At least two people are required to roll the Rack and Safety Enclosure down the ramp and to its final location.

NOTE

Keysight recommends, if possible, that you save the shipping crate and pallet if you plan to ship the rack to a different location. Refer to “Re-crating the Rack and Safety Enclosure for Shipping” on page 42 for detailed information.

Moving the Rack and Safety Enclosure

The Rack and Safety Enclosure has six wheels on the bottom of the rack. Be careful, the rack's center of gravity is high. The rack might tilt over when moving. All wheels have locking mechanisms. Ensure the wheels are locked when using the DPT Rack and Safety Enclosure and unlocked when moving the rack.

After uncrating the Rack and Safety Enclosure, it may be necessary to move the system to a new location.

Shut down the system correctly as described in the manual. Make sure the line power connection was removed correctly from the system. Make sure there is no energy left in the circuits by discharging all circuits to earth. Disconnect all adapters from the system. Disconnect all peripherals that are connected outside the system. Make sure there are no loose components inside the system rack.

NOTE

IMPORTANT: The DPT Rack and Safety Enclosure has six wheels or casters on the bottom. These casters are lockable to prevent the rack from moving. Make certain the wheel locks are disengaged before moving the rack.



Caster Locked



Caster Unlocked

CAUTION

Be very careful when moving the Rack and Safety Enclosure around. The rack's center of gravity is high and the rack might tilt over when moving.

Re-crating the Rack and Safety Enclosure for Shipping

If you need to ship the Double-Pulse Test system to a different location – beyond where it can be rolled on its casters – prepare the PD1550A system for shipping per the following instructions.

NOTE

IMPORTANT: For service and calibration of individual instruments in the PD1550A test system, **DO NOT SHIP THE ENTIRE** Rack and Safety Enclosure to Keysight. Instead, contact Keysight for an Application Engineer to come to your site, remove the individual instrument(s), and return to Keysight. Attach a tag indicating the type of service required, your return address, and model number of the device to be repaired. Refer to the instructions included with each instrument for return instructions.

- 1 Turn the system OFF with the Power On/Off Switch.
- 2 Unplug the AC power cord from the test system Rack and Safety enclosure.
- 3 Remove all test modules, oscilloscope probes, any loose parts from the DPT work surface. These should be packaged separately for shipping.
- 4 Remove any loose pieces (installation bolts, cables, etc.) before shipping.
- 5 Unplug the tower light and remove the tower light from the rack. Refer to “Install Tower Light on Top of the Rack,” starting on page 45 for detailed instructions.
- 6 Wrap the Rack and Safety Enclosure in plastic and foam before putting it in the shipping crate. Use the original packing material if possible. This will protect the rack and safety enclosure from dust, dirt, and scratches during shipping.
- 7 Place the Rack and Safety Enclosure inside the shipping crate. Lock the casters so that the rack does not shift during transportation.
- 8 Install the braces around the base of the rack and the two top braces to prevent it from moving around inside the shipping crate.

When transporting the Rack and Safety Enclosure for long distances or outside a building always make sure that the environmental conditions like humidity, temperature and air pollution never exceed the related instrument specification. The ambient temperature should not exceed -20 °C to +60 °C.

3 Accessory and Probe Installation

This chapter describes the PD1550A system installation process. It includes both system rack hardware assembly as well as installation requirements for general system operation.

Tools Required to Install Accessories	page 44
Install Tower Light on Top of the Rack	page 45
Apply Power and Turn On the PD1500A	page 47
Connect Three Short BNC Cables	page 48
Rack Connections	page 49
Open the Side Shelf	page 51
Install Probe Holders	page 53
Install Components on PD1550A Interface Module	page 56
Install Coaxial Shunt Resistor	page 56
Attach 62 mm DUT Module	page 57
Connect Interface Module to PD1550A Test System	page 65
Install Gate Drive Modules on the Interface Module	page 63
Install Gate Drive Resistor Modules on the Interface Module	page 60
Connect Probes to Oscilloscope	page 67
Connect Oscilloscope Probes to DUT Interface Module	page 70
Connect Probe for High-Side DUT Measurements	page 72
Install UDI Cables	page 75
Install Additional Test Fixture Accessories	page 76
External Loads	page 76
NTC Thermistor Connector	page 77
Fan Out 24 VDC	page 78
Type K Thermocouples, CH1 and CH2	page 78
Install Optional InTEST Temperature Controller with Heating Plate	page 81
Install Optional InTEST - Temptronic Thermostream Heater/Cooler System	page 85
Thermostream Compressed Air Requirements	page 87

Tools Required to Install Accessories

- Small step ladder to access top of rack to install Tower Light
- #2 Pozidrive screwdriver to attach Tower Light, 62 mm DUT module to Interface Module, etc.
- 10 mm open-end wrench to attach probe holders to rails inside of rack
- Optional 5/8" open-end wrench to tighten probe holders
- T10 Torx screwdriver to attach Gate Drive Modules to Interface Module

NOTE

IMPORTANT: Installing the Light Tower should be done before applying power and turning on the system.

Power must be supplied to the PD1550A system and the system turned on before the front safety doors can be opened. Refer to "Apply Power and Turn On the PD1500A" on page 47 for information regarding system turn on.

Stabilize the Rack

After moving the PD1550A rack to its final position, lock the casters to prevent accidental moving.



Caster Unlocked



Caster Locked

Figure 9 Caster Locked and Unlocked

Install Tower Light on Top of the Rack

Installing the Light Tower should be done before applying power and turning on the system. Make sure the rack is turned off and the power cord disconnected before installing the Tower light.

The four color tower light is shipped in an accessory box. Mount it on top of the PD1550A rack.

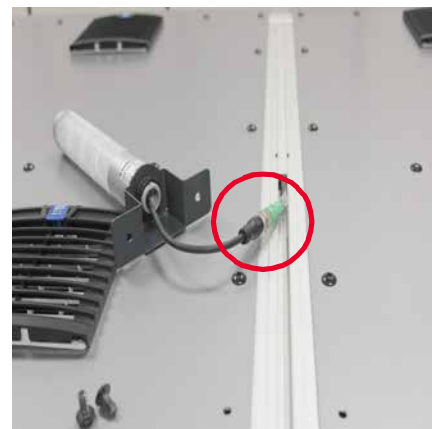
-
- 1** Locate the tower light in the group of accessories.



-
- 2** Standing on a small step ladder, locate and remove two Phillips mounting screws on top of the rack.



-
- 3** Connect the 8-pin Tower Light cable and securely tighten.



-
- 4** Using the two Phillips screws previously removed, install the Tower light. Securely tighten the mounting screws.



-
- 5** Ensure the tower light cable connector and the mounting screws are tight. Route the cable in the slot.



On the Tower Light:

- Red indicates high voltage >42 V to 1300V is present in the system.
- Yellow indicates a system failure or the system is turning on.
- Green indicates no high voltage is present, the front doors may be opened.
- Blue indicates a test is running, the front doors are locked.

Apply Power and Turn On the PD1500A

Connect the PD1500A to an appropriate AC power source (see Chapter 1 for detailed information). At this time all lights in the Tower Light should be off.

Turn the **Power** knob to the **ON** position. The **Yellow** tower light should be on; all other lights should be off.

Press the **RESET** button the front of the PD1500A rack. All Tower Lights should turn on **ON** for approximately 10 seconds. Afterward, only the **Red** Tower Light remains on. The two white lights inside of the rack may be on. After a few moments, the **Red** Tower Light turns off and the **Green** Tower Light turns on.

Wait a few minutes while the oscilloscope turns on and installs all of its applications. A single yellow trace appears when the oscilloscope is finished installing its applications.

Press and hold the **Door Open** button to open the two front doors.-- you may need to pull very hard to open the doors.

Remember, to open the doors on the PD1550A:

- Power must be supplied to the PD1550A system
- PD1550A system turned on
- **Green** Tower Light must be on - all other tower lights off

NOTE

All doors, both front and rear of the test rack, must be closed and locked before running any DPT test.

Connect Three Short BNC Cables

Three short BNC-BNC cables should come pre-installed from the factory. These BNC - BNC cables connect the Waveform Generator to the patch panel immediately below the oscilloscope. Ensure that these cables are in place.



Figure 10 Three short BNC - BNC cables

Rack Connections

USB, External LAN, and HDMI Connectors

The following sockets are on the right side of the PD1550A rack. Connect your site LAN cable or a LAN cable to the controller PC to the LAN External socket. The two USB and the HDMI sockets are reserved for future use only. Do not connect anything to these three sockets.

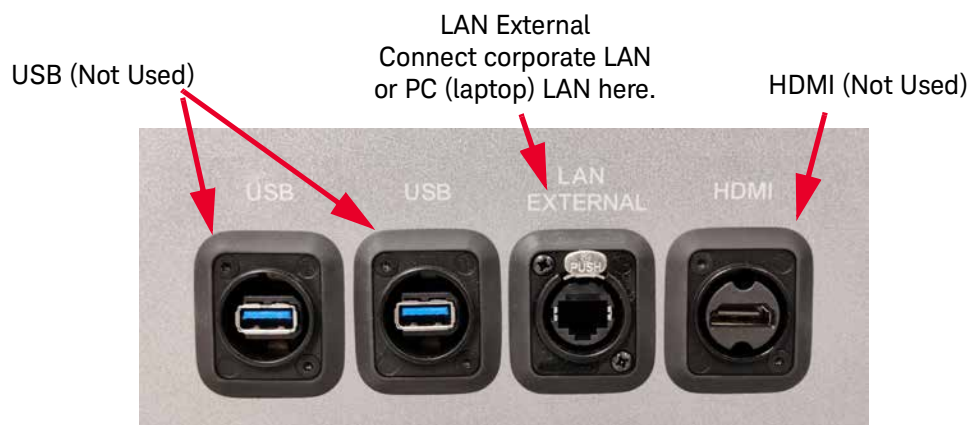


Figure 11 Electrical Jacks near the Shelf

NOTE

USB and HDMI jacks are reserved for future use only.

External Ground Connector

External Ground connection for safety ground on right side of PD1550A rack.



Figure 12 External Ground Connector on right side of Rack

LAN External, E-Stop Signal Light Connectors

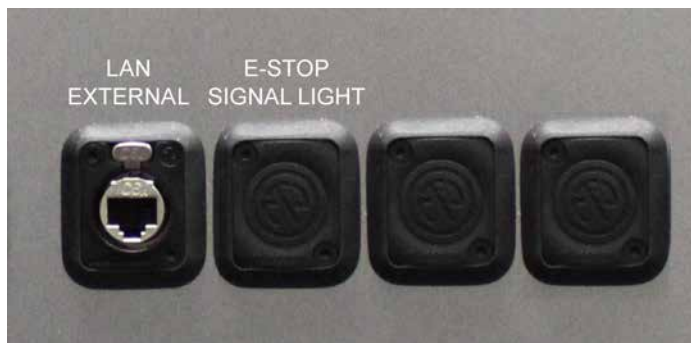


Figure 13 External LAN and Emergency Stop Connectors

NOTE

These jacks are reserved for future use only.

Power In / Power Out Connectors

Maximum AC Power Input to the PD1550A is 12 A at 200 - 250VAC, 2800 Watts.

The Power Out socket is to power an external monitor. It is rated at 6 A maximum.



Figure 14 Power Input and Power Output Connectors

Open the Side Shelf

The shelf is already installed on the rack. It is suitable for holding a laptop computer, test modules, a notebook, etc.

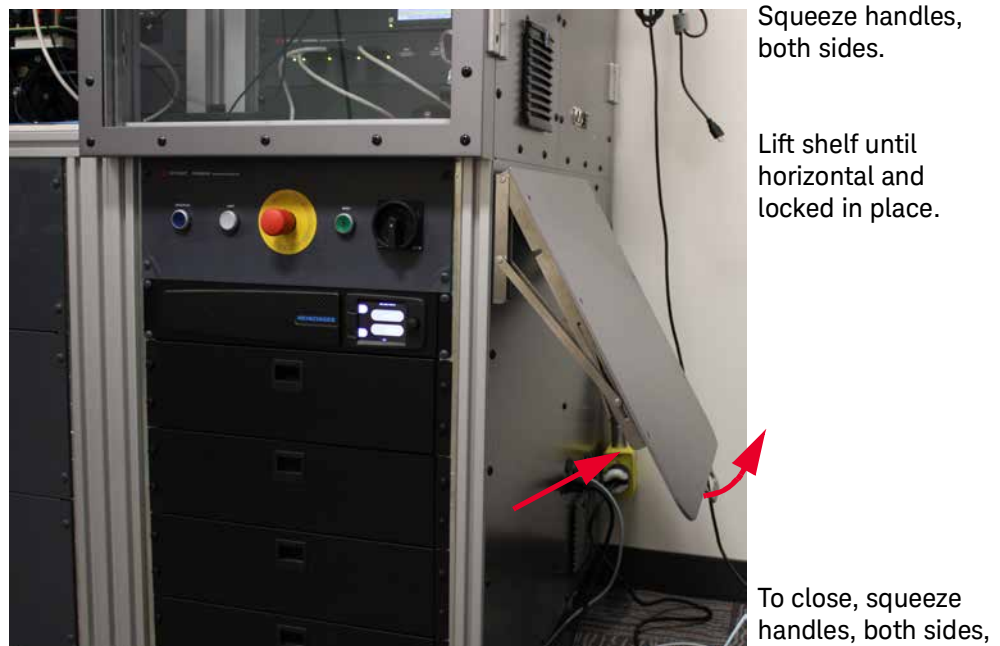
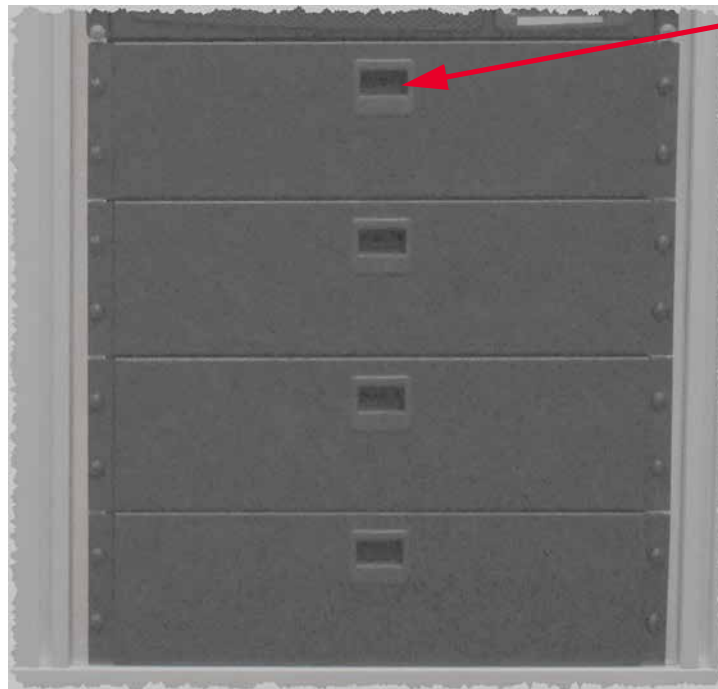


Figure 15 Lift the shelf into position until it locks

Open the Drawers



Press the latch down and pull the drawer out to open.

Figure 16 Opening the Rack Drawers

Install Probe Holders¹

Probe Holder Rails on either side of the left side of the Rack. You may install the probe holders in any of the rail mounting holes. Typically, three probe holders are installed on each side and equally spaced on the rails.

- 1 Remove the probe holders from their blister pack(s).¹



- 2 Thread the Quick Release onto the short threaded end of the articulating arm.



- 3 Locate the two probe holder mounting rails in the left side of the rack enclosure.



- 4 Insert and thread the long threaded arm of the Holdit Arm into the rail. Use a 10 mm wrench to tighten the arm on the rail.

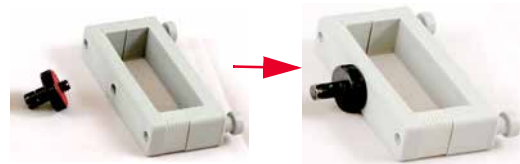


¹ Holdit Pro-Set HS9000 from Noga. For additional information see, www.hoditbynoga.com.

-
- 5** Thread a Nut onto the arm on the back side of the rail. Use a 10 mm wrench to hold the Holdit Arm while hand-tightening the Nut.



-
- 6** Screw the Quick Release Attachments onto the Probe Holders. Hand tighten.



-
- 7** To connect the Quick Release Attachment to the Quick Release, pull back on the red Quick Release sleeve and insert the attachment.



-
- 8** Attach one Probe Holder on each probe.

1 Converter and XchangeCube pieces are not used and may be discarded.

Add Ferrite Core Inductor to N2873A Probe

One 9170-1792 Common Mode choke (ferrite-core inductor clamp) must be added to the N2873A 10:1 Standard oscilloscope probe. On the N2873A probe locate the clamp six to seven inches (15 to 18 cm) from the BNC connector. Pass the cable through the clamp two times.

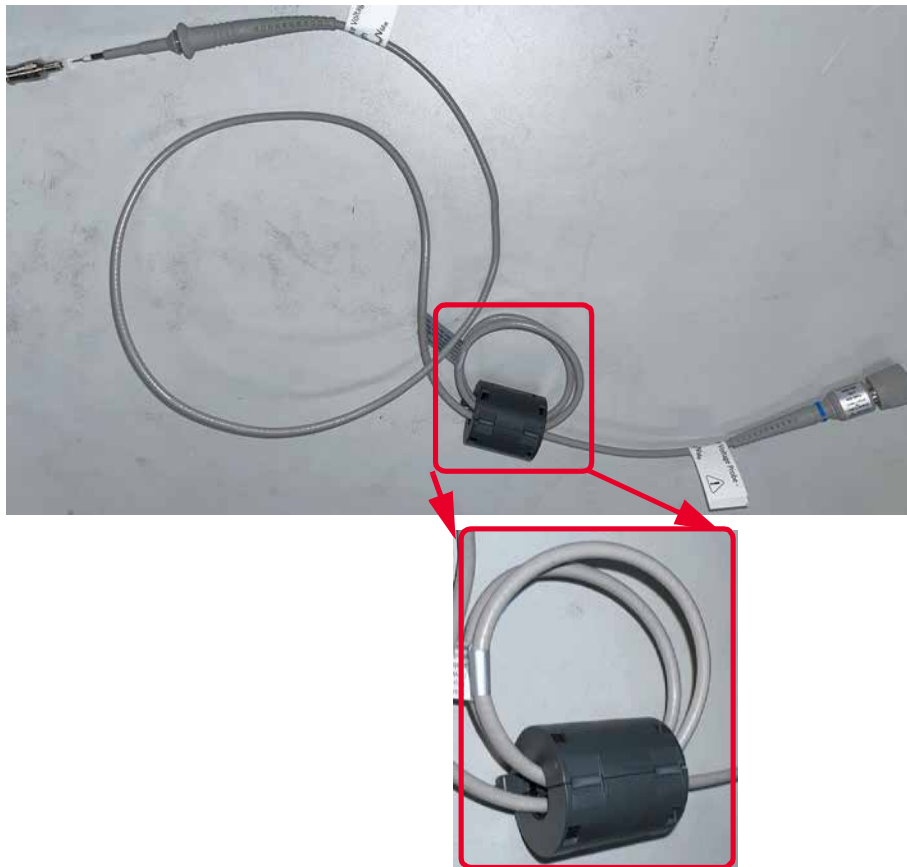


Figure 17 Install Ferrite Clamp on N2873A Oscilloscope Probe

NOTE

Handle with care. The ferrite-core or clamp case may crack if it is dropped or experiences mechanical shock. Do not use excessive force when closing the clamp. It should close with relative ease.

NOTE

Do not wind the cable too tightly or crimp the cable. You may want to add zip-ties to the cable to hold it in place. Do not over tighten the zip-ties and crimp the cable.

NOTE

Four ferrite clamps are provided with the PD1550A. Only this one is used. The remaining three clamps are extras and not used

Install Components on PD1550A Interface Module

NOTE

Important: This section and the following photographs show pictures with the standard 62 mm Interface Module supplied with the PD1550A system. Other Interface Modules including custom Interface Module may be different and require different connections.

Install Coaxial Shunt Resistor

Installation instructions are valid for:

- PD1550-61901, BNC Shunt Resistor, 0.05 Ω , Calibrated (for PD1550A)
- PD1550-61902, BNC Shunt Resistor, 0.005 Ω , Calibrated (for PD1550A)

The coaxial shunt must be installed on the DUT or interface module. It must be removed and re-installed when changing modules. It also must be removed and shipped to a Keysight Service Center for annual characterization. Refer to the *PD1500A Service Guide* or *PD1550A Service Guide* for detailed information.

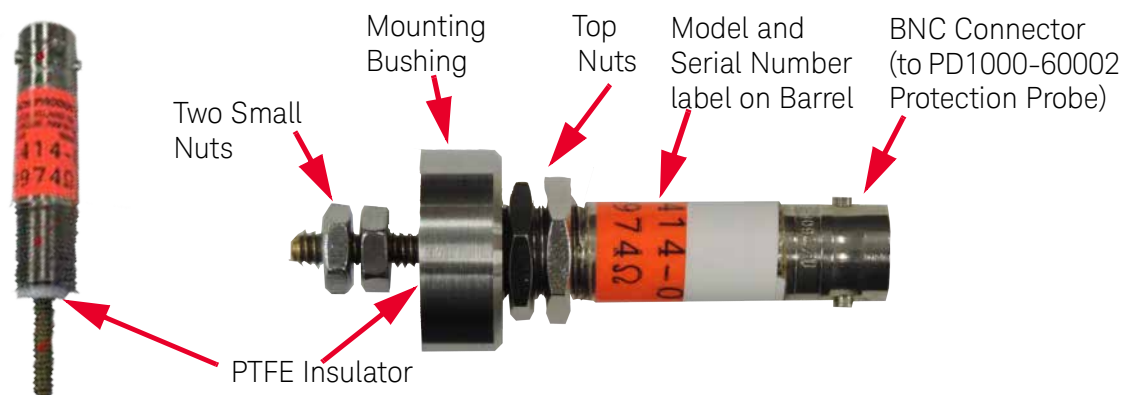


Figure 18 Coaxial Shunt Resistor

CAUTION

IMPORTANT: PD1550-61901, 0.05 Ω , has a 200 A limit. Any test currents or calculated currents greater than 200 A after the 2nd pulse will automatically fail the DPT test. For currents greater than 100 A, use the PD1550-61902, 0.005 Ω shunt.

NOTE

The PD1550-61901, 0.05 Ω , and PD1550-61902, 0.005 Ω shunts will not fit with the PD1500A system DUT modules.

The PD1000-61901, 0.01 Ω and PD1000-61902, 0.001 Ω shunts must not be used with the PD1550A system due to the higher currents used in the PD1550A system.

- 1 Remove both small nuts from the Shunt Resistor.
- 2 Screw the Top Nuts as far as possible to the top of the Shunt Resistor.
- 3 Screw the Mounting Bushing against the top nuts.
- 4 Insert the threaded shaft of the Shunt on the module. The PTFE Insulator must touch the top of the PC board.
- 5 Hand tighten one of the small nuts on the bottom of the module.
- 6 Screw the Mounting Bushing to the bottom, against the module. Hand tighten only.
- 7 Tighten the Top Nut(s) against the Mounting Bushing. Hand tighten only.
- 8 Tighten the second small nut against the first small nut on the bottom of the module. Hand tighten only.

**CAUTION**

Hand-tighten nuts and Mounting Bushing only. The Mounting Bushing must rest against the large circular copper pad on the Module. Ensure all nuts are snug. Do not use a wrench to tighten the nuts; do not over-tighten. Over-tightening the nuts may cause the PTFE insulator to split.

Attach 62 mm DUT Module

A standard 62 mm IGBT or FET power module may be attached to the PD1550-66560 or PD1550-66561 Interface Modules for testing.

NOTE

The PD1550-66560 Interface Module supplied with the PD1550A does not have decoupling capacitors installed on the module. It is suitable for testing the system or commissioning the system. It is not the best module for testing 62 mm DUT modules.

The PD1550-66560 Interface Module with decoupling capacitors is an option to the PD1550A; it is the best choice for testing 62 mm DUT modules.



Figure 19 Typical 62 mm IGBT Module (62 mm FET module is similar)

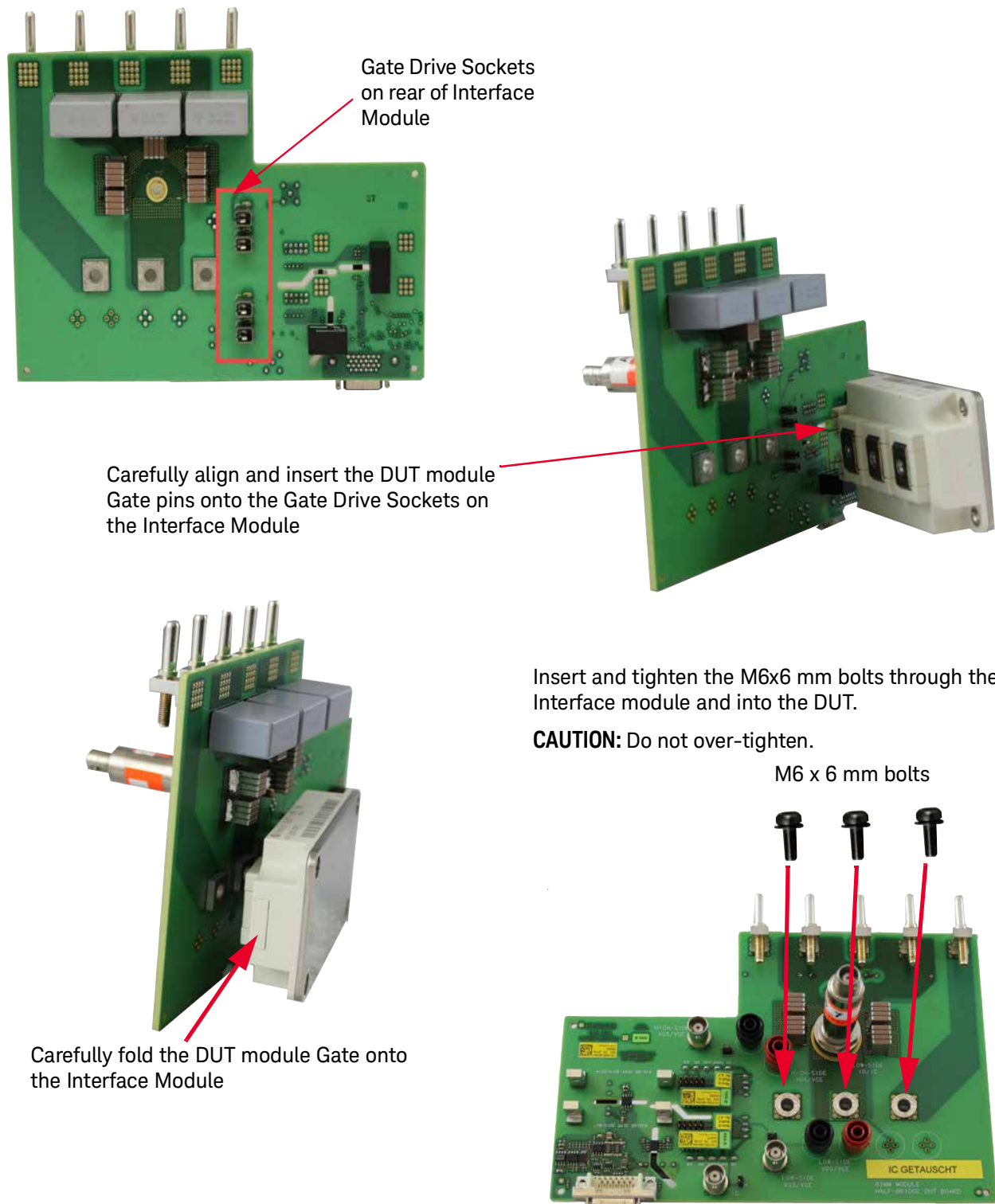


Figure 20 Installing a 62 mm DUT Module on the PD1550A Interface Module

CAUTION

Do not over-tighten bolts. Do not exceed maximum bolt depth into the module.

Install Gate Drive Resistor Modules on the Interface Module

These are tested and calibrated (except for the blank modules). Both High-Side and Low-Side Gate Drive Resistors should have the same resistor value.

Which resistor modules should you use or how do you select custom gate drive resistors? Many FETs and IGBTs have an internal gate resistor, but an external gate drive resistor plays a crucial role in limiting noise and ringing in the gate drive path. Parasitic inductances and capacitances, high dv/dt and di/dt can cause unwanted oscillations and other behavior unless an appropriate-valued gate drive resistor is used.

NOTE

Always use High-Side and Low-Side Gate Drive Modules with the same value resistors. For example, using a 100 Ω Gate Resistor on the High-Side transistor and a 0 Ω resistor on the Low-Side transistor, could cause false turn-on of the non-switching transistor due to high dv/dt and the weakly-driven gate. A 0 Ω resistor on the transistor that is not being switched is generally okay.

NOTE

Switching characteristics of the DUT are influenced by the gate resistor value. A small resistor value allows for faster switching but might increase the ringing. A large gate resistor value slows down the turn-on of the device but allows for a more accurate gate charge measurement.

NOTE

di/dt is a factor of R_G and V_G . If you are trying to match the di/dt value given in a device data sheet, install an appropriate gate drive resistor (R_G) on a blank Gate Drive Module; use an appropriate V_G . It may take several test iterations to match the data sheet di/dt .

PD1550A Gate Resistor Modules are labeled in the form: x, x, xxx, where the first value (typically 0) refers to the R_{ON} resistor value on the module, the second value (typically 0) refers to the R_{OFF} resistor value on the module. The final number (e.g., 4.7, 20, 100, etc.) refers to the value of the common resistor R_C .

Schematic of Path for Gate Resistors

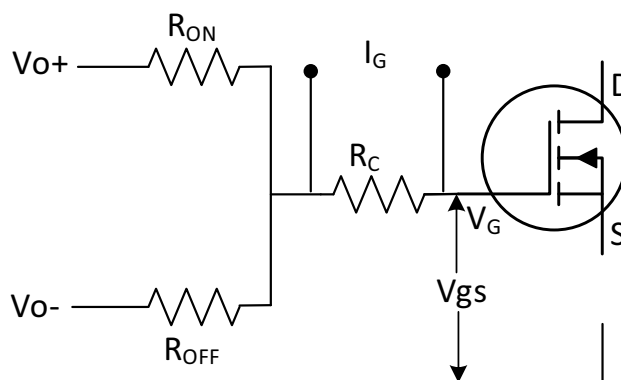


Figure 21 Schematic of Gate Drive Resistors

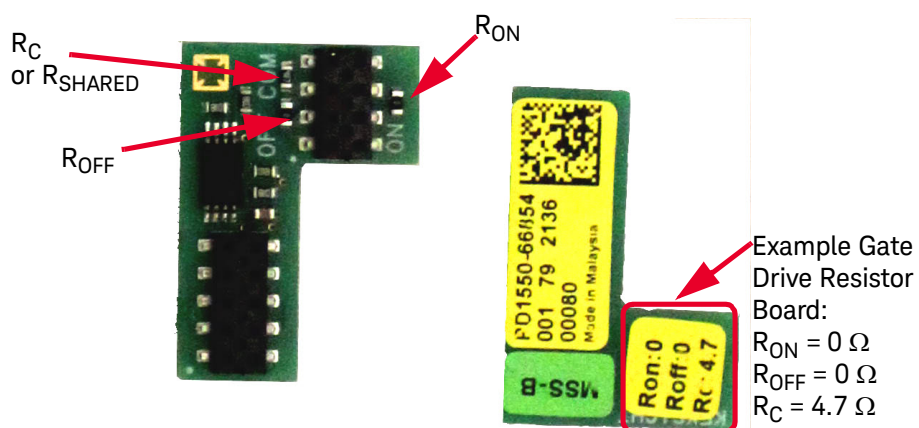


Figure 22 PD1550A Gate Drive Resistor Modules

How to Measure Gate Resistors

You can use a DMM to measure the Gate Resistors directly on the resistor module or, after installing the Gate Resistor Modules on the Interface Module, you can measure the resistor values on the Interface Module itself. This helps to insure the Gate Resistor Modules are properly installed.

- To measure R_C : **VG** to **RC** (R_{SHARED})
- To measure R_{ON} : **ON** to **RC** (R_{SHARED})
- To measure R_{OFF} : **OFF** to **RC** (R_{SHARED})

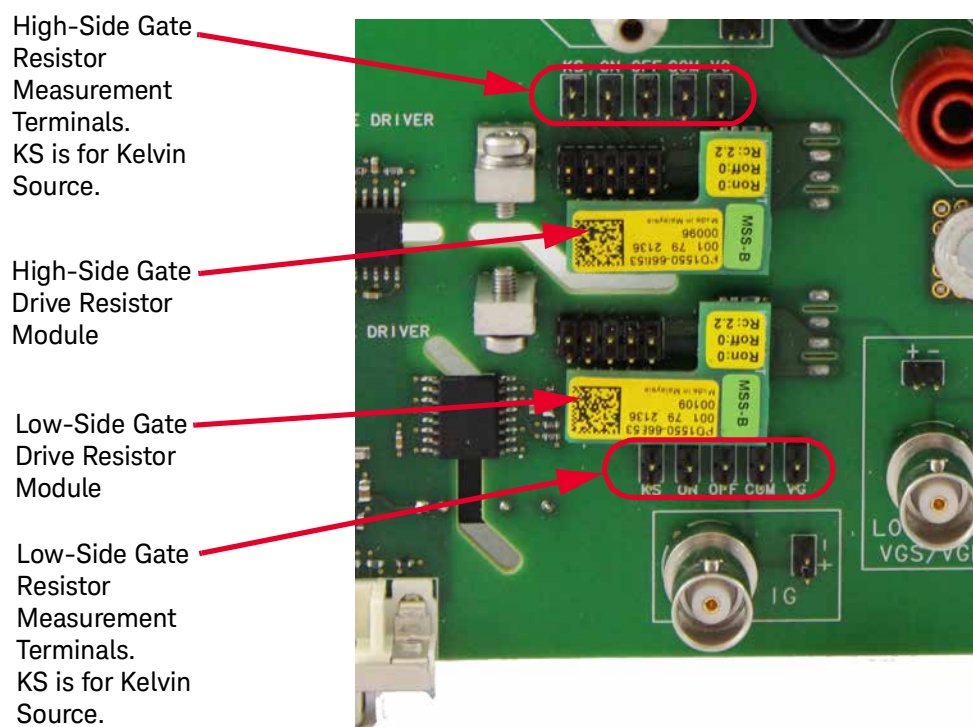


Figure 23 Measuring High-Side and Low-Side Gate Drive Resistor Values (SHRD is the same as R_G)

Install Gate Drive Resistor Modules on the Interface Module

Carefully align the two sockets on the resistor board with the two sets of pins on the Interface Module. Press the Gate Resistor Modules onto the pins.

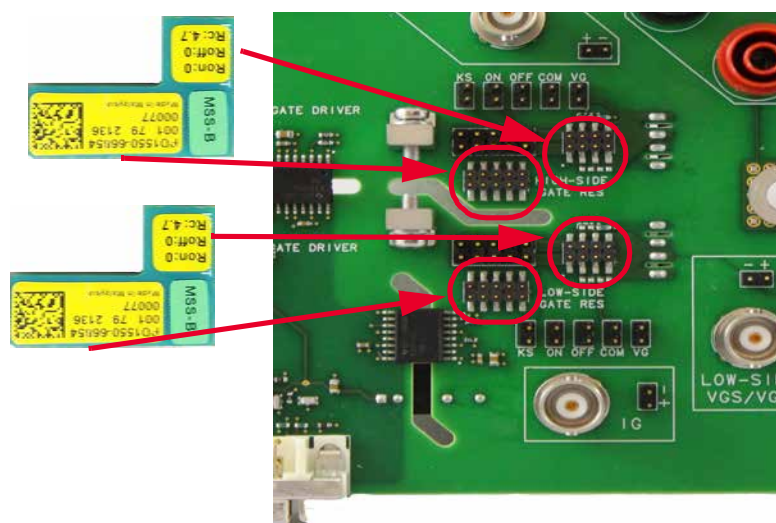


Figure 24 Install Gate Resistor Modules on Interface Module

Install Gate Drive Modules on the Interface Module

Remove the four screws (two for each module) from the Gate Drive Module mounting brackets.

Carefully align the High-Side Gate Drive Module with the pins on the Interface Module. Press the module onto the pins.

Carefully align the Low-Side Gate Drive Module with the pins on the Interface Module. Press the module onto the pins.

Optionally, use the T10 TORX screws to secure the Gate Drive Modules to the brackets on the Interface Module.

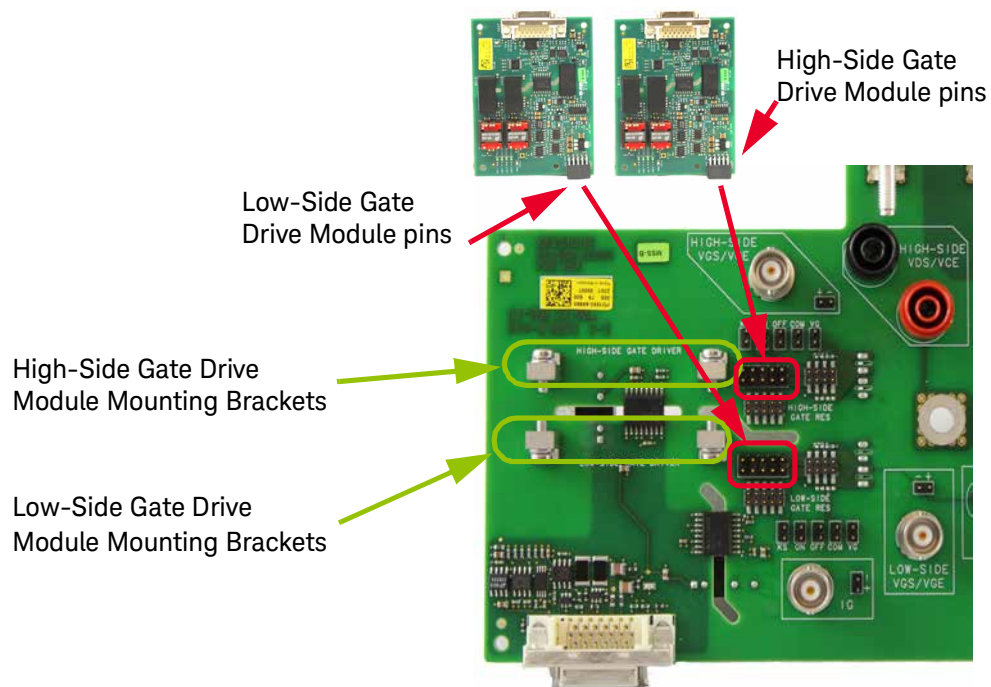


Figure 25 Install High- and Low-Side Gate Drive Modules (Gate Resistor modules not shown)

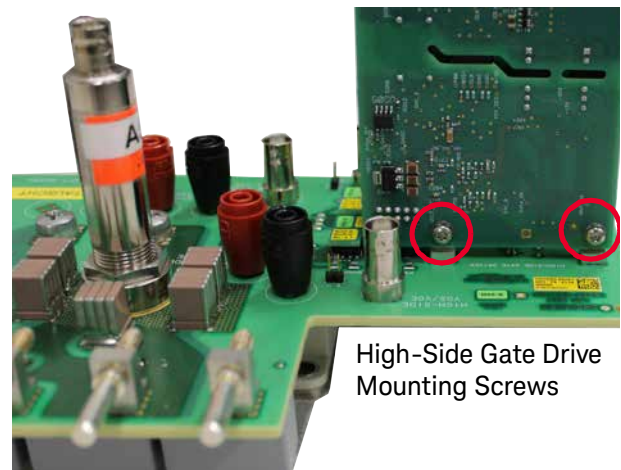
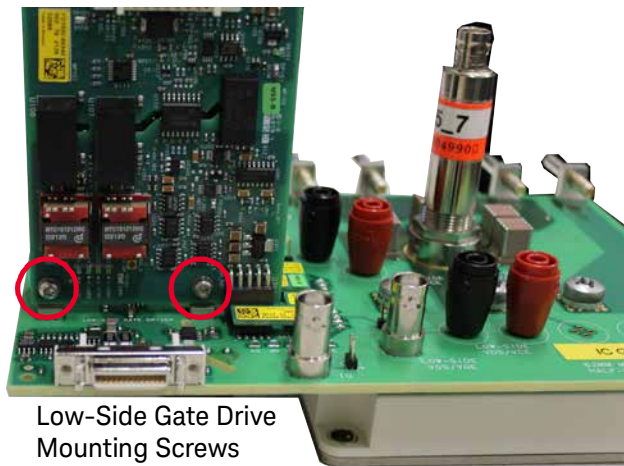


Figure 26 Optional Low-Side and High-Side Gate Drive Module Mounting Screws

Connect Interface Module to PD1550A Test System

If using the InTEST Thermal Plate, place it on the Lift Table first, then the DUT Module on top of the Thermal Plate.

If not using the InTEST Thermal Plate, place the module on the Lift table. Raise the lift table until the high voltage pins on the Interface Module align with the sockets on the Test Fixture. Push the Interface Module high voltage pins into the connectors on the Test Fixture.

CAUTION

The Interface Module must be perpendicular to Test System. It must not be either too high or too low.

Install UDI Cables to the Gate Drive and Interface Modules

Connect UDI cables to the connectors at the top of the High-Side and Low-Side Gate Drive Modules.

Connect a UDI cable to the Interface Module in front of the Gate Drive Modules.

NOTE

Any UDI cable may be connected to any UDI Connector and UDI port on the PD1550-020 Control Unit. Typically:

- UDI Port 1 connects to the Low-Side Gate Drive Module
 - UDI Port 2 connects to the High-Side Gate Drive Module
 - UDI Port 3 connects to the Interface Module in front of the Gate Drive Modules
-

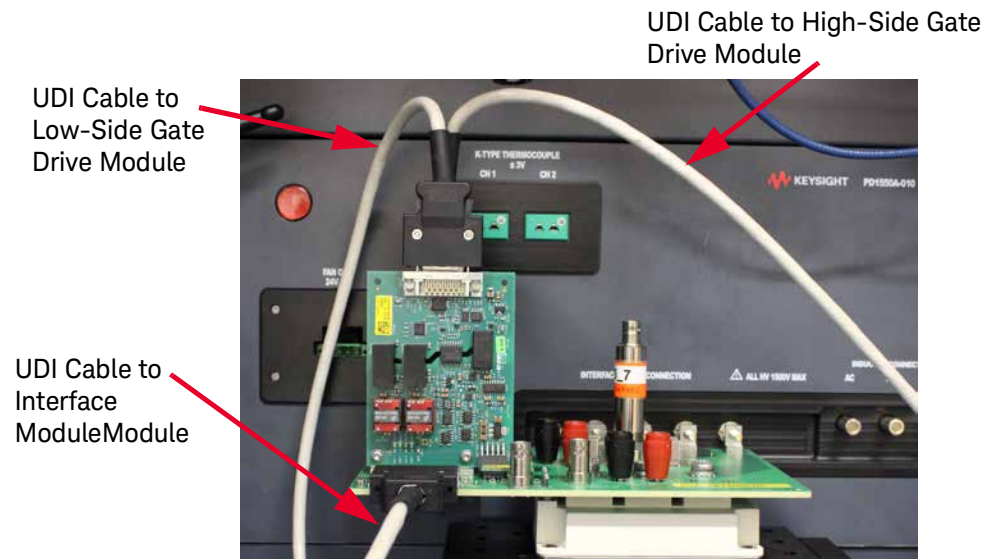


Figure 27 Install UDI Cables on Gate Drive and Interface Modules

Connect Probes to Oscilloscope

- 1 Attach the probe connector to the appropriate oscilloscope channel.
- 2 Connect the probe to the appropriate DPT Test Module.

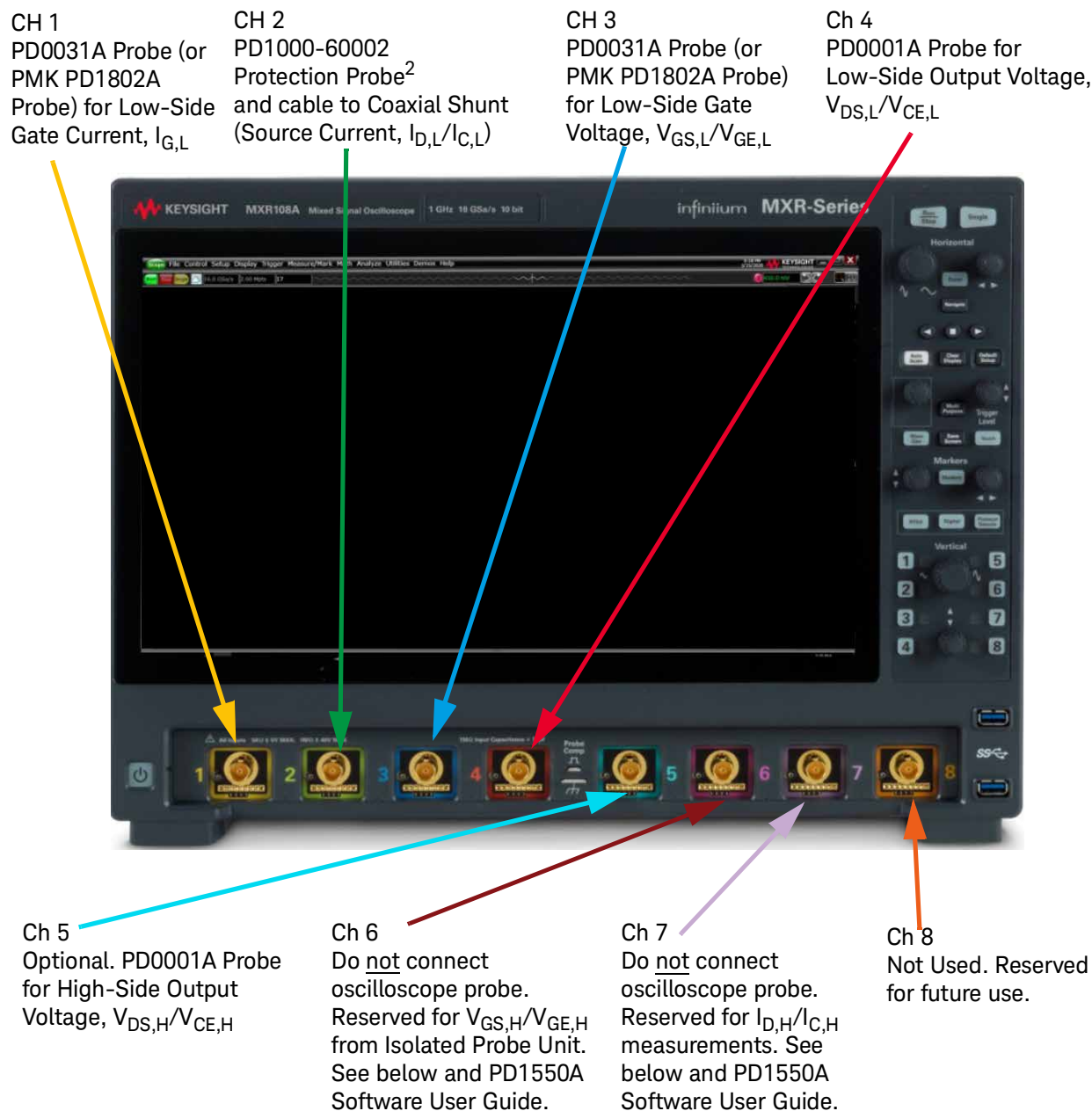


Figure 28 PD1550A Oscilloscope Probe Connections

Oscilloscope Channel	Color	Measures	Oscilloscope Probe
1	Yellow	Low-Side Gate Voltage: $V_{GS,L}/V_{GE,L}$ (LOW-SIDE VGS/VCE on Interface Module)	DP0031A Differential Probe ¹ (requires banana to BNC adapter)
2	Green	Low-Side Output Current: $I_{D,L}/I_{C,L}$ (LOW-SIDE ID/IC on Interface Module) ²	PD1000-60002 Protection Probe and cable to Coaxial Shunt ³
3	Blue	Low-Side Output Voltage: $V_{DS,L}/V_{CE,L}$ (LOW-SIDE VDS/VCE on Interface Module)	DP0031A Differential Probe ¹ (requires banana to BNC adapter)
4	Red	Low-Side Gate Current, $I_{G,L}$ (IG on Interface Module)	DP0001A High Voltage Differential Probe
5	Lt Blue	Optional. High-Side Output Voltage, $V_{DS,H}/V_{CE,H}$ (Interface Module HIGH_SIDE VDS/VCE)	DP0001A High Voltage Differential Probe
6	Dark Red	Do <u>not</u> connect oscilloscope probe. See “ Connect Probe for High-Side DUT Measurements ” below and PD1550A Software User Guide.	Reserved for $V_{GS,H}/V_{GE,H}$ from Isolated Probe Unit.
7	Purple	See “ Connect Probe for High-Side DUT Measurements ” below and PD1550A Software User Guide.	Reserved for $I_{D,H}/I_{C,H}$. See PD1550A Software User Guide.
8	Orange	Not used. Reserved for future use.	Not used. Reserved for future use.

1 Your system may have been provided with PMK PD1802A Differential Probes instead of the Keysight DP0031 probes. These probes are identical in performance.

2 Replace this cable with only the same Keysight part number. The length and type of this cable is assumed for correct Deskew.

3 Use the 0.56 N-m (5 lb-in) 5/16 in. SMA Break-over torque wrench (provided with the PD1550A system) to tighten the SMA cable connector to the PD1000-60002 Protection Probe. Failure to do so might cause extensive ringing in the DPT measurements. See appendix for details.

NOTE

The oscilloscope channels and colors shown above are recommended. You may choose different channels. All examples and screen captures shown in the DPT documentation use this configuration. The colors on the PD1000A Control Software screen match the oscilloscope probe channel number colors: i.e., Channel 1 - $V_{GS,L}/V_{GE,L}$ for Low-Side Gate Current is yellow, Channel 2 - $I_{D,L}/I_{C,L}$ for Low-Side Output Current is green, etc.

NOTE

Do not use a different cable for $I_{DS,L}$ or Isolated Probe Unit oscilloscope probes. The cables and oscilloscope probes supplied with your PD1550A provide correct probe deskew.

CAUTION

- Do not exceed maximum input voltage rating on oscilloscope.
 - The maximum input voltage for 50 Ω input impedance is ± 5 V.
 - The maximum input voltage for 1 M Ω input impedance setting is 30 V_{rms} or ± 40 V_{max} (DC + V_{peak}).
 - Probing technology allows for testing of higher voltages. No transient over voltage allowed.
-

CAUTION

When a probe, adapter, or cable is attached to the oscilloscope, the channel input circuits can be damaged by ESD. Avoid applying static discharges to anything connected to the oscilloscope. Ensure the oscilloscope is properly earth-grounded to prevent buildup of static charge. Wear a wrist strap or heel strap.

CAUTION

Loose cables can hold electrostatic charges. The free end of a cable touching a charged surface can cause oscilloscope input damage. Before connecting any cable to an oscilloscope input, short the center and outer conductors of the cable together to ground momentarily. Alternately, connect to a 50 Ω termination adapter to discharge the cables.

Connect Oscilloscope Probes to DUT Interface Module

NOTE

Important: This section and the following photographs apply only to the standard 62 mm Interface Module supplied with the PD1550A system. Your custom Interface Module may be different and require different connections.

Refer to Figure 29 below. Oscilloscope probes connect to the Test Interface Module as follows:

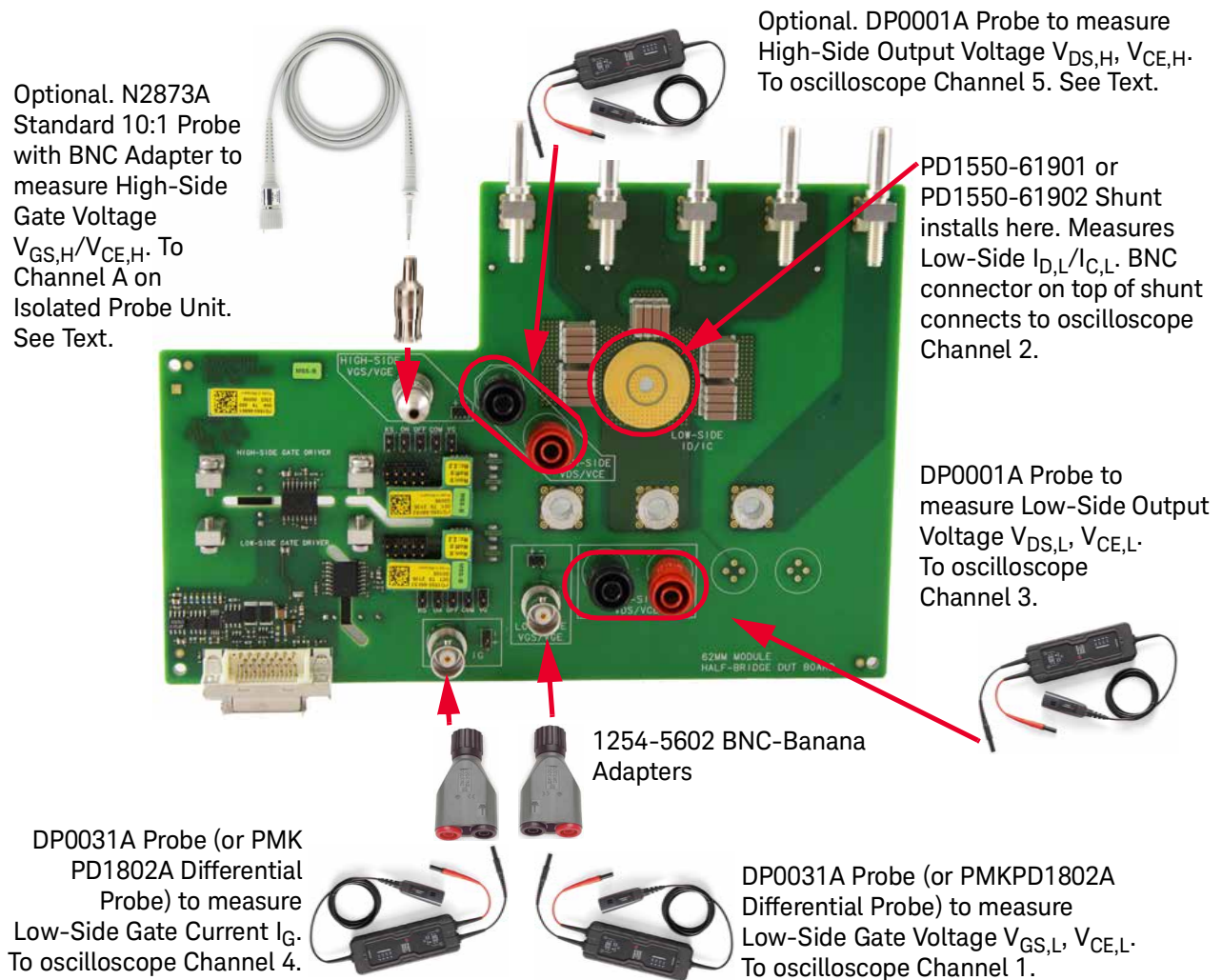


Figure 29 Oscilloscope Probe Connections to 62 mm Interface Module

NOTE: twist probe cables 2 times before connecting to Test Interface Module.

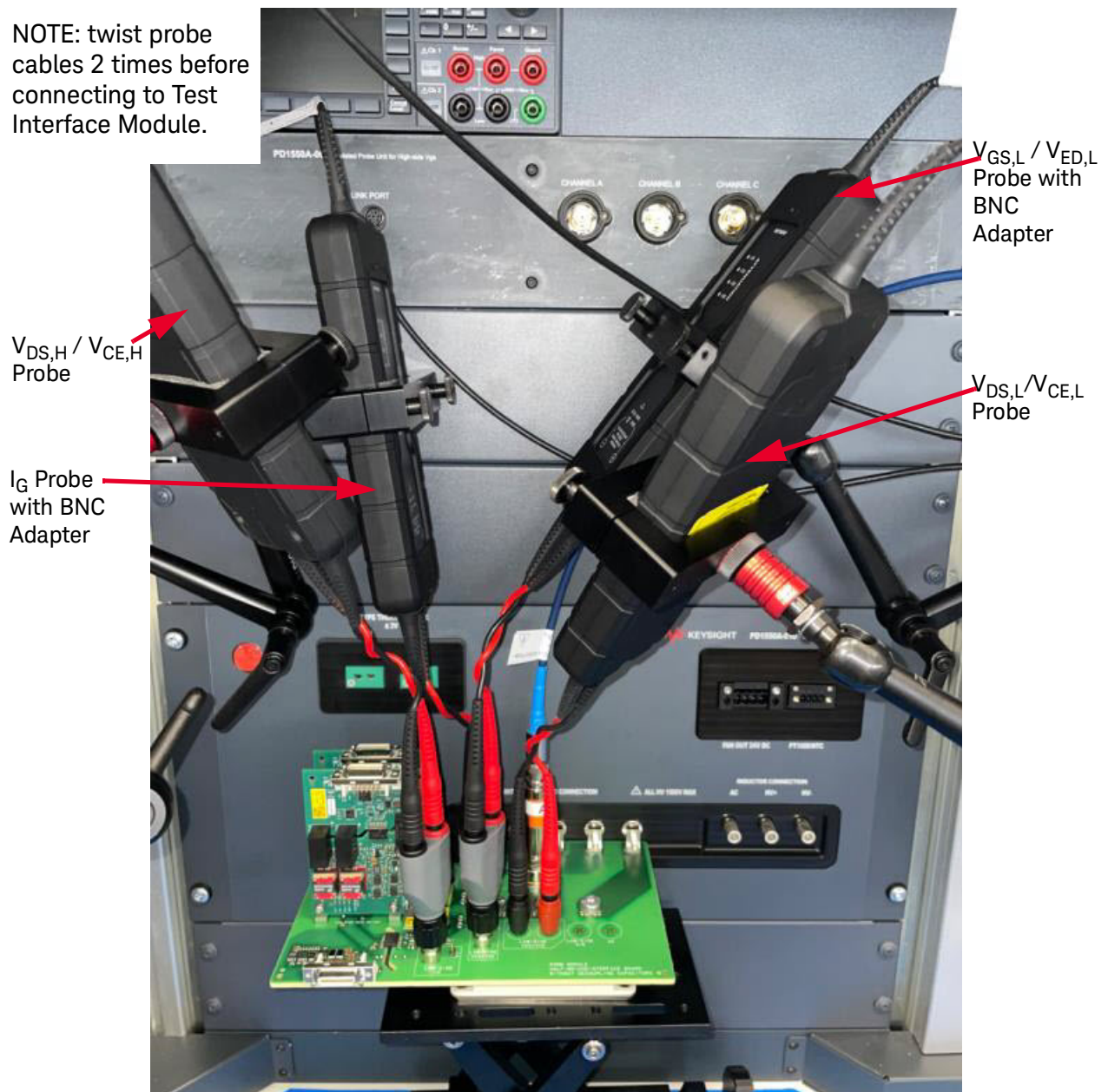


Figure 30 Connect Probes to Test Interface Module

Connect Probe for High-Side DUT Measurements

High-Side Gate Voltage

Keysight's Isolated Probe Unit is used for High-Side Gate Voltage, $V_{GS,H} / V_{GE,H}$, measurements only. Only Channel A is used at this time, the remaining channels are reserved for future use. A standard 10:1 oscilloscope probe connects the Isolated Probe Unit Channel 1 to the Keysight Interface Module.

Make certain that both **Gate Voltage $V_{GS,H}/V_{CE,H}$** and **Use Isolated Probe Unit for $V_{GS,H}/V_{CE,H}$** are selected in the **Settings > Hardware Configuration > Oscilloscope** tab are checked. Default condition is that these two are not checked.

High-Side Drain/Collector Current

For High-Side Drain or Collector current, $I_{D,H}/I_{C,H}$, measurements, a current shunt is not available for the Keysight 62 mm Interface Modules. However, for your custom Interface Modules you may design a place to install a shunt or a small Rogowski coil current probe. This should be connected to Channel 7 on the PD1550A oscilloscope.

Make certain that **Output Current $I_{D,H}/I_{C,H}$** is selected in the **Settings > Hardware Configuration > Oscilloscope** tab are checked. Default condition is that this is not checked.



Figure 31 N2873A Probe to High-Side Gate Voltage $V_{GS,H}/V_{CE,H}$ and Channel A on Isolated Probe Unit

Keysight Isolated Probe Unit

NOTE

The Link Port on the Keysight Isolated Probe Unit is not used.

All green LEDs next to individual channels should be green. There is also a green power LED and a red LED that indicates a trigger has occurred.

Apply Oscilloscope Probe Labels

A sheet of adhesive probe labels was provided with your PD1550A. For ease of reference, you can apply the probe labels to the PD0001A or PD0031A oscilloscope probes, to adapters, or anywhere to mark oscilloscope probe usage.

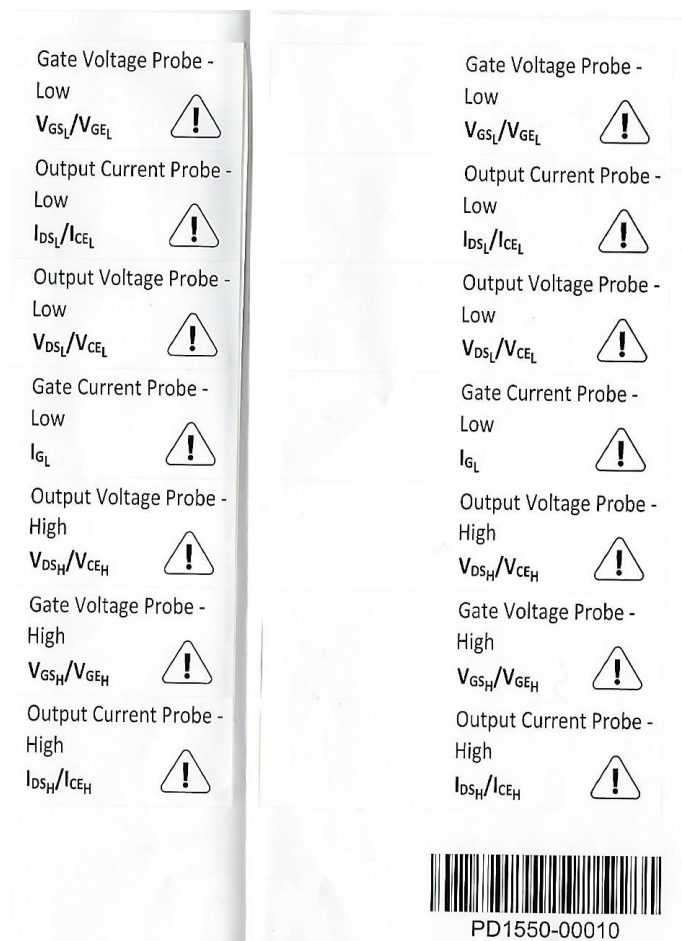


Figure 32 Sheet of Labels to Mark Oscilloscope Probes

Install UDI Cables

Universal Double-Pulse Interface (UDI) cables connect the PD1550A-020 Control Unit to other test units in the system. From the front panel, they connect to:

Connect from PD1550-68720 Control Unit to:

- PD1550-66840 Gate Drive Modules (both Low-Side and High-Side)
- PD1550-6686 Interface Module



Figure 33 UDI Cables Connected to Control Unit Front Panel

UDI cables may be connected to any UDI jack on the Control Unit. Typically:

- UDI Port 1 connects to the Interface Module in front of the Gate Drive Modules
- UDI Port 2 connects to the Low-Side Gate Drive Module
- UDI Port 3 connects to the High-Side Gate Drive Module

UDI jacks 4, 5, and 6 are generally not used and are reserved for future use.

NOTE

UDI jacks 7, 8, 9, 10, 11, and 12 are on the rear panel of the PD1550-020 Control Unit. UDI 11 connects to the rear of the PD1550-010 Test Fixture and UDI 12 connects to the rear of the PD1550-090 Inductor Unit. The remaining UDI jacks are not used and are reserved for possible future use.

Install Additional Test Fixture Accessories



Figure 34 PD1550A-010 Test Fixture Front Panel

External Loads

External Loads¹ (inductors) may be connected to the **AC** and **HV+** terminals on the Test Fixture front panel for Standard Double-Pulse tests

CAUTION

You must select **Inductor Selection > External** under **Output Current** in the main User Interface and specify the inductor value in the PD100A Control Software. See the PD1550A Software Guide for detailed information.

For the mating plugs, use pin connectors:

- 5 mm OD and maximum 18.5 mm long
- Keysight part number: 0363-0370
- Manufacturer (ODU²) Part Number: 181.212.000.301.000



The External Load sockets on the test fixture are rated for:

- Nominal Current: 90 A
- Continuous Current 155 A
- Surge Current 12 kA

¹ External resistive loads are not supported for this release of software.

² www.ODU.de

Range of External Inductors

The control software has limits that provide for a large range of inductors. Minimum is 1 μH ; maximum is 1000000 μH . You need to decide what first pulse length is appropriate for your DUT. Note that self heating and voltage drop in the capacitor bank's high range and switching speed limits the low range.

NTC Thermistor Connector

Negative Temperature Coefficient (NTC) thermistors are built-in to some power modules. Because of minimal self heating, the NTC thermistor remains at almost the same temperature as the power module die and is assumed to be close to the DUT heat sink temperature.

NOTE

Because of the slow response time of thermistors, they are not suitable to detect rapid changes in device temperature. An NTC thermistor cannot be used for short circuit or over current protection.

NOTE

For early releases of the PD1000A Control Software for the PD1550A, this jack and the device temperature are not used.

The PD1550A system uses an analog approach to measuring the temperature with the thermistor.

Reading the temperature(s) in the PD1000A Control Software

Select **NTC_Resistor** from the **Settings > Hardware Configuration > Fixture > Temp. Ref. Meas. Device** drop down menu. The device temperature measured from the thermistor is not displayed in the User Interface.

How to select the Thermistor resistance value

Select the value of the NTC Thermistor from the drop-down box. For early releases of the PD1000A Control Software for the PD1550A, this feature is not used.

Cable Requirements for the PT1000NTC Thermistor

Keysight does not provide a cable for the PTC1000NTC Thermistor for PD1000A Control Software version .



Figure 35 NTC Connector on Front of Test Fixture

Fan Out 24 VDC

An external fan is not available for PD1550A Initial Shipments.

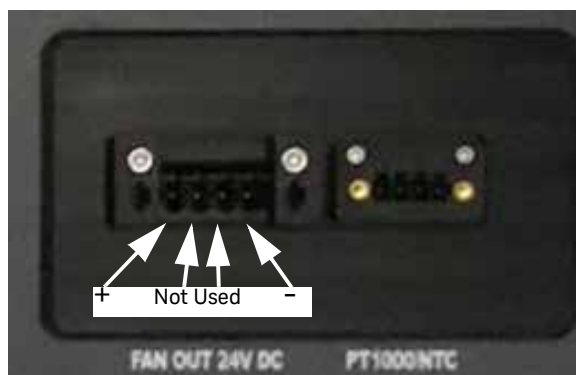


Figure 36 24 V DC Fan Out Connector on Test Fixture Front

NOTE

For early release versions of the PD1000A Control Software for the PD1550A, this jack is not supported.

Type K Thermocouples, CH1 and CH2

Two type K thermocouples may be attached to the DUT for monitoring the temperature during tests. How you create the thermocouples and attach them to the DUT is up to you. The following information provides some general guidelines.

Thermocouples are used to measure the surface temperature of devices. Be very careful, results obtained can be very different from actual test conditions if the thermocouples are not handled correctly.



Figure 37 Type K Thermocouple Jacks on Test Fixture Front

NOTE

For early release versions of the PD1000A Control Software for the PD1550A, these jacks and the device temperature are not supported.

Preparing the Thermocouple

The simplest method of preparing a thermocouple is to simply twist the wires together several times. However, the temperature is measured at the first point of contact with the device. The remaining section of the twisted pair becomes unnecessary and may be cut off. This could result in compromising the contact of the thermocouple wires resulting in unstable temperatures.

The best method is to spot weld the two thermocouple leads together.

Method of Securing the Thermocouple to a device

The easiest method is to tape the thermocouple to the device with polyimide (Kapton) tape. This allows easily securing and removing the thermocouple. However, this method also allows the tape and thermocouple to lift off the device during a test. The tape can also interfere with the heat radiation pattern.

A better method is to use a minimum amount of epoxy adhesive to secure the thermocouple to the DUT. The epoxy adhesive is not likely to peel off during the test and requires a much smaller area to secure the thermocouple to the DUT. This minimizes the effects on the measurements. Note that the epoxy must not get between the thermocouple and the DUT; the thermocouple must remain in direct contact with the DUT.

Recommendations for using a Thermocouple

- Use the shortest wire possible to minimize interference and noise.

For additional Thermocouple information, refer to the Keysight Application Note titled, "Practical *Temperature Measurements*".

Reading the temperature(s) in the PD1000A Control Software

Select either **Thermocouple1** or **Thermocouple2** from the **Settings > Hardware Configuration > Fixture > Temp. Ref. Meas. Device** drop down menu.

Install Optional InTEST Temperature Controller with Heating Plate

IMPORTANT: InTEST (Sigma Systems) Thermal Solutions¹ are not available from Keysight and must be purchased directly from InTEST Thermal Solutions.

Two pieces of equipment are required: the (Watlow) Heater Control Unit and a heating plate. Select from the list below and order directly from InTEST. The Controller and Heating plate are for heating the Device Under Test (DUT) only, it does not provide cooling. When running a series or loop of tests, remember that it takes a long time for the heating plate to cool down

InTEST (Sigma Systems) Part Number	Description
1.001.520-Controller EZ Zone	Heater Control unit only, no heater plate
1.001.561-HP61	Small Plate only (no controller), 6.9 cm x 8.9 cm ¹
1.001.486-HP168	Medium Plate only (no controller), 18.2cm x 9.2 cm ¹
1.001.562-HP448	Large Plate only, (no controller) 28 cm x 16 cm ¹
XHP61PMKEY01	Includes Heater Control unit and small plate
XHP168PMKEY01	Includes Heater Control unit and medium plate
XHP448PMKEY01	Includes Heater Control unit and large plate

¹ Size of heating plate alone, not the entire enclosure.



Figure 38 InTEST (Watlow) Controller Unit in Rack Panel and Heating Plate

¹ See <https://www.intestthermal.com/home>. Select **Product Brands**, then **Sigma Systems**, then **Platforms / Plates**.

NOTE

The Controller Unit comes prewired with the Failsafe switch and heating plate connector. For detailed display information for the Controller Unit, refer to the Watlow EZ-Zone User's Guide provided with the controller.

Install the InTEST Control Unit in the PD1550A Rack

- 1 Turn off the PD1550A system and unplug it from the ac source.
- 2 With a #2 Phillips screwdriver, remove the rack filler panel immediately under the PD1550A-010 Test Fixture.
- 3 Install the Control Unit Rack Panel just below the PD1550-010 Test Fixture.
- 4 With the set of rack keys provided with your PD1550A system, open both back doors on the rack.
- 5 With the supplied power cord, connect the Control Unit to the multiple outlet power distribution unit inside the PD1550A rack. Route the power cord down through the left slot on the rack surface.
- 6 With the supplied LAN cable, connect the Ethernet port on the Heater Controller to any port on the Ethernet Switch Number 2 in the PD1550A rack. Route the power cord down through the right slot on the rack surface.

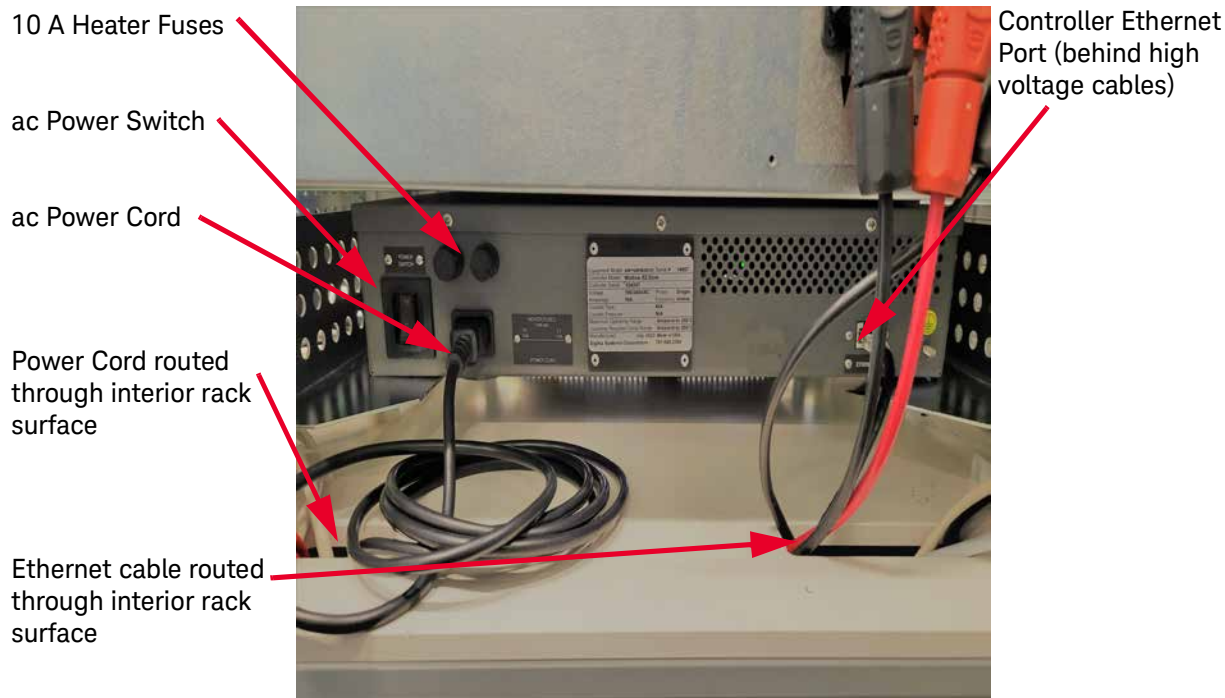


Figure 39 Rear Panel of the Heater Controller

NOTE

The PD1000 A Control Software manages initial setup and all communication with the Heater Control unit. The Watlow software is not used and may be discarded.

Refer to the Watlow EZ-ZONE Software Operators Guide to understand the controller display and messages.

- 7 Turn the Watlow EZ-ZONE control unit on. The switch is on the rear panel of the unit.
- 8 Close and lock the rear doors on the PD1550A rack.
- 9 Connect the heating plate to the multi-pin connector on the front of the control unit rack mount panel.
- 10 Place the heating plate on top of the lift table but under the DUT module.

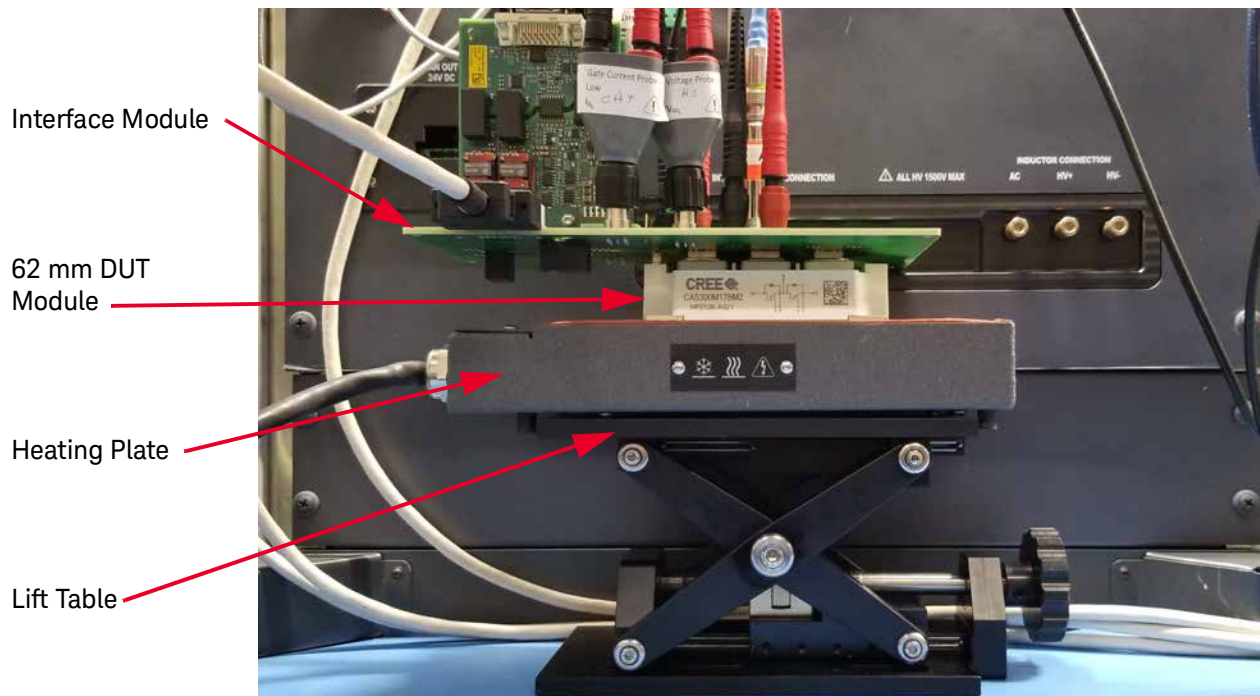


Figure 40 Heating Plate on the Lift Table Supporting the DUT Module.

- 11 Adjust the Lift Table to support the weight of the Heating Plate, the DUT module, and the Interface module.
- 12 Plug in the PD1550A system and turn it on. Press the **Reset** button on the front of the PD1550A system. The Watlow Control Unit should turn on. See Figure 41 on page 84.
- 13 Specify the desired test temperature and Temperature Control Settings in the PD1000A Control Software -- **NOT** on the Watlow EZ-Zone Controller.

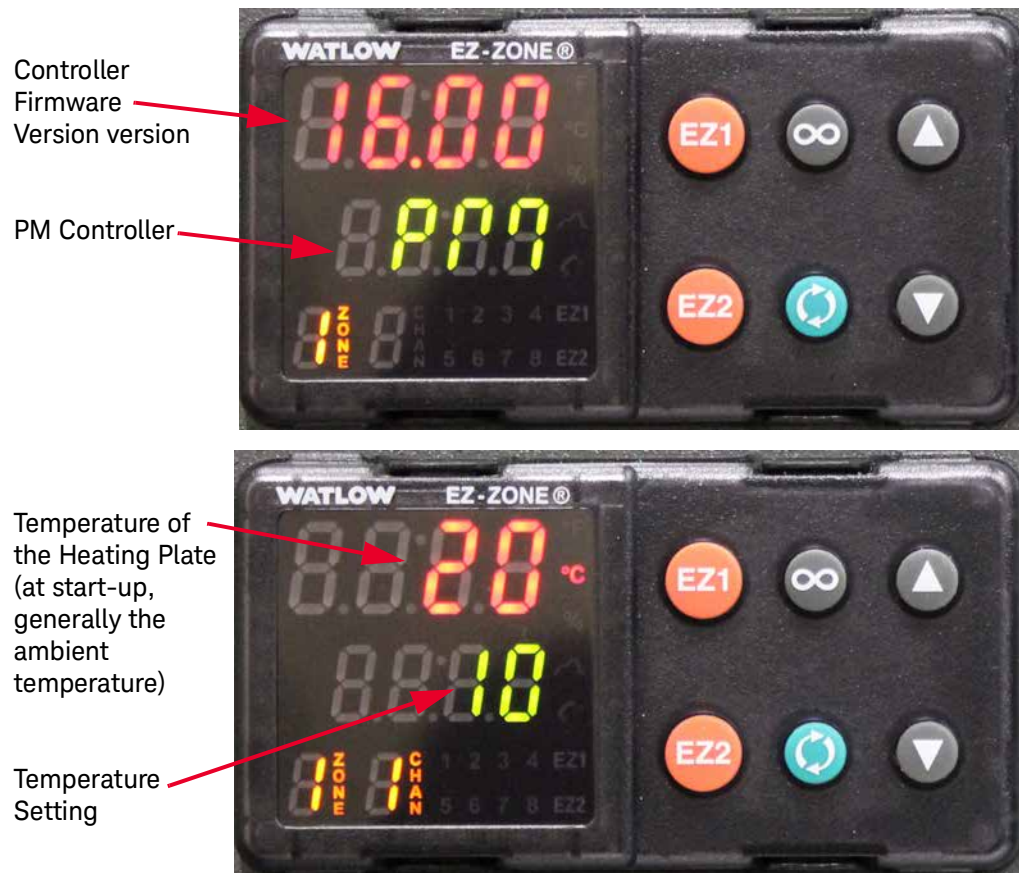


Figure 41 Watlow Controller Turn-on Sequence

NOTE

Set the test temperature(s) in the PD1000A Control Software. Do **Not** use the Watlow EZ-ZONE to set test temperatures, set points, alarms, etc.

Install Optional InTEST - Temptronic Thermostream Heater/Cooler System

IMPORTANT: InTEST Thermal Solutions are not available from Keysight and must be purchased directly from InTEST Thermal Solutions.

Only newer Thermostream units with the “Digital Thermal Sensing” feature may be used, older ones do not have the necessary digital interface.

Specific supported Thermostream units are:

- ATS-710-M
- ATS-730-M
- ATS-750-M
- ATS-770-M
- ECO-710-M

Because of the energy used in the PD1550A, Keysight does not allow any connection between the DUT and anything outside of the safety enclosure. In the following graphic, connections such as “Thermocouple A” or “Thermocouple B” are not allowed. To monitor the DUT temperature, the PD1550A uses a thermocouple connected to the Test Fixture. Temperature information is sent to the Thermostream through an isolated RS-232 connection.

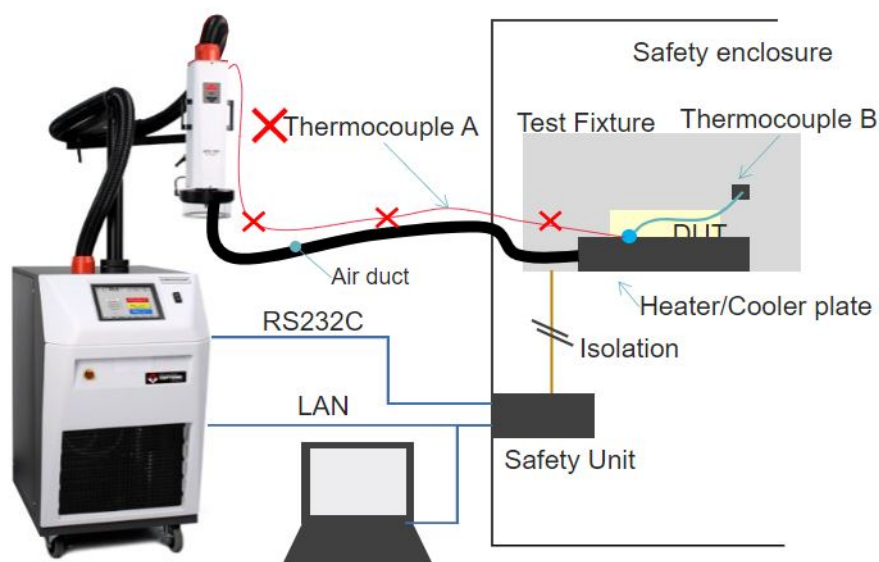


Figure 42

InTEST technicians will install their Thermostream unit on the left side of the PD1550A rack. They remove a left-side panel from the PD1550A rack and install a new side panel. The new, replacement side panel has an exhaust vent. Installation requires a LAN cable and an RS-232 cable (both supplied by InTEST) that connect to the PD1550A rack.

CAUTION

Do not obstruct the exhaust.

NOTE

It is not possible to avoid ice on heating/cooling plate. Additional dry air is not sufficient to avoid the frost or ice buildup on the plate. However, there should not be frost or ice buildup on the Interface Module or DUT module.

Thermostream Electrical Connections to the PD1550A Rack

Connect the Thermostream RS-232 and LAN cables to the left side of the PD1550A rack.



Figure 43 Thermostream RS-232 and LAN Connection on PD1550A Rack

Thermostream Compressed Air Requirements

For sustained low temperature operation and testing, clean dry air (CDA) must be provided¹:

- Filtered to 5 micron particulate contamination
- Oil content: <0.1 ppm by weight, filtered to 0.01 micron oil contaminant
- Dewpoint: <10 °C @ 6.2 BAR (90 PSI)
- Air supply pressure: 6.2 to 7.6 BAR 90 to 110 PSIG)
- Total airflow Rate Required: 7.1 to 14.2 l/s (15 - 30 scfm)
11.8 l/s (25 scfm) nominal
- Air Supply Temperature: + 20 °C to +25 °C; 22 °C Nominal

¹ These specifications are from the InTEST ATS-710-M and ECO-710-M Data Sheets. Different models may have different requirements. Refer to the InTEST model documentation for specific requirements.

4 Turn-on and Software Installation

After installing the Rack and Safety Enclosure, you need to Install and configure the PD1000A Control Software and then verify the installation:

In this Chapter:

- Step 1: Connect LAN and Power Cable to Rack [page 90](#)
- Step 2: Install System Software on Host PC [page 92](#)
 - Install IO Libraries Suite on Host PC [page 92](#)
 - Download PD1000A System Control Software [page 92](#)
 - Set AC Line Frequency and Date/Time on the B2902A [page 94](#)
- Step 3: Obtain and Install Coaxial Shunt Resistor De-Embedding File [page 95](#)
 - Obtain the Shunt De-embedding file [page 95](#)
 - Install the De-Embedding Transfer File on the Oscilloscope [page 97](#)

Step 1: Connect LAN and Power Cable to Rack

Before powering the system on, connect a LAN cable from the host computer to the side of the DPT Rack and Safety Enclosure. Connect the AC power cord to the rack.

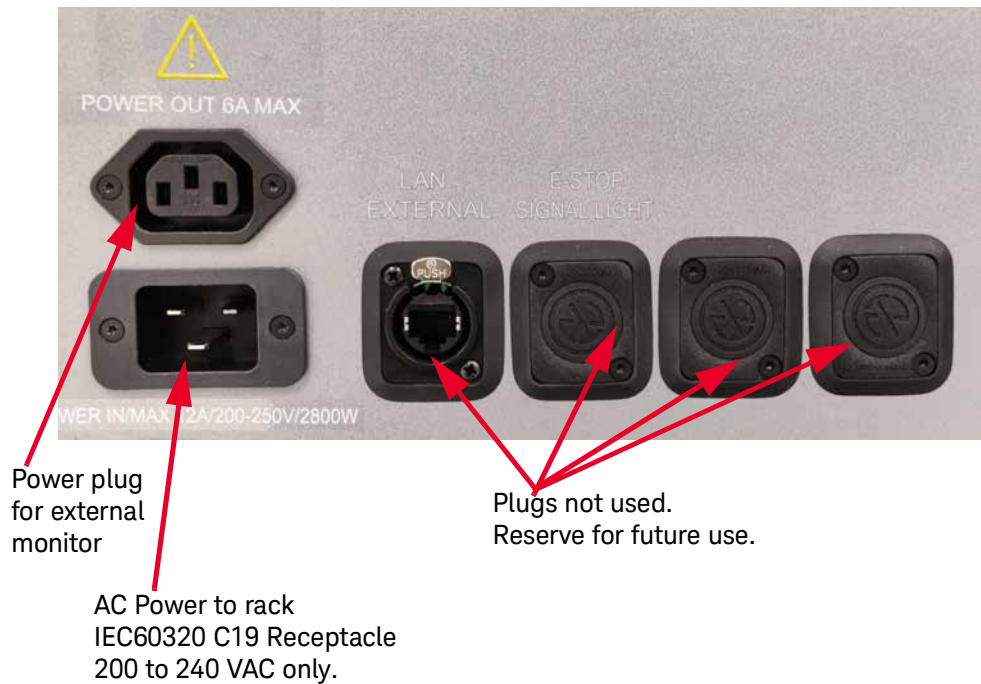


Figure 1 Right side of DPT Rack showing LAN and Power Connections

Double-Pulse Test System Turn-On and Turn-Off

With all of the test instruments and test fixture installed in the rack, it is time to turn on the system.

- 1** Connect the AC Power cable to the AC Jack on the side panel of the DPT Rack and Safety Enclosure.
- 2** Plug the other end of the cable in an appropriate AC outlet. See “Connect the Rack and Safety Enclosure to AC Mains” on page 20.
- 3** Ensure the **Emergency Stop** button is pulled out.
- 4** Turn the large round knob on the DPT Rack and Safety Enclosure to the left (horizontal position) to power on the system. The fans start but test instruments do not turn on. See the figure below.
- 5** Press the **Reset** button. Test instruments turn on. You should hear a few clicks as the safety relays energize. The system is now operational.
- 6** If the individual test instruments are not already turned on, turn them on now.

Turning the System Off

To shut down the test system, turn the power switch to the left (so that it is horizontal).



Figure 2 PD1550A-030 Safety Unit
(Power switch shown in the On position)

Light Tower on top of Rack

Green Light -- High voltage is off. It is safe to open the safety doors.

Amber Light -- Emergency Shut-down button has been pushed. Pull the **Emergency Off** button out and press the **RESET** button. Safety doors are locked.

Red Light -- Safety doors are locked and cannot be opened. High Voltage may be present. Safety doors are locked.

Blue Light -- Indicates a test is running. Safety doors are locked.

Emergency Off Functionality

The **Emergency Stop** button functionality works in two steps:

- When pressed, it interrupts the interlock of the high voltage source and unlocks the safety switch. If the Safety Doors are closed, It keeps the enclosure locked. After about 1 second the high voltage source shuts off by interrupting the main power line.
- To reset, pull out to release the **Emergency Off** button. Reset the Emergency Off circuit by pressing the **Quit** button.

Step 2: Install System Software on Host PC

To communicate with the PD1000A test equipment, Keysight I/O Libraries Suite must also be installed on your host computer. IO Libraries Suite is a collection of libraries and utilities that enable you to connect your instruments to the host computer and run programs on the computer that interact with the instruments. The IO Libraries Suite is used with all Keysight instruments

Install IO Libraries Suite on Host PC

Download the latest version from: www.keysight.com/find/iosuite. Always install IO Libraries Suite before installing any instrument driver or software. Use the latest version of the IO Libraries Suite.

NOTE

IO Libraries Suite Connection Expert may not find the B1506A until Easy EXPERT is running. Run EasyEXPERT before using Connection Expert.

Download PD1000A System Control Software

The PD1000A System Control Software may be downloaded from Keysight at any time. Download the software from the following website:

www.keysight.com/find/PD1000A

or

www.keysight.com/find/PD1550A

Set Oscilloscope VISA Address

To obtain the oscilloscope's IP Address:

- 1 Touch or click the **Utilities** soft key at the top of the oscilloscope display.
- 2 Touch or click the **Remote...** soft key. This opens the **Remote Setup** screen.

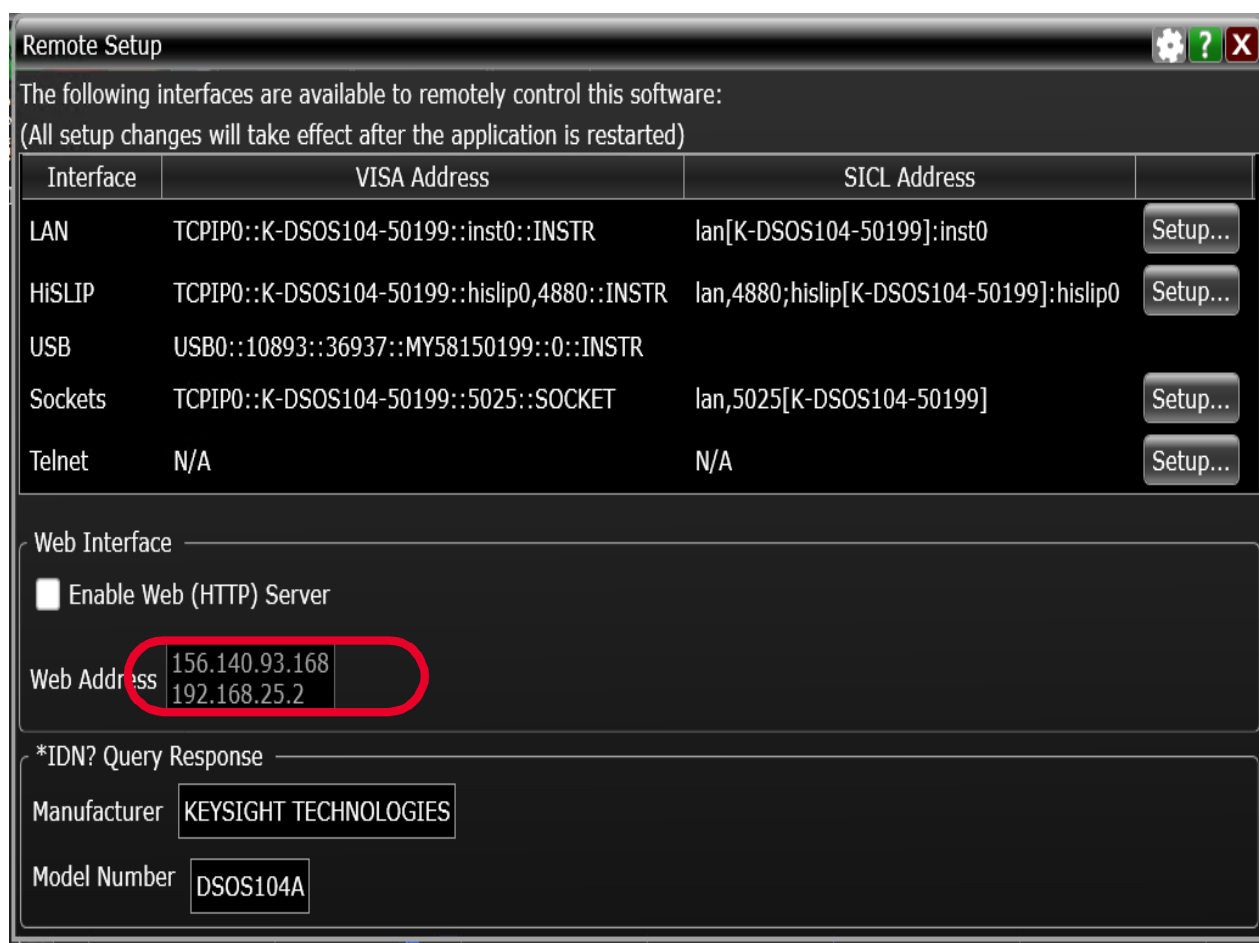


Figure 3 Remote Setup -- Web Interface

- 3 Locate the **Web Interface** field. In the example above, the correct web address to use is **156.140.93.168** for the Oscilloscope IP Address. This is the Oscilloscope IP address that you will use in the PD1000A Control Software **Settings > Hardware Configuration > DPT System Selection**. Do **NOT** use the 192.168.25.2 address.

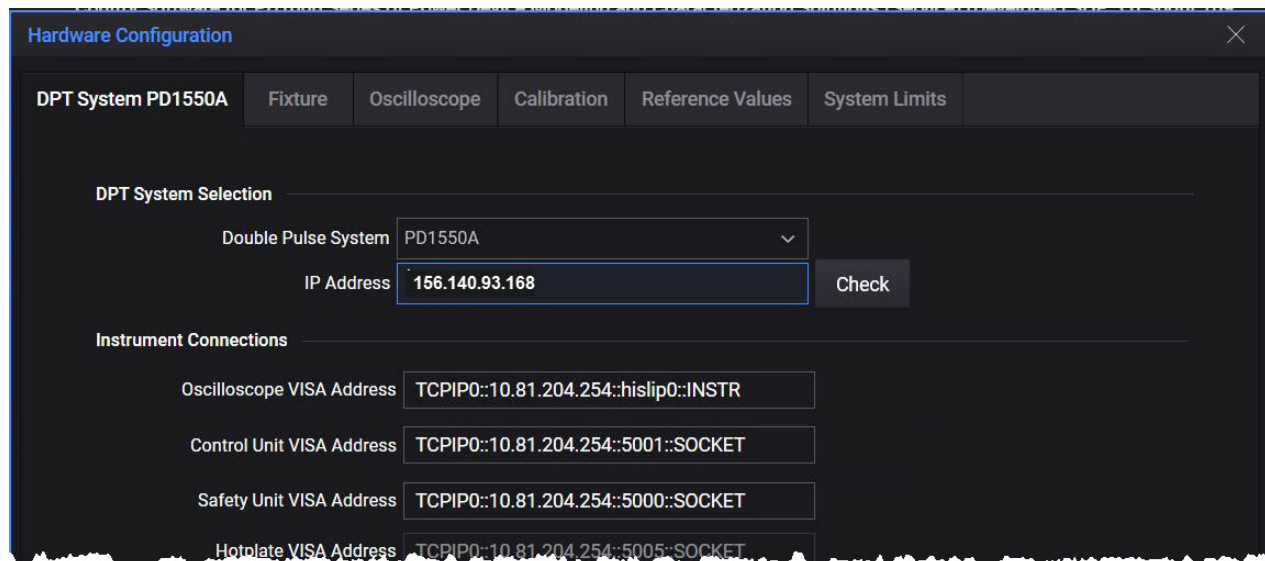


Figure 4 Oscilloscope IP Address in the **Settings > Hardware Configuration > DPT System Selection**.

For additional information, refer to the PD1550A Control Software Guide.

Set AC Line Frequency and Date/Time on the B2902A

The Keysight B2902A Source Measure Unit (SMU) is used only for the system calibration. Its factory default line frequency is set to 50 Hz and must be changed to 60 Hz in those countries with a 60 Hz line frequency. To change the line frequency from the instrument front panel, press the following keys:

- For setting to 50 Hz: **More > System > PLC > 50 Hz**
- For setting to 60 Hz: **More > System > PLC > 60 Hz**

Optional: To set the Date and Time press the following:

More > System > More > Info > Date/Time

More about IP Addresses and Dot Notation

Dot-notation addresses ("*nnn.nnn.nnn.nnn*" where "*nnn*" is a byte value from 0 to 255) must be expressed with care, as most PC web software interprets byte values with leading zeros as octal (base 8) numbers. For example, "192.168.020.011" is actually equivalent to decimal "192.168.16.9" because ".020" is interpreted as "16" expressed in octal, and ".011" as "9". To avoid confusion, use only decimal values from 0 to 255, with no leading zeros.

Step 3: Obtain and Install Coaxial Shunt Resistor De-Embedding File

For maximum DPT accuracy, the Coaxial Shunt Resistor's De-embedding File (also known as a Transfer File) must be installed in the oscilloscope. Recharacterization of the Coaxial Shunt should be performed annually and the updated De-embedding file installed in the oscilloscope. The Coaxial Shunt Resistor's De-Embedding file has to do with maximizing the Shunt Resistor's bandwidth and requires configuration on the oscilloscope.

Annual Characterization of the Coaxial Shunt

The Keysight PD1000-61901 Coaxial Shunt requires annual characterization; return the Shunt to a Keysight Sales and Service Office for characterization. A list of offices is available at: www.keysight.com/find/assist

After the shunt is characterized, Keysight will return the shunt to you. This provides the latest characterization .tf2 file. Download the file from the *Keysight Infoline* website and install it in the oscilloscope.

Obtain the Shunt De-embedding file

Whether the initial installation or installation of the de-embedding file after characterizing the shunt, the process is the same:

- 1 Locate the Coaxial Shunt Resistor Serial Number located on the side of the shunt resistor housing. The shunt's product number is: PD1000-61901¹ or PD1000-61902.
- 2 Go to Keysight Support Portal:
<https://support.keysight.com/s/service-and-warranty-status>.
- 3 Enter the shunt's product (model) number (PD1000-61901 or PD1000-61902) and its serial number (for example, MY58400001). Click **Search**.
- 4 Select **Calibration Documents** tab.
- 5 Select the Certificate Number (for example, PD1000-61901MY58400001)
- 6 Click the appropriate service document file, for example: **PD1000-61901MY58400001.zip**. It is a simple ASCII text file with a .tf2 file extension. This file contains the de-embedding information for the Coaxial Shunt Resistor with the specified serial number. The file name includes the shunt's serial number, for example: MY58400001.tf2.

¹ PD1000-61901 or PD1000-61902 are the Keysight part numbers for the shunt. If you need to order additional shunts, order Keysight part number PD1500-61901AU-SH1 or PD1500-61901AU-SH2. This includes a characterized shunt, mounting bushing, serial number, and installation instructions.

Install the De-Embedding Transfer File on the Oscilloscope

NOTE

For new PD1550A systems, the de-embedding file was installed in the oscilloscope at the factory with the file name:

MY5840xxxx.tf2

where xxx is the serial number labeled on the shunt itself.

- 1 From the temporary location where you unzipped the de-embedding file, copy the .tf2 file to the MXR108A Oscilloscope. Place it in the folder: **C:\Users\Public\Documents\Infiniium\Filters**.

NOTE

On the oscilloscope, the file path will show as:

C:\Users\Public\Public Documents\Infiniium\Filters. However, this is an alias path. Use the path: *C:\Users\Public\Documents\Infiniium\Filters* in the Shunt Settings De-embedding File path in the Control Software.

- 2 In the PD1000A Control Software, type the complete path and .tf2 file name into the **Double-Pulse Measurement Control > Settings > Instrument Configuration > De-embedding File** field. Refer to the *PD1550A Control Software Guide* for additional information.

NOTE

The oscilloscope channel you specify for the **Output Current** I_D/I_C in the DPT Control Software Hardware Configuration screen is the channel that the Coaxial Shunt De-embedding is applied to. Refer to the *PD1500A Control Software Guide* for detailed information.

5 PD1550A System Calibration- AutoCal

In this chapter:

Initiate Calibration & Compensation Procedures	page 101
1 Oscilloscope Probe Offset Compensation	page 102
PD1550A System Calibration (AutoCal)	page 106
2 Low-Side Gate Voltage Source Calibration -- $V_{GS,L}$ Output	page 108
3 Low-Side Common Resistor Calibration -- $R_{COM,L}$	page 109
4 Low-Side Gate Resistance Calibration -- $R_{GON,L}$	page 110
5 Low-Side Gate Resistance Calibration -- $R_{GOFF,L}$	page 111
6 High-Side Gate Voltage Source Calibration -- $V_{GS,H}$ Output	page 112
7 High-Side Common Resistor Calibration -- $R_{COM,H}$	page 113
8 High-Side Gate Resistance Calibration -- $R_{GON,H}$	page 114
9 High-Side Gate Resistance Calibration -- $R_{GOFF,H}$	page 115
10 Calibration Complete	page 116
Coaxial Shunt Resistor Characterization	page 117

NOTE

IMPORTANT: The calibration procedures in this chapter are for the Si/SiC DUT Interface Modules, Gate Drive modules, Gate Drive Resistor modules, and probes.

There are several calibration-related procedures that should be performed regularly. These procedures should be performed anytime the ambient temperature changes ± 5 °C, anytime the oscilloscope probes or anything in the test system are changed.

- **Oscilloscope Probe Compensation**
- **PD1550A System Calibration**
- **Coaxial Shunt Resistor Characterization & De-embedding.** Characterization should be performed annually. A De-embedding file will be available on Keysight InfoLine and should be installed in the oscilloscope immediately after characterization.

Additionally, a **Full Calibration** (also known as **Service Calibration**) is required annually for the oscilloscope, 33512B Waveform Generator, B2902A Precision Source/Measure Unit, and Heinzinger EVO Power Supply test instruments.

Initiate Calibration & Compensation Procedures

From the PD1000A Control Software, select the **Double-Pulse Test Control** tab. From the **Settings** drop-down menu, select **Calibration & Compensation**. Carefully follow all instructions.

The software reads the EEPROMS on the Gate Drive and Gate Drive Resistor Modules.

Refer to the PD1000 Control Software Online help file for additional calibration information.

If everything is installed, click the **Continue** button to start the calibration.

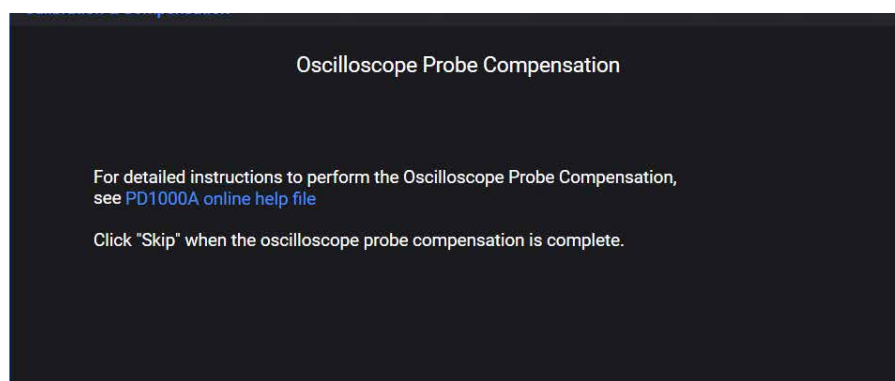


Figure 7 Instruction to Perform Oscilloscope Probe Compensation

The following PD1550A system calibration (AutoCal) steps are provided:

- 1 Oscilloscope Probe Offset Compensation page 102
- 2 Low-Side Gate Voltage Source Calibration -- $V_{GS,L}$
Output page 108
- 3 Low-Side Common Resistor Calibration -- $R_{COM,L}$ page 109
- 4 Low-Side Gate Resistance Calibration -- $R_{GON,L}$ page 110
- 5 Low-Side Gate Resistance Calibration -- $R_{GOFF,L}$ page 111
- 6 High-Side Gate Voltage Source Calibration -- $V_{GS,H}$
Output page 112
- 7 High-Side Common Resistor Calibration -- $R_{COM,H}$ page 113
- 8 High-Side Gate Resistance Calibration -- $R_{GON,H}$ page 114
- 9 High-Side Gate Resistance Calibration -- $R_{GOFF,H}$ page 115
- 10 Calibration Complete page 116

1 Oscilloscope Probe Offset Compensation

As the first step calibrating the Double-Pulse Test system, the oscilloscope probes must be adjusted for low frequency compensation. For this, the N2873A passive probes have built-in compensation RC divider networks. The Keysight N2873A probe is used only with the Isolated Probe Unit.

NOTE

Allow the oscilloscope and probes to warm up at ambient temperature for a minimum of 60 minutes (1 hour) before performing the adjustment.

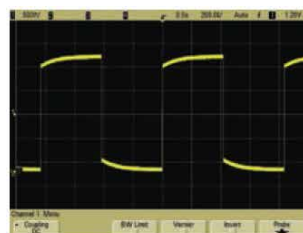
Required Equipment

- Spring hook and ground clips for passive oscilloscope probes.
- Low Frequency Compensation trimmer/adjustment tools (small non-metallic screwdriver).

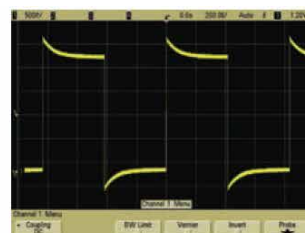
Low Frequency Compensation for the N2873A Probe

Keysight Infiniium oscilloscopes have a square wave reference signal available on the front panel to use for compensating the passive probes. Attach the spring hook and ground clip to the probe and then to the square wave terminals.

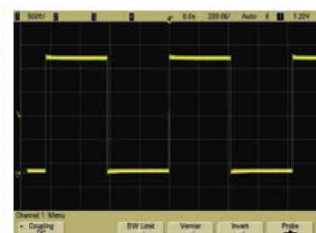
- 1 Refer to the [N2873A Probe User Guide](#) for instructions. A general description and procedure can also be found on page 5 (Hint #3) of the [Keysight 8 Hints for Better Scope Probing](#).
- 2 Connect the probe to the oscilloscope's front-panel square wave terminals.
- 3 Use the supplied trimmer tool to adjust the Low Frequency compensation to an optimum square wave response as shown below.
- 4 Adjust so that the square wave on the oscilloscope screen looks square.



Under Compensated



Over Compensated



Optimum

DP0001A Settings in the Oscilloscope User Interface

After making hardware connections, perform the following steps in the Infiniium oscilloscope software GUI to configure probe settings such as attenuation ratio and DC offset and gain calibration. These settings are required to get accurate measurement results.

Setting the Attenuation Mode

The probe supports four attenuation modes. An Infiniium oscilloscope automatically switches the attenuation mode for the probe to the value necessary to make the dynamic range of the probe greater than or equal to the level required to measure the current input signal.

The automatic switching of probe's attenuation also helps in preventing the overvoltage condition on the probe.

The Attenuation Setting LED on the probe indicates the currently set attenuation. You can also view the currently set attenuation in the Infiniium GUI's Probe Configuration dialog box as displayed below.

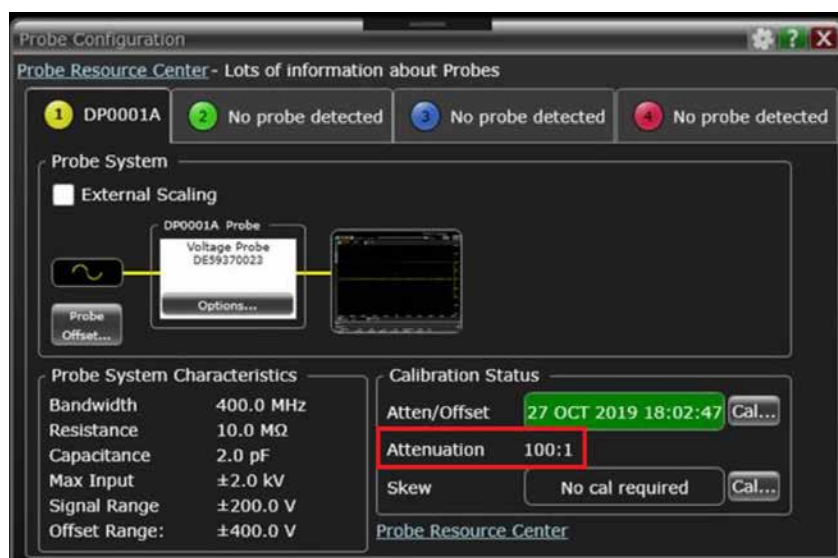
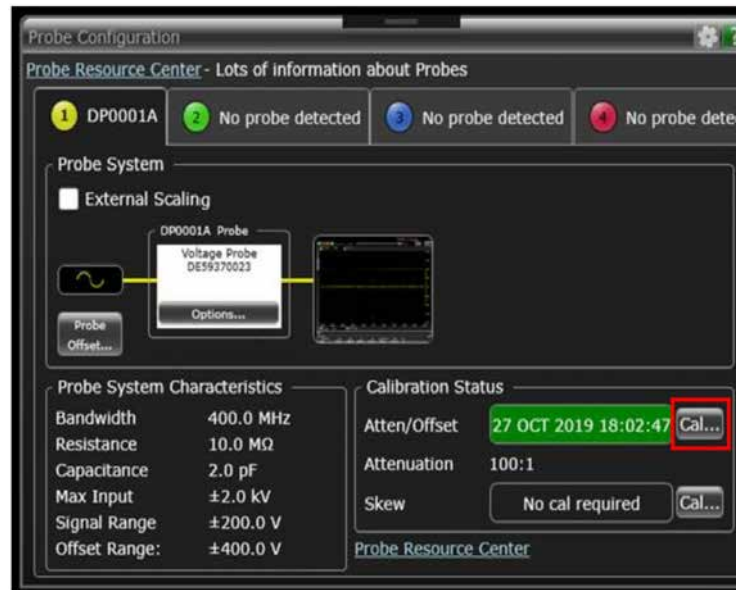


Figure 8 Setting PD0001A Probe Attenuation

Performing DC Offset and Gain Calibration

Probe gain (or attenuation ratio) correction adjusts the oscilloscope's scaling factors of the signal displayed on screen to properly match the correct DC values. Perform the DC offset and gain calibration to remove any DP0001A offset errors. The most common correction method for probes is the DC adjustment, which entails the adjustment of probe gain and probe offset.

- 1 In the **Probe Configuration** dialog box, click the **Cal...** button next to **Atten/Offset**.



The **Probe Calibration** dialog box displays:



- 2 Ensure that the probe is connected to the oscilloscope as illustrated in the **DC Offset/Gain Cal** dialog box.
- 3 Click the **Start Cal...** button to initiate calibration.
- 4 Follow the instructions displayed on the Infiniium GUI screens.

DP0031A Settings in the Oscilloscope User Interface

Not available, to be developed

PD1550A System Calibration (AutoCal)

Calibration requires the B2902 Precision Source/Measure Unit (SMU) and the following cables:

	Qty. 2 Black Test Patch Lead, 0.64 mm Square Pin Socket to 4 mm Stackable Banana Plug, 1 M.
	Qty. 2 Red Test Patch Lead, 0.64 mm Square Pin Socket to 4 mm Stackable Banana Plug, 1 M.

Requirements

- Perform the Oscilloscope Probe Offset Compensation first.
- Remove the DUT module from the Interface Module before calibration.

CAUTION

The DUT module must be removed before beginning System Calibration. The DUT module may be damaged if not removed.

- Remove both High-Side and Low-Side Gate Drive modules. Depending on the calibration step, you will be instructed to re-install either the Low-Side or the High-Side Gate Drive module.
- Install both High-Side and Low-Side Gate Resistor Modules that you want calibrated on the Interface module.
- The rack and Safety Enclosure doors may be left open for calibration.

NOTE

All test instruments must be warmed up for at least 60 minutes at ambient temperature before starting the calibration procedure. Failure to allow warm up may result in inaccurate calibration.

NOTE

IMPORTANT: The following descriptions and illustrations show the Keysight PD1550-66560 or PD1550-66561 Interface Modules. With customization for different DUTs, your Interface Module will be different. The basic instructions still apply.

NOTE

The Interface Module may remain unplugged from the Test Fixture for these calibration procedures.

CAUTION

Follow all on-screen instructions. Damage to the Test Module is possible if instructions are not followed.

Schematic for Gate Resistor Modules

The following schematic shows the calibration terminals on the Gate Resistor modules.

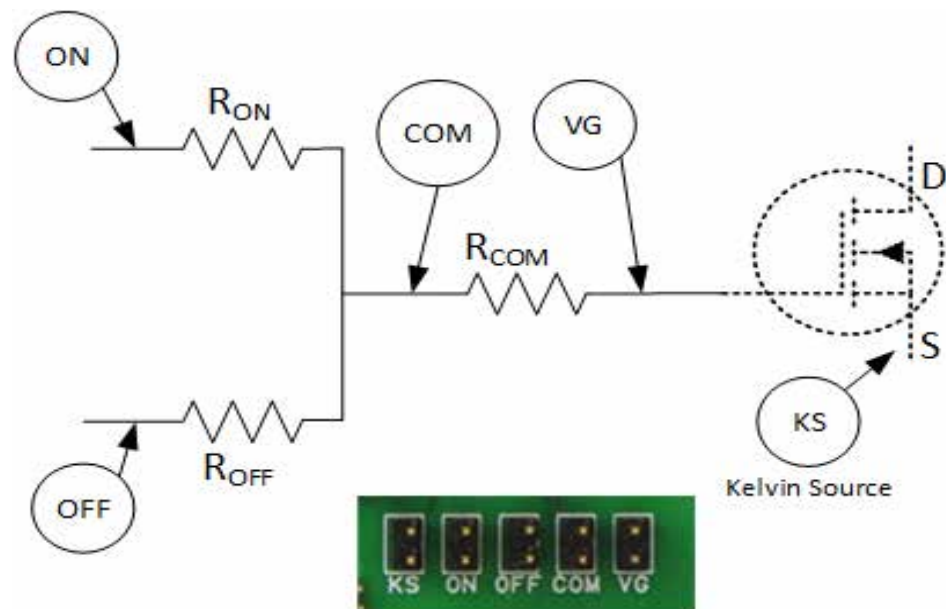


Figure 9

2 Low-Side Gate Voltage Source Calibration -- $V_{GS,L}$ Output

Calibrates voltage gain and offset for the Low-Side Gate Drive.

Hardware Setup:

- Remove the DUT module from the Interface Module before calibration.
- Install the Low-Side Gate Drive Module on the Interface Module.
- Install a low value resistance Low-Side Gate Resistance module (for example, $2.2\ \Omega$).
- Install UDI cables on the Low-Side Gate Drive Module and Interface Module.
- Use a red calibration cable to connect the SMU red Force terminal to either of the **VG** pins on the Low-Side of the Interface Module.
- Use a black calibration cable to connect the SMU black Force terminal to either of the **KS** pins on the Low-Side of the Interface Module.

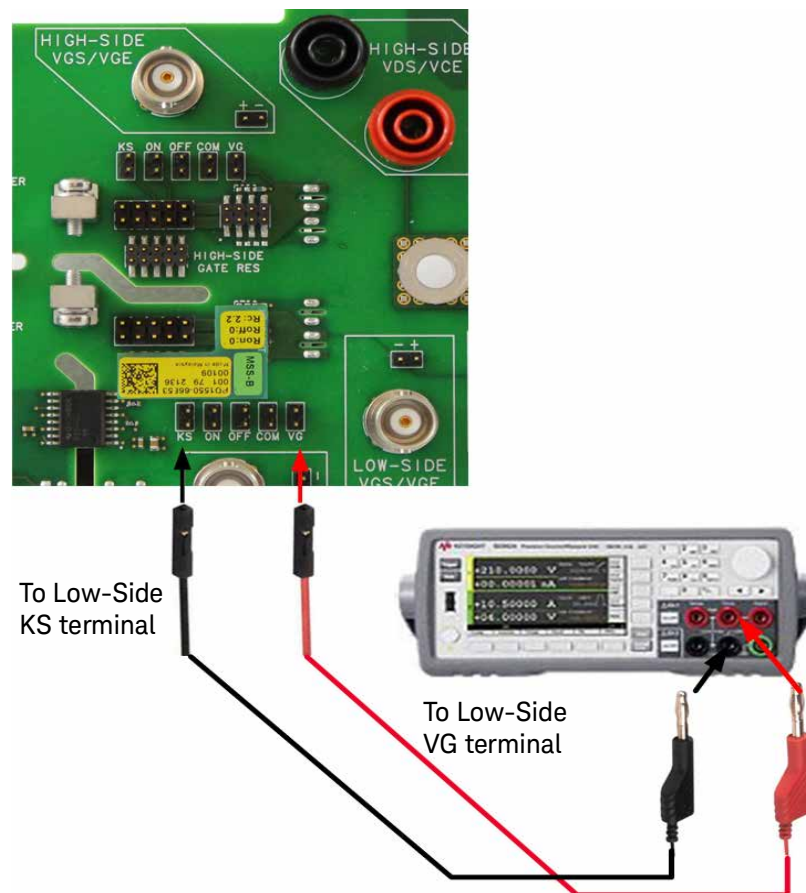


Figure 10 Low-Side Gate Voltage Source Calibration Connections

Procedure: Click **Start** to perform the calibration and continue to next step.

3 Low-Side Common Resistor Calibration -- $R_{COM,L}$

Hardware Setup:

- Remove the DUT module from the Interface Module before calibration.
- Remove the Low-Side Gate Drive Module from the Interface Module.
- Install the Low-Side Gate Resistor Module that you want calibrated.
- Install a UDI cable on the Interface Module.
- Use two sets of calibration cables for a four-wire resistance measurement as follows:
 - Red cable from SMU Force to Low-Side **COM** terminal.
 - Red cable from SMU Sense to Low-Side **COM** terminal.
 - Black cable from SMU Force to Low-Side **VG** terminal.
 - Black cable from SMU Sense to Low-Side **VG** terminal.

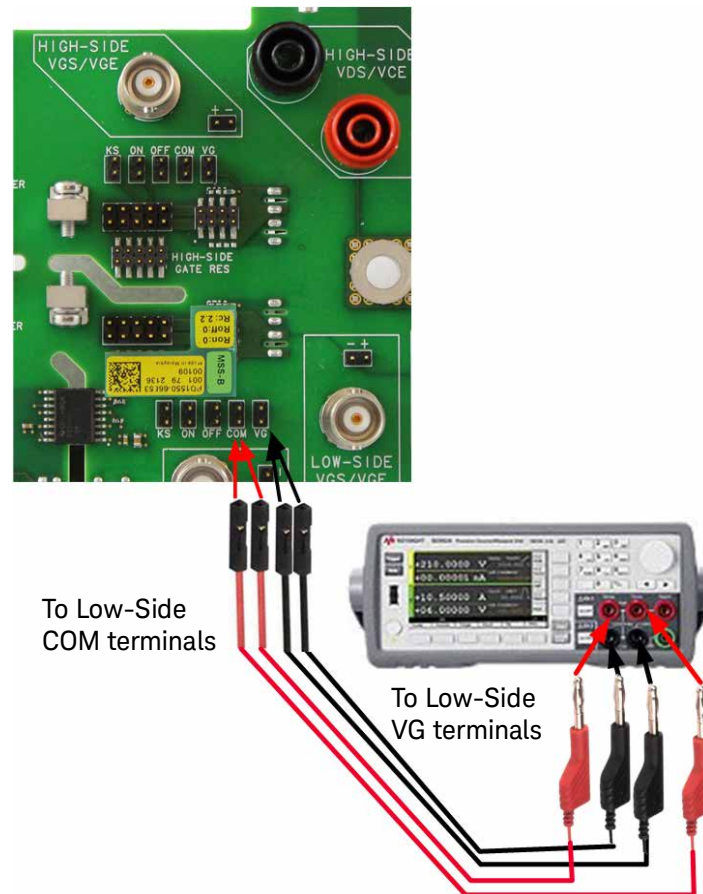


Figure 11 Low-Side R_{COM} Calibration Connections

Procedure: Click **Start** to perform the calibration and continue to next step.

4 Low-Side Gate Resistance Calibration -- $R_{GON,L}$

NOTE

IMPORTANT: Perform this calibration step only after performing:
3 Low-Side Common Resistor Calibration -- $R_{COM,L}$

Hardware Setup:

- Remove the DUT module from the Interface Module before calibration.
- Remove both High-Side and Low-Side Gate Drive Modules from the Interface Module.
- Install the Low-Side Gate Resistor Module that you want calibrated.
- Install UDI cables on the Low-Side Gate Drive Module and Interface Module.
- Use two sets of calibration cables for a four-wire resistance measurement :
 - Red cable from SMU Force to Low-Side **ON** terminal.
 - Red cable from SMU Sense to Low-Side **ON** terminal.
 - Black cable from SMU Force to Low-Side **VG** terminal.
 - Black cable from SMU Sense to Low-Side **VG** terminal.

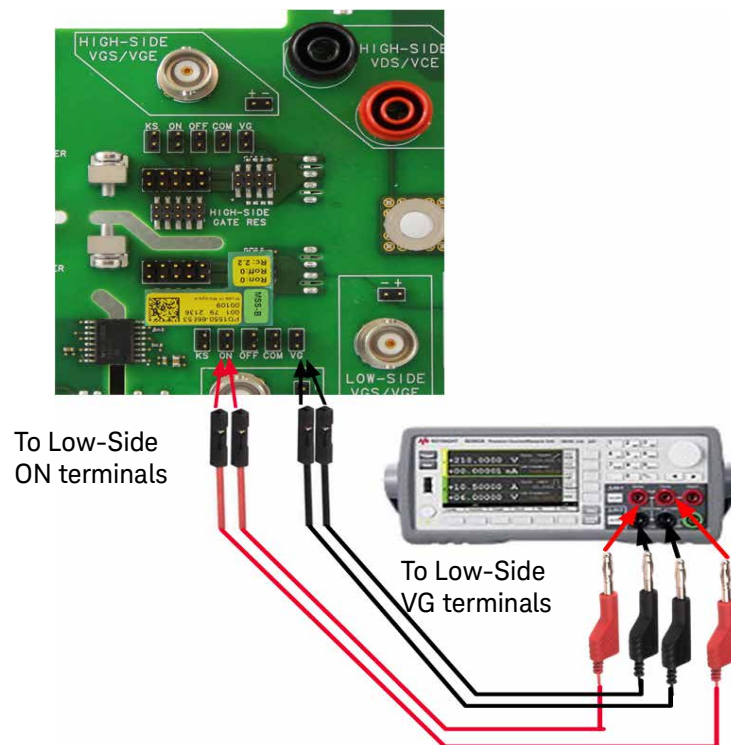


Figure 12 Low-Side $R_{G,ON}$ Calibration Connections

Procedure: Click **Start** to perform the calibration and continue to next step.

5 Low-Side Gate Resistance Calibration -- $R_{G,OFF,L}$ **NOTE**

IMPORTANT: Perform this calibration step only after performing:
3 Low-Side Common Resistor Calibration -- $R_{COM,L}$

Hardware Setup:

- Remove the DUT module from the Interface Module before calibration.
- Remove both High-Side and Low-Side Gate Drive Modules from the Interface Module.
- Install the Low-Side Gate Resistor Module that you want calibrated.
- Install UDI cables on the Low-Side Gate Drive Module and Interface Module.
- Use two sets of calibration cables for a four-wire resistance measurement:
 - Red cable from SMU Force to Low-Side **OFF** terminal.
 - Red cable from SMU Sense to Low-Side **OFF** terminal.
 - Black cable from SMU Force to Low-Side **VG** terminal.
 - Black cable from SMU Sense to Low-Side **VG** terminal.

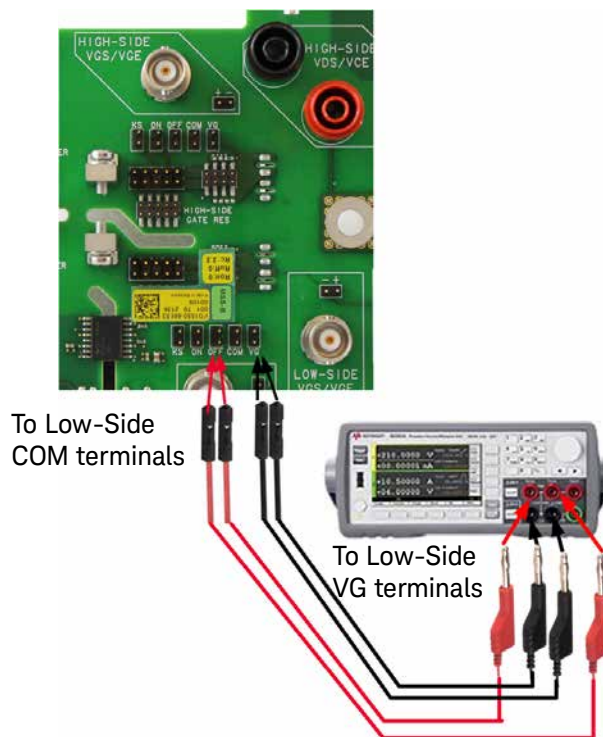


Figure 13 Low-Side $R_{G,OFF}$ Calibration Connections

Procedure: Click **Start** to perform the calibration and continue to next step.

6 High-Side Gate Voltage Source Calibration -- $V_{GS,H}$ Output

Calibrates voltage gain and offset for the High-Side Gate Drive.

Hardware Setup:

- Remove the DUT module from the Interface Module before calibration.
- Install the High-Side Gate Drive Module.
- Install a High-Side Gate Resistance Module with a low resistance (for example, $2.2\ \Omega$).
- Install UDI cables on the Low-Side Gate Drive Module and Interface Module.
- Use a red calibration cable to connect the SMU red Force terminal to either of the **VG** pins on the High-Side of the Interface Module.
- Use a black calibration cable to connect the SMU black Force terminal to either of the **KS** pins on the High-Side of the Interface Module.

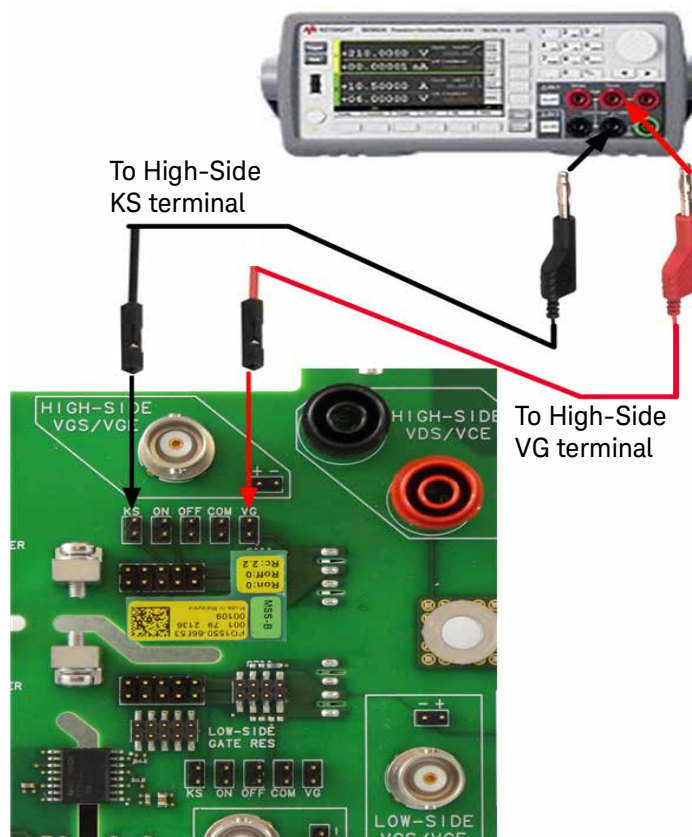


Figure 14 High-Side Gate Voltage Source Calibration Connections

Procedure: Click **Start** to perform the calibration and continue to next step.

7 High-Side Common Resistor Calibration -- $R_{COM,H}$

Hardware Setup:

- Remove the DUT module from the Interface Module before calibration.
- Remove the High-Side Gate Drive Module from the Interface Module.
- Install the High-Side Gate Resistor Module that you want calibrated.
- Install a UDI cable on the Interface Module.
- Use two sets of calibration cables for a four-wire resistance measurement as follows:
 - Red cable from SMU Force to High-Side **COM** terminal.
 - Red cable from SMU Sense to High-Side **COM** terminal.
 - Black cable from SMU Force to High-Side **VG** terminal.
 - Black cable from SMU Sense to High-Side **VG** terminal.

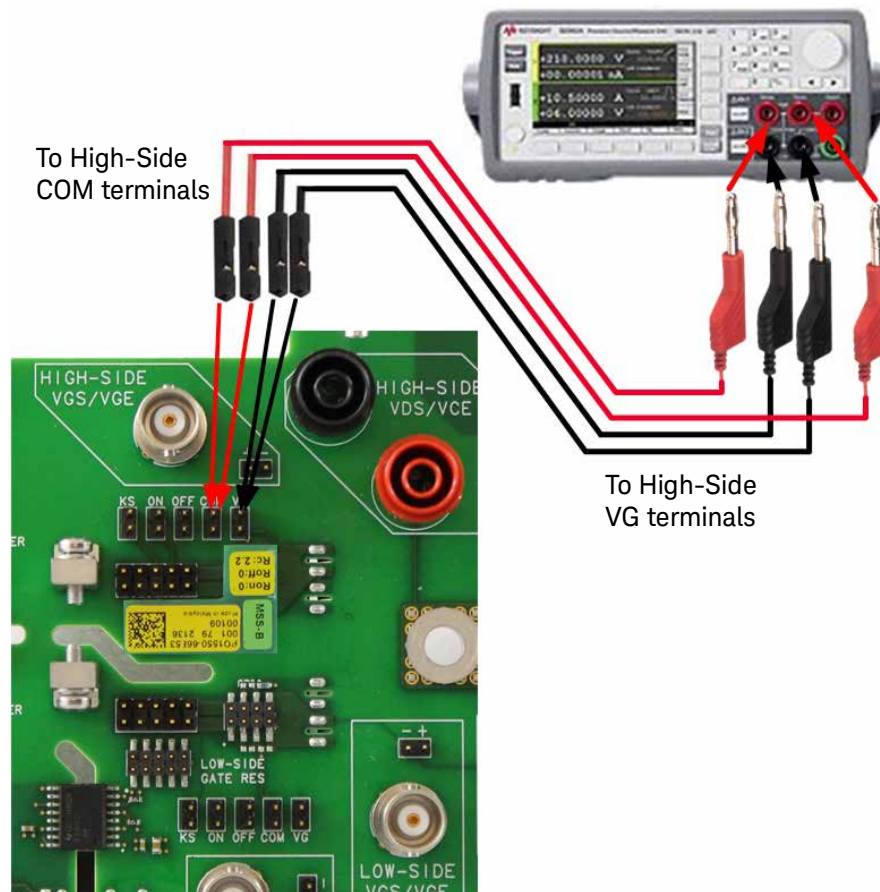


Figure 15 High-Side R_{COM} Calibration Connections

Procedure: Click **Start** to perform the calibration and continue to next step.

8 High-Side Gate Resistance Calibration -- $R_{GON,H}$

NOTE

IMPORTANT: Perform this calibration step only after performing:
7 High-Side Common Resistor Calibration -- $R_{COM,H}$

Hardware Setup:

- Remove the DUT module from the Interface Module before calibration.
- Remove both High-Side and Low-Side Gate Drive Modules from the Interface Module.
- Install the High-Side Gate Resistor Module that you want calibrated.
- Install UDI cables on the Low-Side Gate Drive Module and Interface Module.
- Use two sets of calibration cables for a four-wire resistance measurement:
 - Red cable from SMU Force to High-Side **ON** terminal.
 - Red cable from SMU Sense to High-Side **ON** terminal.
 - Black cable from SMU Force to High-Side **VG** terminal.
 - Black cable from SMU Sense to High-Side **VG** terminal.

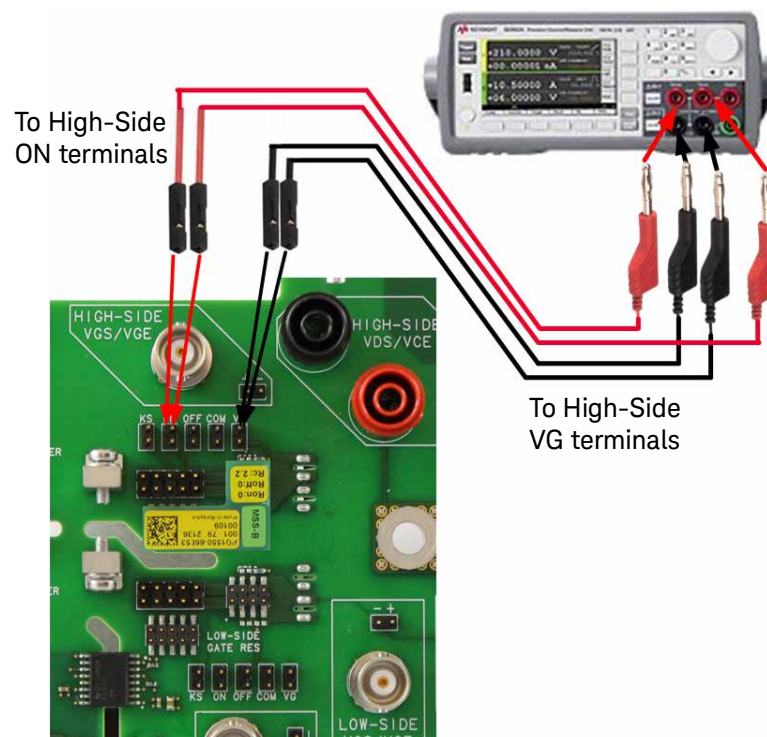


Figure 16 High-Side $R_{G,ON}$ Calibration Connections

Procedure: Click **Start** to perform the calibration and continue to next step.

9 High-Side Gate Resistance Calibration -- $R_{G,OFF,H}$ **NOTE**

IMPORTANT: Perform this calibration step only after performing:
7 High-Side Common Resistor Calibration -- $R_{COM,H}$

Hardware Setup:

- Remove the DUT module from the Interface Module before calibration.
- Remove both High-Side and Low-Side Gate Drive Modules from the Interface Module.
- Install the High-Side Gate Resistor Module that you want calibrated.
- Install UDI cables on the Low-Side Gate Drive Module and Interface Module.
- Use two sets of calibration cables for a four-wire resistance measurement:
 - Red cable from SMU Force to High-Side **OFF** terminal.
 - Red cable from SMU Sense to High-Side **OFF** terminal.
 - Black cable from SMU Force to High-Side **VG** terminal.
 - Black cable from SMU Sense to High-Side **VG** terminal.

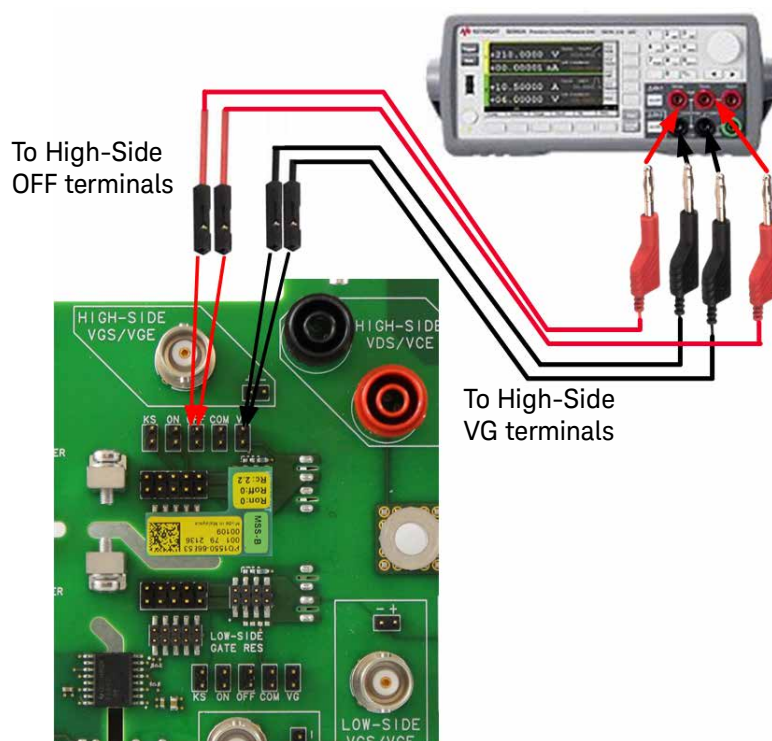


Figure 17 High-Side $R_{G,OFF}$ Calibration Connections

Procedure: Click **Start** to perform the calibration and continue to next step.

10 Calibration Complete

Click **Exit** to complete the **Calibration & Compensation** process.

After Calibration, remove all test cables from the Interface Module and reconnect all oscilloscope probes to the Interface Module.

Coaxial Shunt Resistor Characterization

There is no separate calibration for the PD1550-61901 50 m Ω and the PD1550-61902 5 m Ω Coaxial Shunt Resistors. The De-embedding characterization file installed in the Oscilloscope provides the necessary accuracy.

NOTE

The PD1550-61901 and PD1550-61902 Coaxial Shunts should be removed from the DUT Test Module and shipped to a Keysight Service Center for characterization. This should be done annually.

This creates the latest characterization .tf2 file. After the shunt is characterized, Keysight returns the shunt to you. Download the file from the [Keysight Service Portal](#) website and install it in the oscilloscope.

Install the De-Embedding Transfer File on the Oscilloscope

- 1 From the temporary location where you unzipped the de-embedding file, copy the .tf2 file to the Oscilloscope. Place it in the folder:
`C:\Users\Public\Documents\Infiniium\Filters`.

NOTE

On the Oscilloscope, the file path will show as:
`C:\Users\Public\Public Documents\Infiniium\Filters`. However, this is an alias path. Use the path: `C:\Users\Public\Documents\Infiniium\Filters` in the Shunt Settings De-embedding File path in the Control Software.

- 2 In the PD1000A Control Software, type the .tf2 file name into the **Double-Pulse Measurement Control > Settings > Instrument Configuration > De-embedding File** field. For new PD1550A systems, the de-embedding file was installed in the oscilloscope at the factory with the file name:
`MY5840xxxx.tf2`

where xxxx is the serial number labeled on the shunt itself.

NOTE

The oscilloscope channel you specify for the **Output Current I_D/I_C** in the DPT Control Software Hardware Configuration screen is the channel that the Coaxial Shunt De-embedding is applied to.

A Selecting Gate Drive Resistors

Figure 18 below shows a basic N-channel FET drive circuit. R_G is the external Gate Drive Resistor. Its value affects the switching speed and therefore switching loss of the FET. The drive voltage (V_G) must be sufficiently larger than the FET's threshold voltage (V_{TH}) to turn on the FET and sufficiently low enough to fully turn off the FET. The gate drive must have capability to sufficiently charge the FET input capacitance.

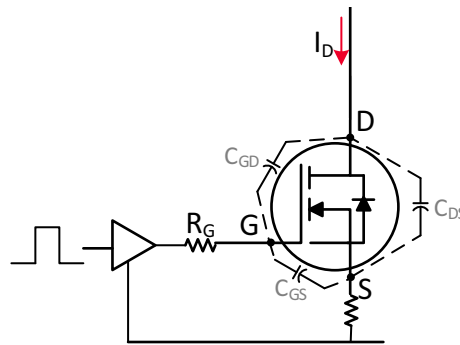


Figure 18 Basic N-channel FET Drive Circuit

Proper selection of a gate drive resistor affect the following three things:

- drive current
- gate-drive power dissipation
- rise and fall times.

Small Gate Resistor Values

Small gate resistor values increase the switching speed of a FET making it susceptible to voltage surge and oscillation and ultimately device failure. Too small of a gate drive resistor results in overshoot in the gate drive voltage (V_{GS}). At $R_G = 0 \Omega$, there may unwanted ringing in the gate-source waveform; the internal device resistance is insufficient to dampen oscillation. transient voltage spikes or excessive gate drive voltage and could puncture the gate-source oxide destroying the device.

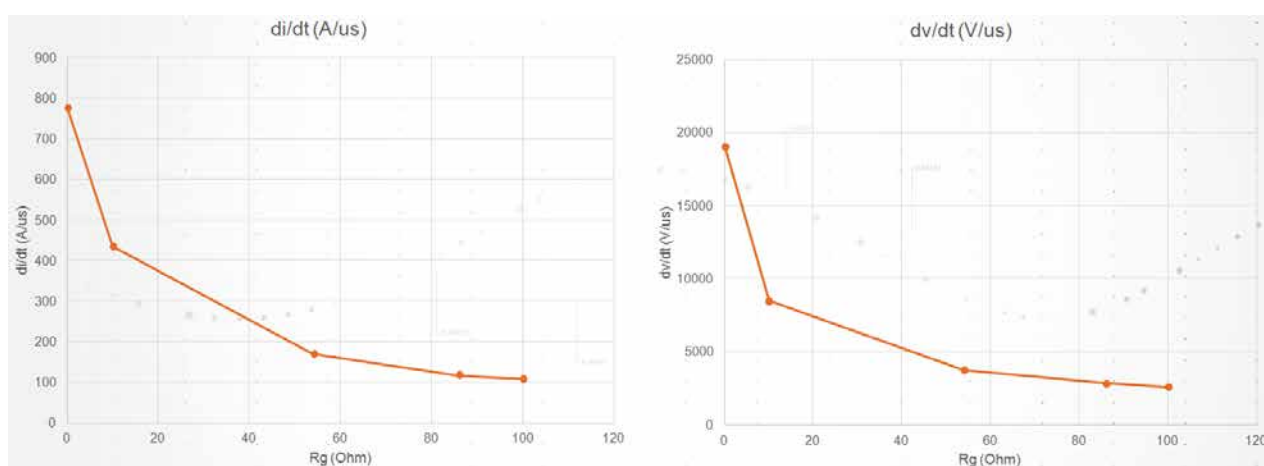
Large Gate Resistor Values

Large gate resistor values decrease switching speed of the device resulting in increased power loss, a reduction in performance, and potential heat issues. Too high of a value over-damps the oscillation and extends the switching times.

Optimal Gate Resistor Value

As described above, increasing the gate resistor value reduces the ringing but also reduces switching speed and therefore increases switching loss. This is because the gate resistor value and gate voltage restrict the gate charge current. Reducing the gate resistor value increases switching speed at the expense of increased ringing.

Figure 19 and Figure 20 illustrate how di/dt and dv/dt change with different values of Gate resistors.



$V_{GS} = 0 \text{ to } 18 \text{ V}$
 $V_{DS} = 400 \text{ V}$
 $I_{DS} = 10 \text{ A}$

R_G (in Ohms)	di/dt (A/ μ s)	t_d (ns)	t_f (ns)	t_{off} (ns)	dv/dt (V/ μ s)	E_{ON} (μ J)	E_{OFF} (μ J)
100	108.8	262	156.6	418.6	2632.7	737	325
86	118.2	234.7	141.2	375.9	2870	674	287
54	171	156	103.6	259.6	3779	503	174
10	437	61.4	43.5	104.9	8524	253	52
0	778	15	31	46	19112	20	20

Figure 19 Gate Resistor vs. Switching Speed at Turn-On

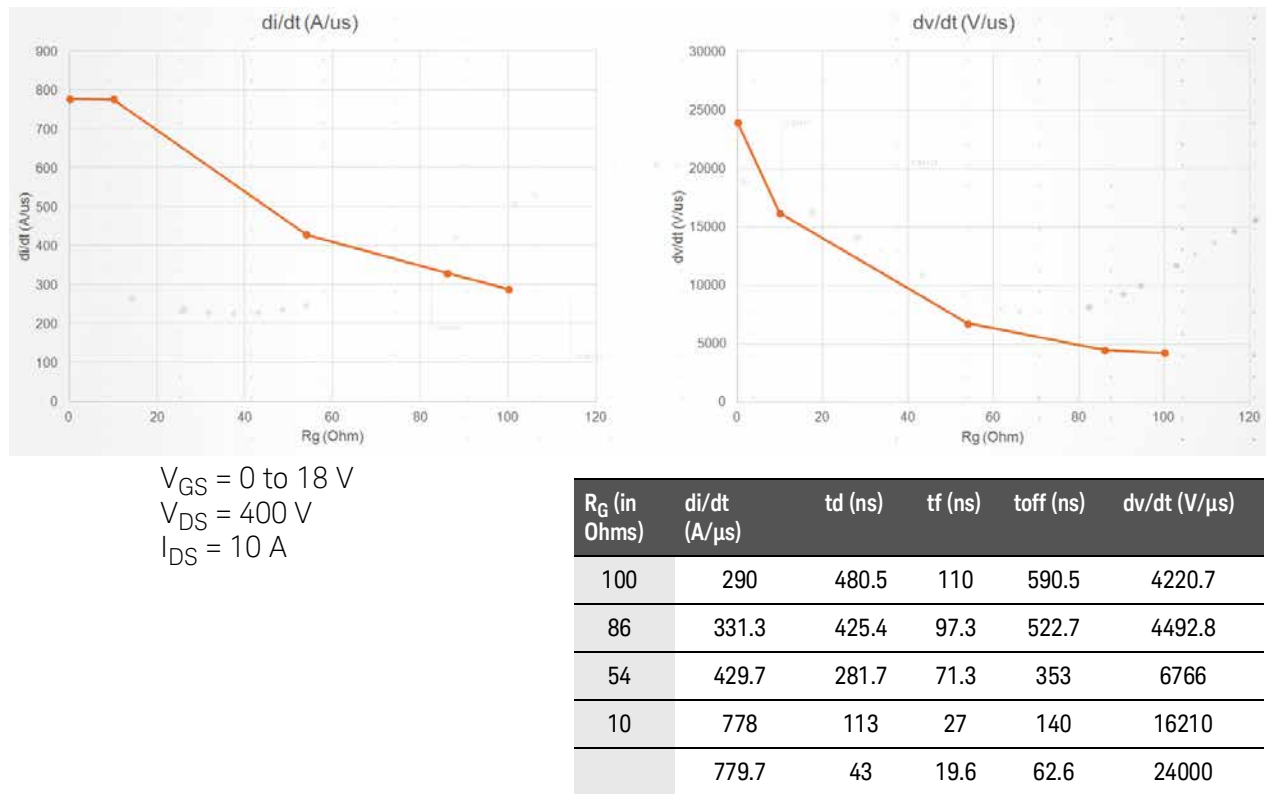


Figure 20 Gate Resistor vs. Switching Speed at Turn-Off

Additional factors to consider:

- For general modeling purposes, a larger gate drive resistor is good. The PD1550A makes high power IV derivations. It requires a clean curve for both V_{GS} and I_{DS} .
- For Gate Charge measurements having a plateau is important. Whether the V_{GS} display shows the plateau depends on the device being tested (DUT) as well as voltage and current settings. A $100\ \Omega$ R_G should give a better plateau than the $10\ \Omega$ R_G .

NOTE

Always use High-Side and Low-Side Gate Drive Modules with the same value resistors. Using a $100\ \Omega$ Gate Resistor on the High-Side transistor and a $0\ \Omega$ resistor on the Low-Side transistor, could cause false turn-on of the non-switching transistor due to high dv/dt and the weakly-driven gate. A $0\ \Omega$ resistor on the transistor that is not being switched is generally okay.

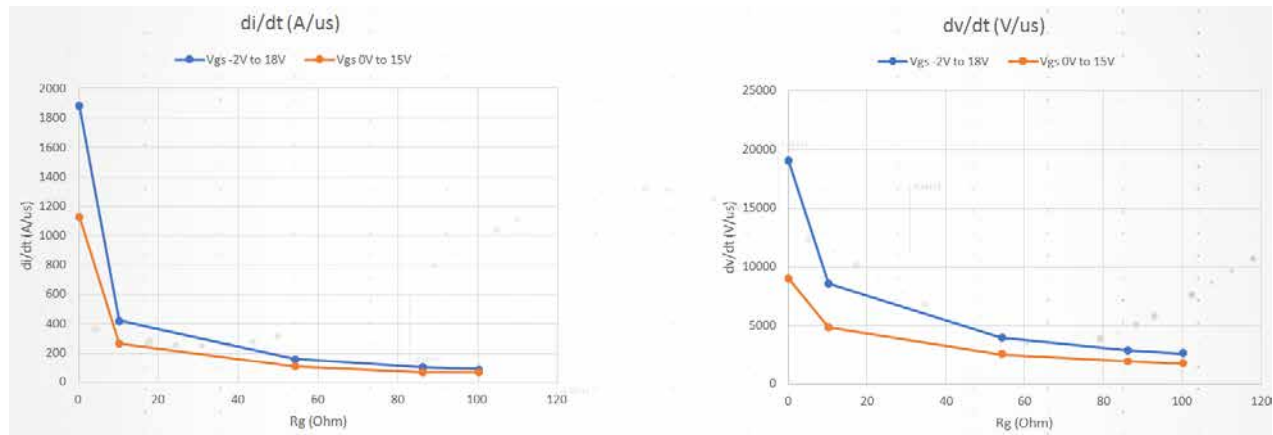
NOTE

Switching characteristics of the DUT are influenced by the Gate resistor value. A small resistor value allows for faster switching but it increasing the ringing. A large gate resistor value slows down the turn-on of the device but allows for a more accurate gate charge measurement.

NOTE

A $0\ \Omega$ R_G cannot be used for Gate Charge measurements because the gate current cannot be measured.

- In some cases, di/dt is defined in device data sheets for reverse recovery measurements. Using 0, 10 and 100 Ohm Gate Drive Resistors (R_G), draw a graph like the one shown in Figure 21, it is easier to find the appropriate R_G . For example, in Figure 21, if the defined di/dt is 200 A/ μ s for a condition (400V/10A with V_{GS} 0V to 18V which corresponds to orange curve), the R_G value should be in between 10 Ω and 20 Ω .



Measured data for
blue plot

R_G (in Ohms)	di/dt (A/ μ s)	t_d (ns)	t_f (ns)	t_{off} (ns)	dv/dt (V/ μ s)
100	91	1.7	163	218	2649
86	105	1.8	178	196	2892
54	160	2.5	205	140	4000
10	422	4.3	138	62.6	8587
	1891	8.5	134	33.7	19090

Measured data for
orange plot

R_G (in Ohms)	di/dt (A/ μ s)	t_d (ns)	t_f (ns)	t_{off} (ns)	dv/dt (V/ μ s)
100	68	1.3	164	313	1768
86	68	1.4	158	260	1946
54	109	1.7	154	169	2567
10	265	2.9	124	109	4861
	1132	4	114	58.9	9033

Figure 21 Gate Resistor vs. di/dt for Reverse Recovery

- When measuring Reverse Recovery, R_G on the High-Side module plays an important role. For switching characterization, use an R_G value similar to the R_G in your final design. If you have a specific R_G , you can use the PD1000-66550 Gate Drive resistor modules and install your own resistors.
- To see the fastest di/dt and dv/dt for your circuit design, use the $0\ \Omega$ R_G . However, remember that the $0\ \Omega$ R_G cannot be used for measuring gate charge or gate current.

B Installing Surface-Mount Devices

For installing surface-mount gate resistors on the PD1000-66550 Gate Drive Resistor Modules, a very small-tipped soldering iron may be used. However, you may find it easier to use a hot air solder reflow tool.

For the custom Gate Drive resistors, use the correct size of SMD resistors. Because of the tight spacing and small size of the resistors, it is best to use a hot air type solder reflow tool and push the SMD resistors in place. Gate Drive Resistors are an imperial size 0603 ($L = 0.6 \text{ mm}$, $W = 0.3 \text{ mm}$).

Use Anti-static procedures when soldering the devices to the Test Module.

NOTE

These Keysight printed circuit assemblies (PCAs) are RoHS compliant. To ensure a reliable connection when installing surface mount devices or custom gate resistors, you must use a lead-free soldering process.

NOTE

For detailed information on soldering devices to the printed circuit assembly, refer to the latest IPC 610 standard.

CAUTION

Do not use solder paste that contains a toxic substance (lead). Use extreme caution when handling and using the paste. Follow all manufacturers warning and guidelines.

WARNING

All soldering involves temperatures that may exceed 500°C . These temperatures may burn skin, eyes, clothing, etc. Always use eye protection when soldering.

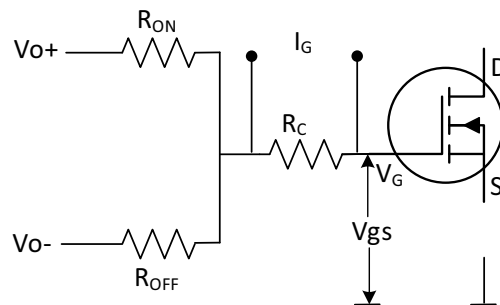


Figure 22 Schematic of Gate Drive Resistors

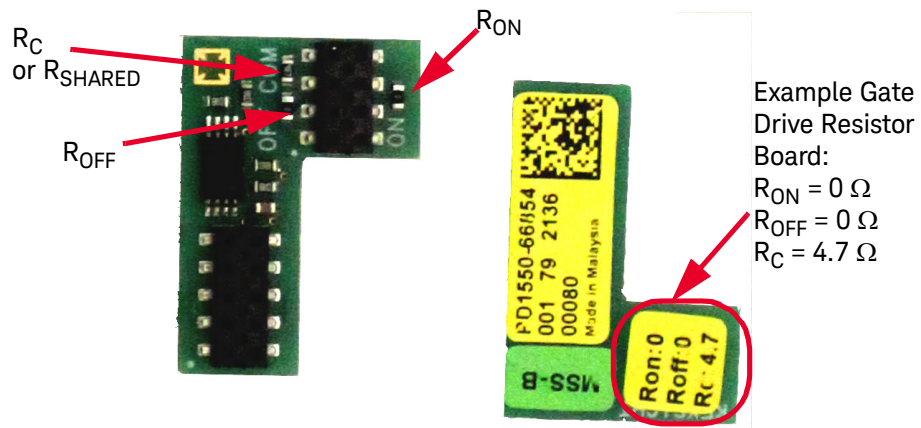


Figure 23 PD1550A Gate Drive Resistor Modules

Using a Hot Air Solder Reflow Tool

- 1 Start by applying flux to the pads on the test module. The flux cleans the pad and makes it easier for the solder to adhere properly.
- 2 Apply a small amount of solder paste on the all the pads of the component you want to solder.
- 3 Using bent-nose tweezers or pointed probe, place the component in its correct position and hold it there.
- 4 Use the hot air solder reflow toll to melt the solder tool to melt the solder. Remove the hot air tool as soon as the solder melts.
- 5 Your device should now be soldered to the Test Module. Inspect the solder joints with a microscope to ensure solder joints are good and that there are no solder bridges. Use solder braid to remove excess solder if necessary.

Using a Small-tip Soldering Iron

Use a small pencil type 10-15 watt soldering iron. A sharp, pointed tip is essential when soldering surface mount components. Keep the tip of the iron clean and well tinned at all times. Many areas on the printed circuit board are close together and care must be given not to form solder bridges. Solder bridges may occur if you accidentally touch an adjacent foil, particularly a previously soldered connection, using too much solder, or dragging the iron across adjacent foils. If a solder short occurs, remove it with your hot iron. Use only lead-free rosin core solder. For a good soldering job, the areas being soldered must be heated sufficiently so that the solder flows freely.

Use small diameter solder, (e.g., 0.05 or 0.031 inch diameter).

- 1** Start by applying a small amount of flux to all pads on the module. The flux cleans the pad and makes it easier for the solder to adhere properly.
- 2** Apply a small amount of solder paste from a syringe to each pad.
- 3** Carefully place the device(s) on the pads. Bent-nose tweezers are useful when positioning the resistors.
- 4** Place the tip of the soldering iron onto each of the pads so that the solder melts and makes good connection between the component and the module.
- 5** Remove the soldering iron and allow the solder joint to cool.
- 6** Inspect the solder joints with a microscope to ensure solder joints are good and that there are no solder bridges. Use solder braid to remove excess solder if necessary.

D SMA Connector Care & Connection

Good connections are essential for accurate calibrations and measurements and require a skilled operator. The most common cause of measurement error is poor connections. The following information is for use when connecting the two Waveform Generator cables to the DPT Test Fixture and when connecting the BNC-SMA cable to the PD1000-60002 Protection Probe. **IMPORTANT:** proper connection can help prevent ringing during a DPT test.

SMA connectors mate with 2.92 and 3.5 mm connectors. However, a damaged SMA connector, or a used SMA connector with a slightly bent pin can destroy a 2.92 or 3.5 mm connector. In SMA connectors, the center pin connects first, before the threads. If an SMA pin is bent or off-center for any reason, then the pin will make contact with the 2.92/3.5 mm female contacts which are unsupported as an air dielectric is used, and the female contact may be pushed out of place.

- 1 Ground yourself and all devices. Wear a grounded wrist strap and work on a grounded, conductive table mat.
- 2 Visually inspect the connectors. If necessary, clean the connectors.
- 3 Carefully align the connectors. As you make the actual connection, be sure the connectors align perfectly.
- 4 Push the connectors straight together. Do not twist or screw the connectors together.
- 5 Engage the connector nut (of the connector with the retracted sleeve) over the threads of the other connector (the connector with the extended sleeve). Turn only the connector nut. Let the connector nut pull the two connectors straight together.
- 6 Do not over tighten this connection. A connection in which the outer conductors make gentle contact at all points on both mating surfaces is sufficient. Very light finger pressure is enough to accomplish this.
- 7 Make sure the connectors are properly supported. Relieve any side pressure on the connection from long or heavy devices or cables.
- 8 Torque the connection according to the procedures described below.

Final Connection Using a Torque Wrench

Using a torque wrench guarantees the connection is not too tight, preventing possible connector damage. It also guarantees that all connections are equally tight. Prevent the rotation of anything other than the connector nut that you are tightening.

Use a Keysight 8710-1582, 0.56N-m (5 lb-in) 5/16 inch break-over torque wrench to make a final connection. A Torque wrench is supplied as part of the PD1550A Accessory Kit.



Figure 21 Keysight 8710-1582 SMA Torque Wrench

NOTE

The Keysight 8710-1582, 5 lb-in Torque Wrench is a precision instrument and should be treated and maintained like a measuring instrument.

- 1 Turn the connector nut. This may be possible to do by hand if one of the connectors is fixed (as on a test port). However, it is recommended that you use a second open-end wrench to keep the body of the device from turning.
- 2 Position both wrenches within 90 degrees of each other before applying force. Wrenches opposing each other (greater than 90 degrees apart) will cause a lifting action that can misalign and stress the connections of the device involved. This is especially true when several devices are connected together. Refer to the following figure.

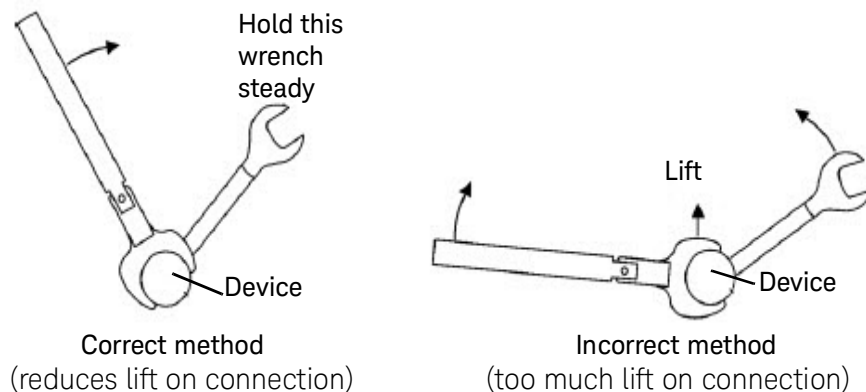


Figure 22 Wrench Positions

- 3 Hold the torque wrench lightly, at the end of the handle only (beyond the groove). See the following figure.

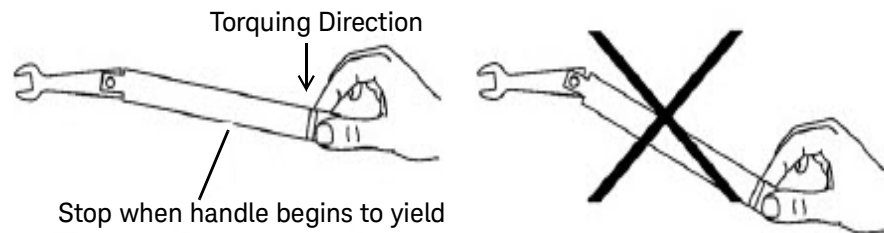


Figure 23 Using the Torque Wrench

- 4 Apply force downward to the wrench handle. This applies torque to the connection through the wrench. Do not hold the wrench so tightly that you push the handle straight down along its length rather than pivoting it, otherwise you apply an unknown amount of torque.

CAUTION

You don't have to fully break the handle of the torque wrench to reach the specified torque; doing so can cause the handle to kick back and loosen the connection. Any give at all in the handle is sufficient torque.

- 5 Tighten the connection just to the torque wrench break point. The wrench handle gives way at its internal pivot point. Do not tighten the connection further.

Separating Connections

To avoid lateral (bending) force on the connector mating plane surfaces, always support the devices and connections.

CAUTION

Do not turn the device body. Only turn the connector nut. Damage to the center conductor can occur if the device body is twisted.

- 1 Use an open-end wrench or spanner wrench to prevent the device body from turning.
- 2 Use another open-end wrench or the torque wrench to loosen the connector nut.
- 3 Complete the separation by hand, turning only the connector nut.
- 4 Pull the connectors straight apart without twisting, rocking, or bending.

Inspect and Clean Connectors

Clean connector interfaces prolong connector life and produce more accurate and repeatable measurements. When using SMA female connectors, pay special attention to the contact fingers on the female center conductor. These can be bent or broken, and damage to them is not always easy to see. A connector with damaged contact fingers will not make good electrical contact and must be repaired or replaced.

Inspect each connector to make sure that no particles or residue are present.

Connector Cleaning

WARNING

Always use protective eye-wear when using compressed air or nitrogen.

WARNING

Keep isopropyl alcohol away from heat, sparks, and flame. Store in a tightly closed container. Isopropyl alcohol is extremely flammable. In case of fire, use alcohol foam, dry chemical, or carbon dioxide; water may be ineffective.

Use isopropyl alcohol with adequate ventilation and avoid contact with eyes, skin, and clothing. It causes skin irritation, may cause eye damage, and is harmful if swallowed or inhaled. It may be harmful if absorbed through the skin.

Wash thoroughly after handling. In case of spill, soak up with sand or earth. Flush spill area with water.

Dispose of isopropyl alcohol in accordance with all applicable federal, state, and local environmental regulation.

- Use compressed air to loosen particles on the connector mating plane surfaces.
- Apply a small amount of isopropyl alcohol to a lint-free swab. Clean the connector threads. Let the alcohol evaporate, then blow the threads dry with a gentle stream of clean, low-pressure compressed air or nitrogen. Always completely dry a connector before you reassemble or use it.

D Simplified System Wiring Diagrams

This appendix shows simplified wiring diagrams for the DPT system.

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PD1550A Power Wiring	page 135
PD1550A Ethernet Wiring	page 136
PD1550A Internal UDI Wiring	page 137
PD1550A BNC Wiring (Internal to the Rack)	page 138
PD1550A D-Sub Connector Wiring (Internal to the Rack)	page 139
PD1550A Connect Probes to Oscilloscope	page 140
Connect Probes for High-Side DUT Measurements	page 142

PD1550A High Voltage Wiring

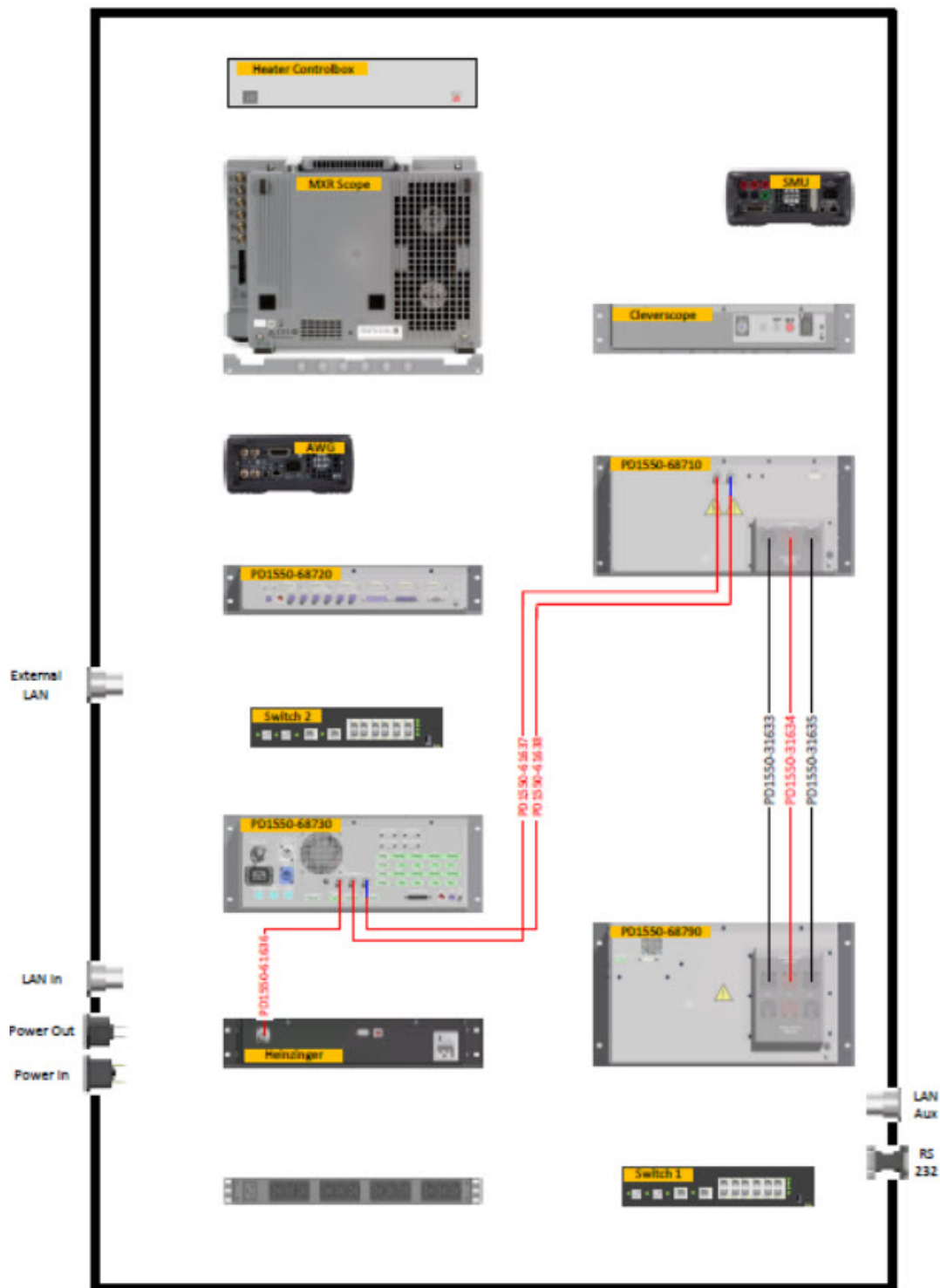
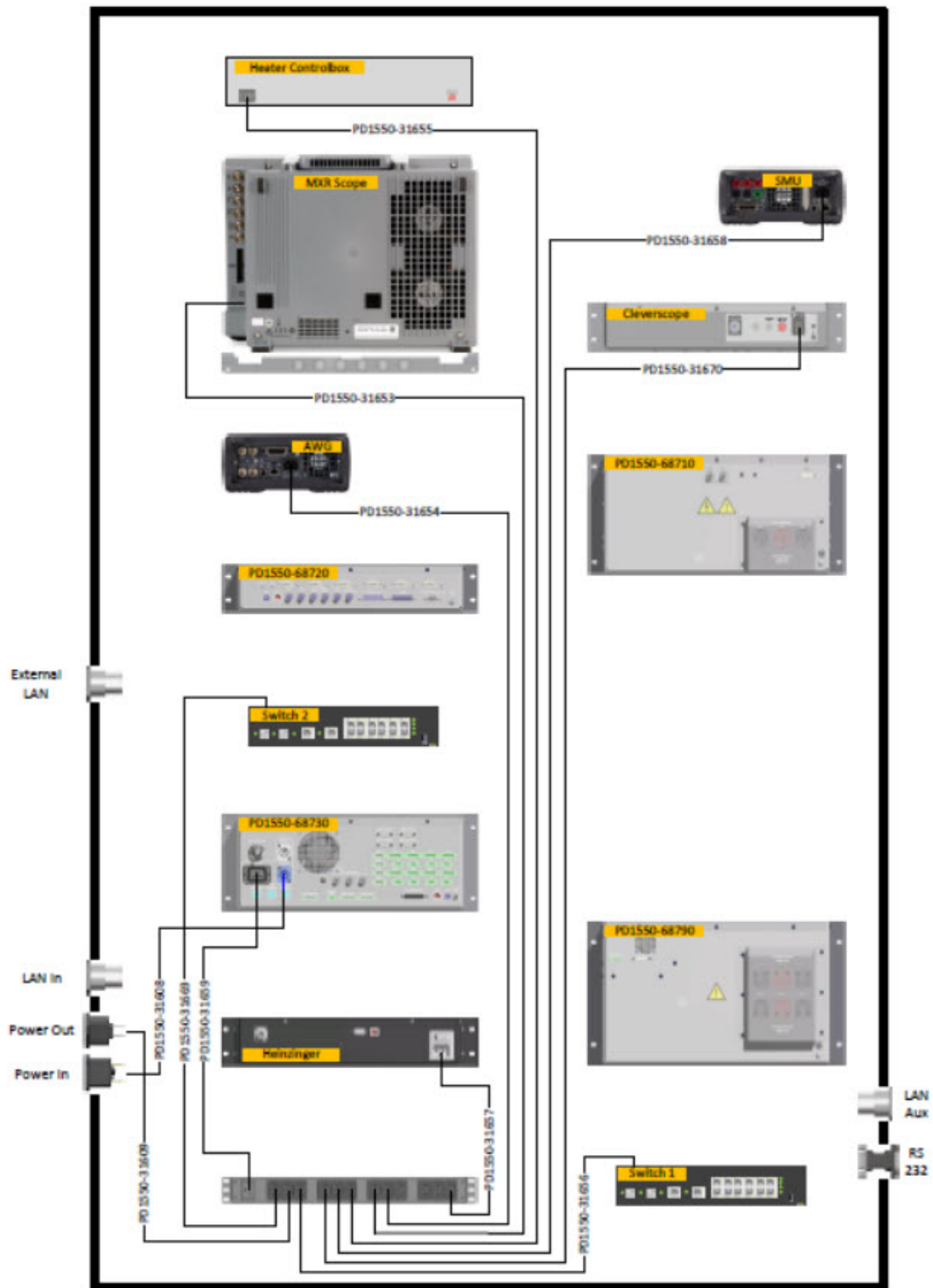
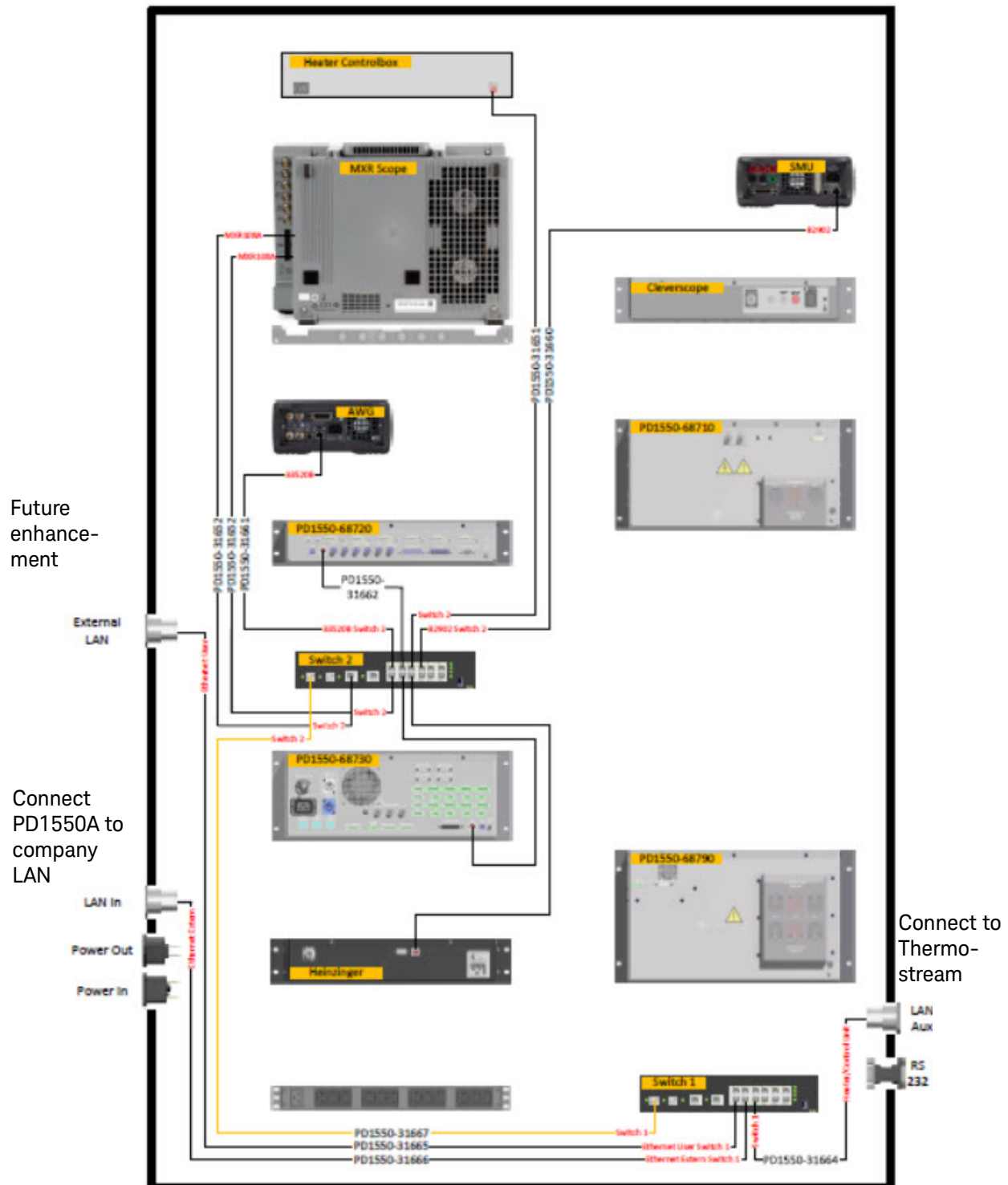


Figure 27 PD1550A High Voltage Wiring

PD1550A Power Wiring

**Figure 28** PD1550A Power Wiring

PD1550A Ethernet Wiring

**Figure 29** PD1550A Ethernet Wiring

PD1550A Internal UDI Wiring

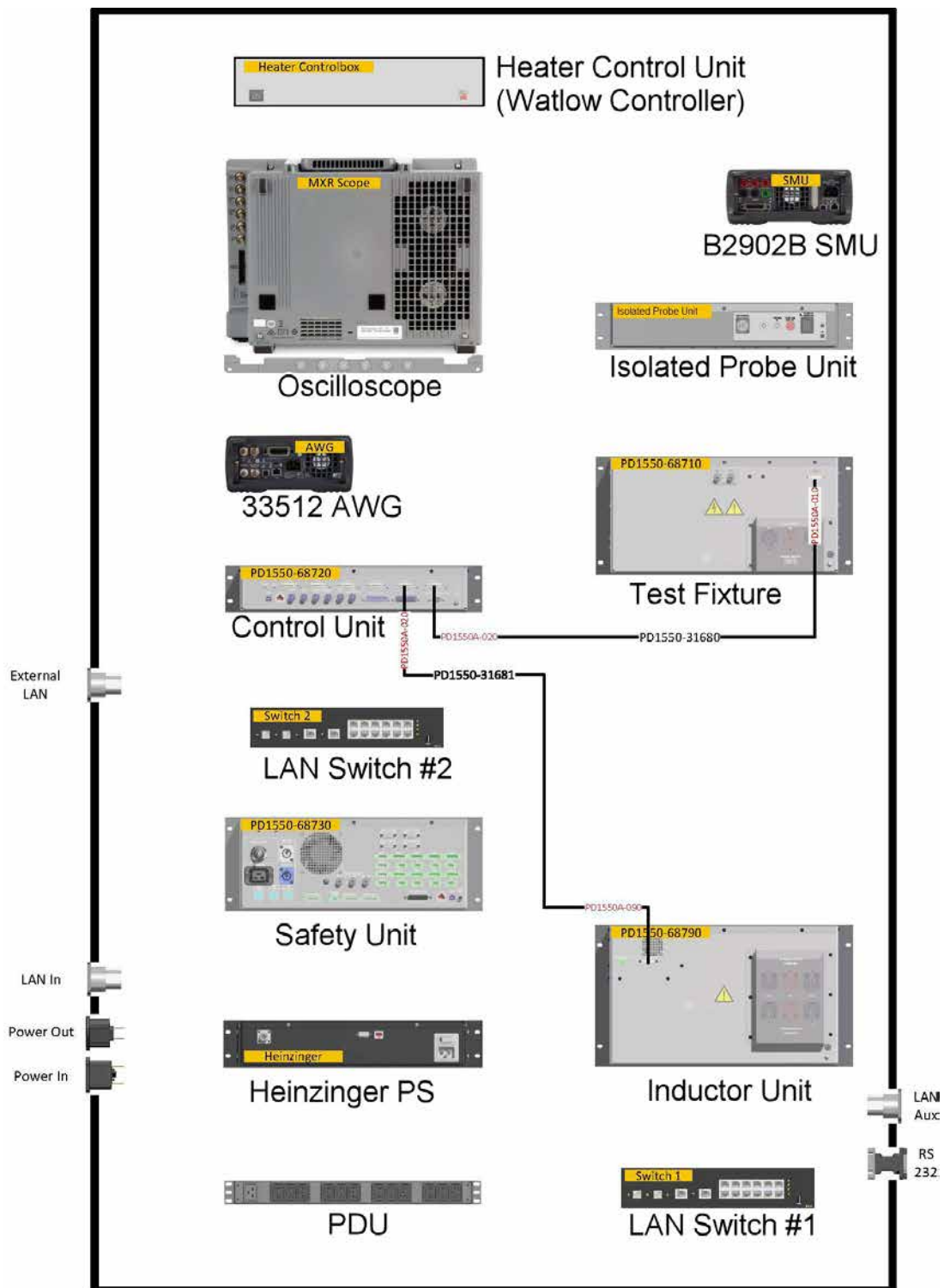
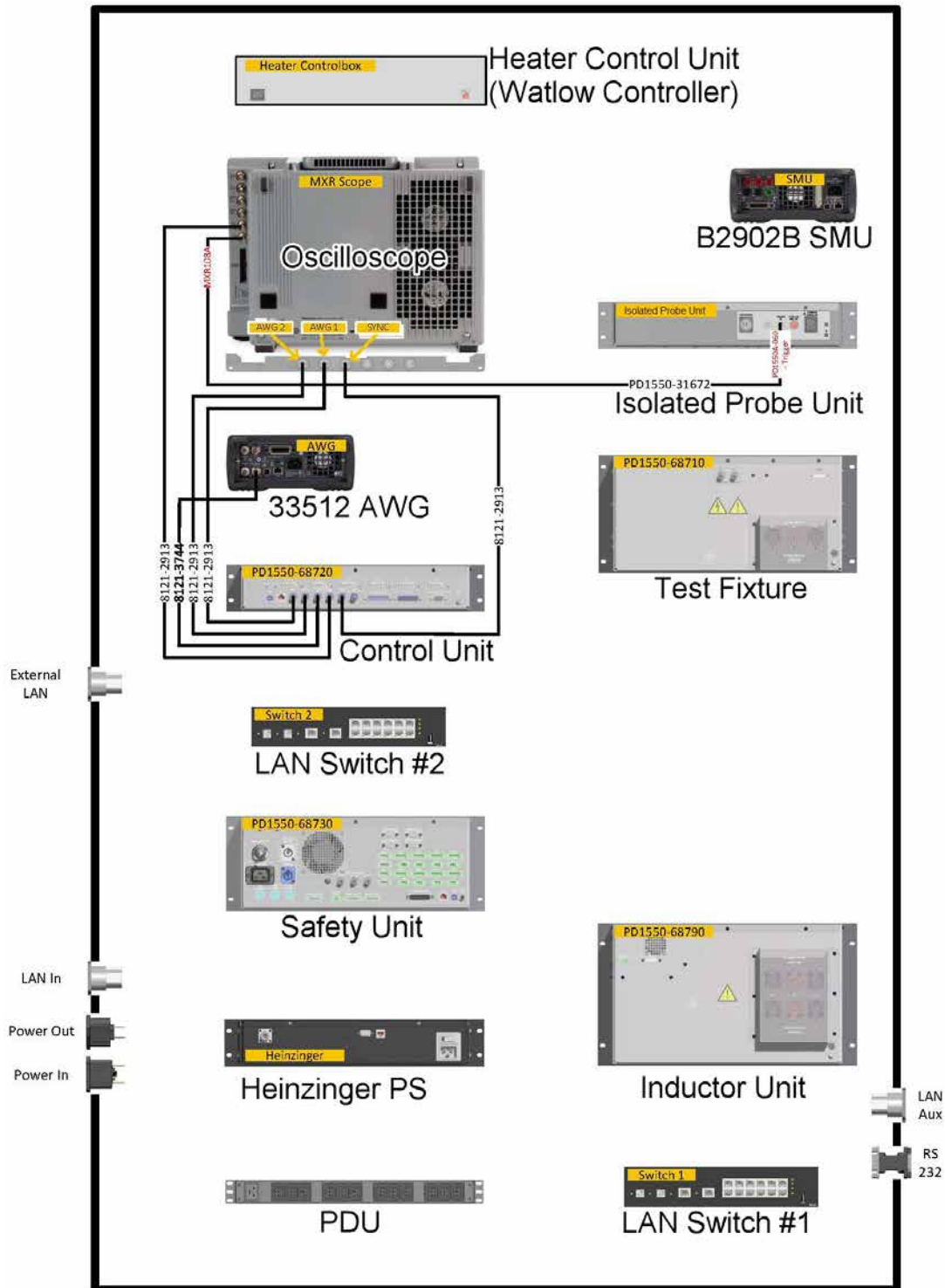
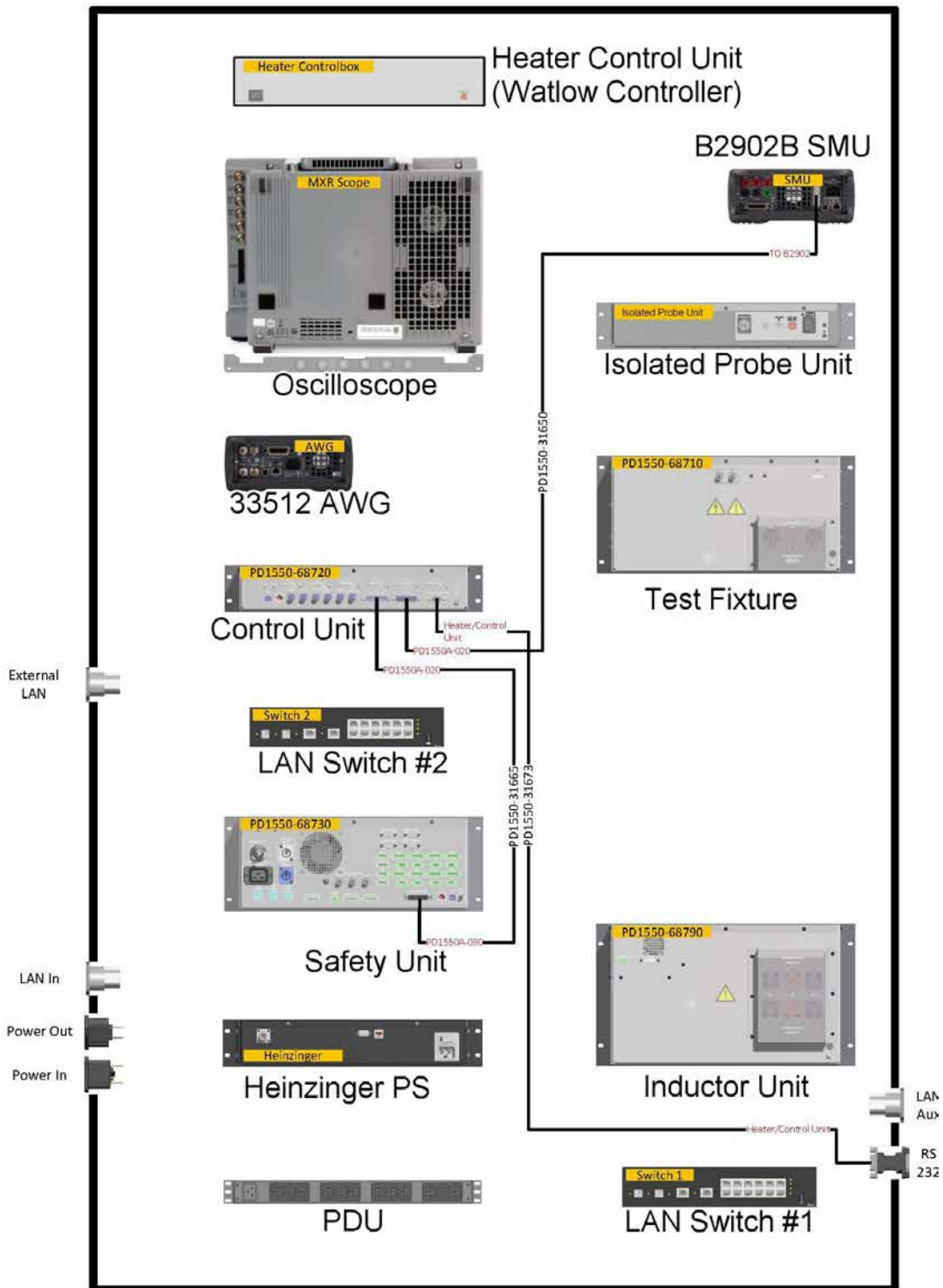


Figure 30 PD1550A Internal UDI Wiring

PD1550A BNC Wiring

**Figure 31** PD1550A BNC Wiring (Internal to the Rack)

PD1550A D-Sub Connector Wiring

**Figure 32** PD1550A D-Sub Connector Wiring (Internal to the Rack)

PD1550A Connect Probes to Oscilloscope

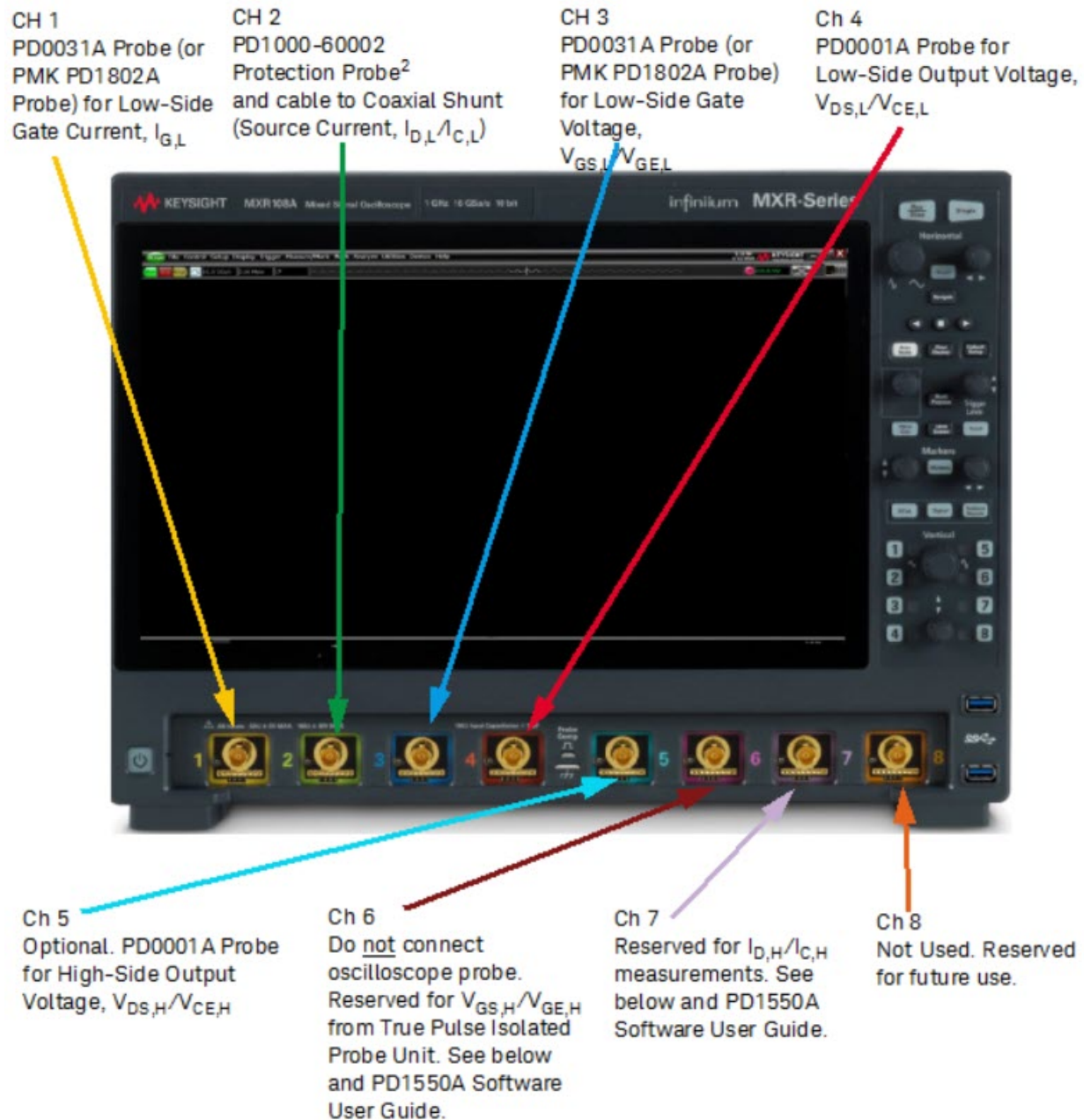


Figure 33 Standard (default) Oscilloscope Probe Connections

Oscilloscope Channel	Color	Measures	Oscilloscope Probe
1	Yellow	Low-Side Gate Voltage: $V_{GS,L}/V_{GE,L}$ (LOW-SIDE VGS/VCE on Interface Module)	DP0031A Differential Probe ¹ (requires banana to BNC adapter)
2	Green	Low-Side Output Current: $I_{D,L}/I_{C,L}$ (LOW-SIDE ID/IC on Interface Module)	PD1000-60002 Protection Probe and cable to Coaxial Shunt ²
3	Blue	Low-Side Output Voltage: $V_{DS,L}/V_{CE,L}$ (LOW-SIDE VDS/VCE on Interface Module)	DP0031A Differential Probe ¹ (requires banana to BNC adapter)
4	Red	Low-Side Gate Current, $I_{G,L}$ (IG on Interface Module)	DP0001A High Voltage Differential Probe
5	Lt Blue	Optional. High-Side Output Voltage, $V_{DS,H}/V_{CE,H}$ (Interface Module HIGH_SIDE VDS/VCE)	DP0001A High Voltage Differential Probe
6	Dark Red	Do <u>not</u> connect oscilloscope probe. See “ Connect Probes for High-Side DUT Measurements ” and PD1550A Software User Guide.	Reserved for $V_{GS,H}/V_{GE,H}$ from Isolated Probe Unit Isolated Probe Unit.
7	Purple	See “ Connect Probes for High-Side DUT Measurements ” and PD1550A Software User Guide.	Reserved for $I_{D,H}/I_{C,H}$. See PD1550A Software User Guide.
8	Orange	Not used. Reserved for future use.	Not used. Reserved for future use.

¹ Your system may have been provided with PMK PD1802A Differential Probes instead of the Keysight DP0031 probes. These probes are identical in performance.

² Use the 0.56 N-m (5 lb-in) 5/16 in. SMA Break-over torque wrench (provided with the PD1550A system) to tighten the SMA cable connector to the PD1000-60002 Protection Probe. Failure to do so might cause extensive ringing in the DPT measurements. See appendix for details.

NOTE

The oscilloscope channels and colors shown above are recommended. You may choose different channels. All examples and screen captures shown in the DPT documentation use this configuration. The colors on the PD1000A Control Software screen match the DSOS104 Oscilloscope probe channel number colors: i.e., Channel 1 - $V_{GS,L}/V_{GE,L}$ for Low-Side Gate Current is yellow, Channel 2 - $I_{d,L}/I_{C,L}$ for Low-Side Output Current is green, etc.

NOTE

Do not use a different cable for $I_{DS,L}$ or Isolated Probe Unit oscilloscope probes. The cables and oscilloscope probes supplied with your PD1550A provide correct probe deskew.

Connect Probes for High-Side DUT Measurements

High-Side Gate Voltage

Keysight's Isolated Probe Unit is used for High-Side Gate Voltage, $V_{GS,H} / V_{GE,H}$, measurements only. Only Channel A is used at this time, the remaining channels are reserved for future use. A standard 10:1 oscilloscope probe connects the Isolated Probe Unit Channel 1 to the Keysight Interface Module.

Make certain that both **Gate Voltage $V_{GS,H}/V_{CE,H}$** and **Use Isolated Probe Unit for $V_{GS,H}/V_{CE,H}$** are selected in the **Settings > Hardware Configuration > Oscilloscope** tab are checked. Default condition is that these two are not checked.

High-Side Drain/Collector Current

For High-Side Drain or Collector current, $I_{D,H}/I_{C,H}$, measurements, a current shunt is not available for the Keysight 62 mm Interface Modules. However, for your custom Interface Modules you may design a place to install a small Rogowski coil current probe. This should be connected to Channel 7 on the PD1550A oscilloscope.

Make certain that **Output Current $I_{D,H}/I_{C,H}$** is selected in the **Settings > Hardware Configuration > Oscilloscope** tab are checked. Default condition is that this is not checked.

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Printed in Malaysia

Edition 1, May 2023



PD1550-90002

www.keysight.com