

Keysight PD1500A Double-Pulse Test Rack and Safety Enclosure

Provides detailed information to install the Double-Pulse Test Rack and Safety Enclosure at a customer site. The Rack and Safety Enclosure is used with the PD1500A Dynamic Power Device Analyzer/Double-Pulse Tester.



System Installation
Guide

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www.keysight.com/find/PD1500A

(product-specific information and support, software and documentation updates)

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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:



Refer to manual for additional 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:
High Voltage



Hot Surface; DO NOT Touch!



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.



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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-SP19629

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

A 급 기기 (업무용 방송통신기자재)
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기로서 판 매자 또는 사용자는 이 점을 주
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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.

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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.

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 on the light tower is on inside the Double-Pulse Test Rack and Safety Enclosure, lethal voltage (± 1000 V dc/pulse) may appear at measurement terminals.
- Never attempt to defeat the safety interlock function of the Safety Hood.
- Do not operate the system unless another person is around the work space who is familiar with system operation and hazards or 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 Technologies 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/PD1500A for all documentation.

WARNING



Hazardous voltage: System maximum output voltage may appear at the measurement terminals inside the Safety Hood. Never attempt to bypass the safety interlock and features of the PD1500A Double-Pulse Test System Rack and 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 Hood must remain closed. There are no user-serviceable parts inside.

Do not intentionally modify the interlock function of the Safety Hood. 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 Technologies 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.

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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 assemble and install the PD1500A Dynamic Power Device Analyzer/Double-Pulse Tester. Note that the PD1500A is part of the overall PD1000A Power Device Measurement System for Advanced Modeling.

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Customer Responsibilities

This System Installation Guide provides instructions for a Keysight-trained Application Engineer to install the Keysight PD1500A DPT System Rack and Safety Enclosure.

<input type="checkbox"/>	Receive the Double-Pulse Test System (multiple shipping containers). See page 20
<input type="checkbox"/>	Ensure the operating environment (space, noise, etc.) is suitable. See page 18 .
<input type="checkbox"/>	Electrical and environmental requirements are met. See page 18
<input type="checkbox"/>	Provide a qualified electrician to do one of the following. See page 18 <ul style="list-style-type: none"> permanently hard wire the free end to the AC power source or <ul style="list-style-type: none"> attach an IEC 60309 AC power plug (L+N+P 6h is recommended) to the AC power cable (a matching IEC 60309 AC Power receptacle must also be installed). IEC 60309 connectors are not included with the PD1500A system.
<input type="checkbox"/>	Host Computer requirements.
<input type="checkbox"/>	Additional supplies (host computer, LAN cable, etc.) are not included.

Rack and Safety Enclosure Dimensions and Weight

	Weight	Height	Depth	Width
Shipping Crate (with DPT Rack and Safety Enclosure)	300 kg (660 lbs)	167 cm (65.75 in)	92 cm (36.25 in)	120 cm (47.25 in)
Rack and Safety Enclosure alone (no test equipment installed)	150kg (330.7lbs)	160 cm (63 in.)	70 cm (27.6 in.)	100 cm (39.4 in.)
Rack and Safety Enclosure (all test equipment and fixtures installed)	162.5 kg (358 lbs)			

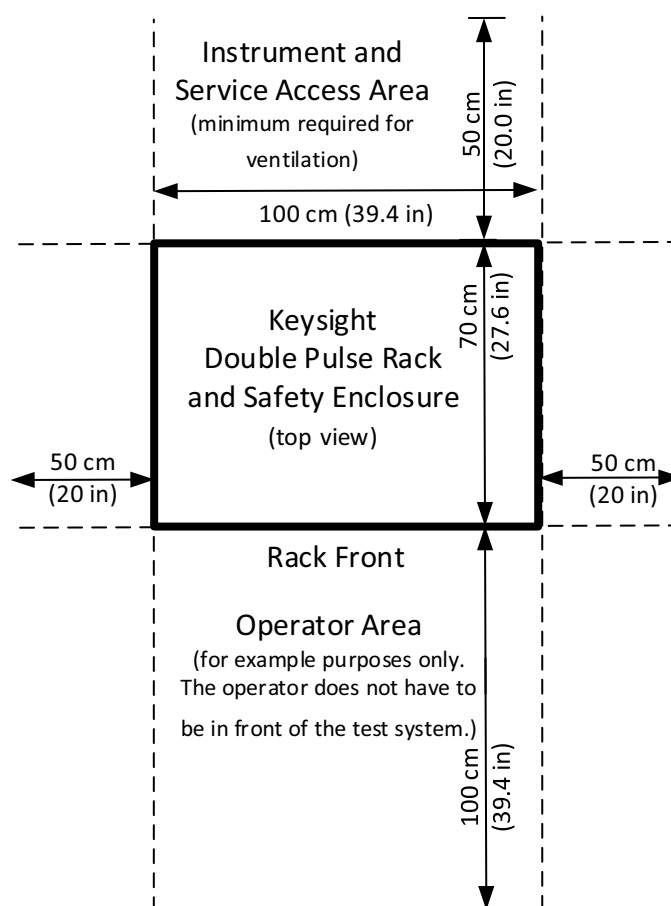
Tools Supplied for Installation and Instrument Removal

- T30 Torx screwdriver to remove/attach test rack rear panels
 - 3 mm L-shaped hex key wrench
 - T25 L-shaped Torx key wrench
 - T9 Torx screwdriver to attach Heater/Thermocouple assembly to DUT
 - Large, 6 mm flat blade screwdriver to remove/attach test rack side panels
 - Small flat blade screwdriver to attach N1294A GPIO-BNC adapter
 - #2 PoziDrive screwdriver to install rack mounting kits
 - Side cutters to remove cable ties
- } for removing Work Surface. Your system will have only one type of screw head.

Double-Pulse Test Rack and Safety Enclosure Location

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

The following figure shows a typical layout for the Rack and Safety Enclosure. You should allow a minimum one meter of space in front of the rack for operator access, one meter of space behind the system for service and 61 cm on either side of the rack for sufficient air flow for cooling and ventilation.



Allow a minimum of one meter above the Rack and Safety Enclosure for opening the Safety Enclosure hood.

NOTE

The Air Intake fans on the rack sides are temperature controlled. They turn on only when the temperature in the lower portion of the rack exceeds approximately 30 °C.

Electrical and Environmental Requirements

Input Voltage	Operating Temperature	Operating Humidity	Operating Environment
200-240 VAC, $\pm 10\%$, Maximum Power rating 13A, Typical 600 VA, 50/60 Hz	20 °C to +30 °C	50% to 80% RH, Non-condensing	Indoor location only

CAUTION

The Double-Pulse Test Rack and Safety Enclosure is designed to operate on 200 to 240 VAC single phase. Do not attempt to operate the DPT Rack and Safety Enclosure on 120 VAC.

Connect the DPT 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 mains power cord, (8121-3445 for N. America and Japan, or 8121-3356 for all other countries) 2.5 m long, Type A, IEC-60320 C19 to Type B Free End) is supplied with the PD1500A. A qualified electrician must either:

- permanently hard wire the free end to the AC power source

or

- attach an IEC 60309 AC power plug (recommended) to the cable (a matching IEC 60309 AC Power receptacle must also be installed). IEC 60309 connectors are not included with the PD1500A system.

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.

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:

- Open all line conductors and neutral conductors where local code applies, but do 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 or 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 to access the disconnect.

Convenience outlets should be installed near the system for external equipment such as computers and monitors, etc. Locate the outlets within one meter (three feet) of the rear of the system.

Optional Safety Ground Connection

This DPT Rack and Safety Enclosure must be grounded properly for proper operation and safety. Because the rack is connected to the AC mains by a plug/socket connection, Keysight recommends a redundant permanent earth ground connection to reduce the risk of electric shock.

NOTE

A Safety Ground wire is not supplied with the DPT Rack and Safety Enclosure and must be installed by a qualified electrician familiar with local electrical codes.

Receiving The Rack and Safety Enclosure and Test Instruments

Your DPT Rack and Safety Enclosure shipment arrives in multiple shipping containers. Before uncrating the Rack and Safety Enclosure or unpacking any test instrument, carefully inspect the shipping containers for any damage that may have occurred during shipment such as:

- dents
- scratches
- cuts
- water damage

Report any damage to the shipping agent immediately, as such damage is not covered by the Keysight warranty.

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 Technologies Sales and Service office immediately.

Moving the Rack and Safety Enclosure



On initial receipt, the Rack and Safety Enclosure exceeds 150 kg (330 lbs). This does not include the weight and size of the shipping crate. Use a mechanical lift to lift the shipping crate. The rack has 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 multiple shipping containers. Use the packing list that comes with your system to ensure you received all pieces of the system. DPT Rack and Safety Enclosure (includes 2.5 m C19 power cord, unlocking tool, etc). The rack has the following instruments preinstalled:
 - Keysight 33512B Waveform Generator with ARB (installed in the back of the rack)
 - Keysight B2902B Precision Source/Measurement Unit
 - Heinzinger EVO High Voltage Power Supply
- The following items are shipped separately:
 - Depending on availability, either the:
 - Keysight DSOS104 4-Channel Oscilloscope with PD1500A orders prior to February 2022
 - or
 - Keysight MXR108 8-Channel Oscilloscope with PD1500A orders after February 2022. This oscilloscope can be used when upgrading the PD1500A.
 - PD1000-68701 DPT Test Fixture
 - Oscilloscope Probes
 - N2873A 10:1 Oscilloscope Probe (qty. 4 supplied with oscilloscope)
 - 10076C 100:1 High Voltage Oscilloscope Probe (10076-60003)
 - N2819A Differential Oscilloscope Probe, 10:1, 800 MHz
 - PD1000-60002 Oscilloscope Protection Probe (uses 8121-2816 BNC to SMA cable to go from Probe to Coaxial Shunt)
 - 8121-2816 BNC to SMA Cable 1 M (quantity 1) (to go from Oscilloscope Protection Probe to Coaxial Shunt)
 - 1855-2942 SCT2080 N-Channel, SiC Power MOSFETs. For performing sample DPT tests (quantity 2)
 - 8710-1582, 0.56 N-m (5 lb-in) 5/16 in Break-over torque wrench for SMA connections
 - PD1000-00004 Set of hand tools
 - One roll Polyimide (Kapton) tape. 0.75" wide, 33 M Long, 2.7 MIL thick

The following cables and adapters are used only for the AutoCal procedure:

- 1251-2277 Banana to BNC Adapter, quantity 1
- 8121-2816 BNC to SMA Cable, 1 m, 50 Ω , quantity 1
- U1168B Standard Probe Kit, quantity 2
- 1258-0225, 2.54 mm jumpers, quantity 10

Optional Si/SiC Device Test Modules (at least one set is required¹):

- PD1000-60901 DUT module (Power Loop) for TO-247, 3-pin devices
- PD1000-60902 DUT module (Power Loop) for TO-247, 4-pin devices
- PD1000-62401 DUT module (Power Loop) for D2PAK7 device package
- PD1000-61901 Characterized 10 m Ω
- PD1000-61902 Characterized 100 m Ω Coaxial Shunt
- Gate Drive Modules for Si/SiC devices

Low-Side Gate Drive Modules

PD1000-66540 No installed Gate Resistor
 PD1000-66542 0 Ω (2x 0 Ω) Gate Resistor
 PD1000-66544 10 Ω (2x 4.99 Ω) Gate Resistor
 PD1000-66546 100 Ω (2x 50 Ω) Gate Resistor

PD1000-66848 ± 28 V, No Gate Resistor installed
 PD1000-66850 ± 28 V, 0 Ω Gate Resistor installed
 PD1000-66852 ± 28 V, 4.4 Ω Gate Resistor installed
 PD1000-66854 ± 28 V, 9.4 Ω Gate Resistor installed
 PD1000-66856 ± 28 V, 20 Ω Gate Resistor installed
 PD1000-66858 ± 28 V, 44 Ω Gate Resistor installed
 PD1000-66860 ± 28 V, 200 Ω Gate Resistor installed

Using these optional
 ± 28 V gate drive
 modules requires
 PD1000A control
 software version
 2022.321 or later

High-Side Gate Drive Modules

PD1000-66541 No installed Gate Resistor
 PD1000-66543 0 Ω (2x 0 Ω) Gate Resistor
 PD1000-66545 10 Ω (2x 4.99 Ω) Gate Resistor
 PD1000-66547 100 Ω (2x 50 Ω) Gate Resistor

PD1000-66849 ± 28 V, No Gate Resistor installed
 PD1000-66851 ± 28 V, 0 Ω Gate Resistor installed
 PD1000-66853 ± 28 V, 4.4 Ω Gate Resistor installed
 PD1000-66855 ± 28 V, 9.4 Ω Gate Resistor installed
 PD1000-66857 ± 28 V, 20 Ω Gate Resistor installed
 PD1000-66859 ± 28 V, 44 Ω Gate Resistor installed
 PD1000-66861 ± 28 V, 200 Ω Gate Resistor installed

Using these optional
 ± 28 V gate drive
 modules requires
 PD1000A control
 software version
 2022.321 or later

- PD1000-66505 PCA Clamp Circuit module
- PD1000-62001 Device Heater kit with integrated Type K Thermocouple

¹ Note: a minimum of one DUT module, one Gate Drive pair, and one Coaxial Current Shunt are required for the PD1500A. The Clamp Circuit module and the Device Heater Kit are not required.

What is not Supplied with the Rack and Safety Enclosure

- Dedicated host computer. See **Host Computer System Requirements** below.
- Quantity 1, 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 System Requirements

Operating System	Windows 10
OS versions	32-bit and 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 with 128 MB graphics memory recommended

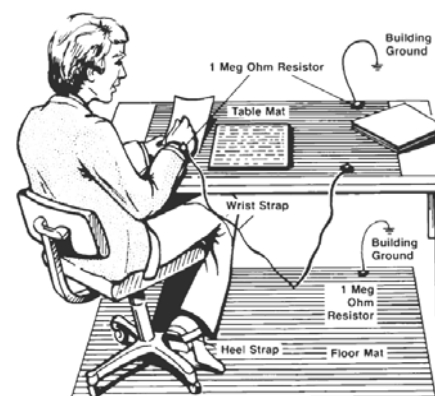
1. Because of the installation procedure, less memory may be required for operation than is required for installation.

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.

PD1500A Documentation

Each test instrument comes complete with its own documentation. The Country-specific power cord and other cables or accessories may be discarded. All necessary power cords and cables are included in the DPT system Rack and Safety Enclosure. For detailed information about any of the test instruments, refer to the documentation provided with the instrument.

- **PD1500A Control Software Guide:** Provides detailed information to install, configure, and use the PD1000A Control Software for the PD1500A DPT system. PN: PD1500-90001
- **PD1500A Rack and Safety Enclosure Operation Guide:** Provides detailed information to operate and maintain the PD1500 Test Rack and Safety Enclosure. PN: PD1500-90003
- **PD1500A Si/SiC Test Fixture User Guide:** Provides detailed information to install and use the Double-Pulse Test Modules for testing Si/SiC devices in the DPT Test Fixture. PN: PD1500-90004
- **PD1500A System Installation Guide:** Provides detailed information for Keysight personnel to install the Double-Pulse Rack and Safety Enclosure at a customer's site. PN: PD1500-90002

Documentation and software are available at: www.keysight.com/find/PD1500A

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/DSOS104A 4-Channel Oscilloscope¹

www.keysight.com/find/MXR108A 8-Channel Oscilloscope¹

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>.

¹ Depending on product availability, you will receive either the DSOS104 A 4-Channel oscilloscope or the MXR108A 8-Channel oscilloscope. Both oscilloscopes provide the same functionality. The MXR108A may be used when upgrading the PD1500A system.

Simplified System Diagrams

Refer to [Appendix A](#), “Simplified System Diagrams and Schematics on page [page 97](#) for diagrams. These diagrams illustrate the overall system wiring.

2 Uncrate the Rack and Safety Enclosure

The Double-Pulse Test (DPT) Rack and Safety Enclosure is the largest of all of the items shipped for the system. Unpack all of the other instruments, rack mount kits, cables, etc. and have them ready for installation in the rack. This chapter describes how to uncrate the DPT Rack and Safety Enclosure.

In this chapter:

- Uncrate the Rack and Safety Enclosure [page 28](#)
- Moving the Rack and Safety Enclosure [page 29](#)
- Rack and Safety Enclosure System Hardware Components [page 30](#)
- Re-crating the Rack and Safety Enclosure for Shipping [page 31](#)

NOTE

IMPORTANT: A minimum of 2 meters of clearance is required all the way around and above the shipping crate to enable removing of the packing material.

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 2 M (6 ft) is required in front of the crate (ramp+ Rack and Safety Enclosure). See Figure 1 below.

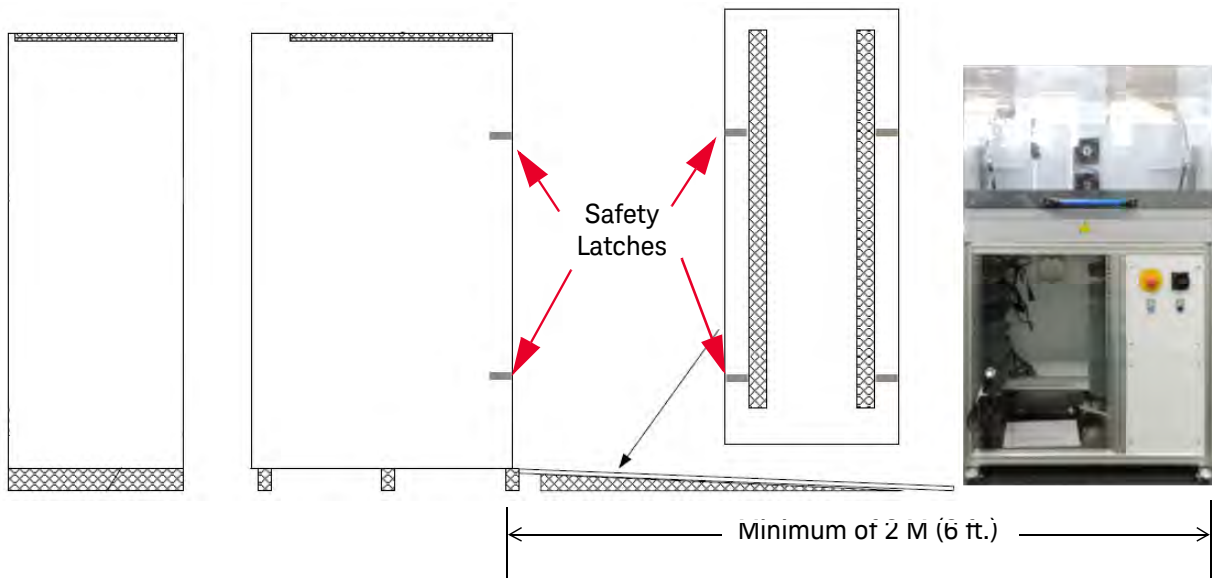


Figure 1 PD1500A Rack and Safety Enclosure Shipping Crate

- 2 Unlatch the safety latches on the front of the shipping crate. These latches secure the ramp (front of the shipping crate) to the sides.
- 3 Carefully remove the ramp from the crate. Position the ramp so that the top of the ramp rests on the shipping crate foot as shown in Figure 1.
- 4 Remove any packing materials from the Rack and Safety Enclosure.

WARNING

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

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

NOTE

Keysight recommends, if possible, that you save the shipping crate, oscilloscope carton, and the Test Fixture carton if you plan to ship the rack to a different location. Refer to “Re-crating the Rack and Safety Enclosure for Shipping” on page 31 for detailed information.

Moving the Rack and Safety Enclosure

The Rack and Safety Enclosure has four 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 four wheels have locking mechanisms. Ensure the wheels are locked when using the DPT Rack and Safety Enclosure.

After all of the test equipment is properly installed and secured in 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 four 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.

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. Also, the DSOS104 Oscilloscope and the DPT Test Fixture are not secured to the top of the rack. They may slide around if the rack tips.

Rack and Safety Enclosure System Hardware Components

Verify that your Rack and Safety Enclosure system includes the following test instruments before beginning to install the DPT system:

- A Rack and Safety Enclosure. Included with the rack are:
 - A mains power cord (Type A, IEC-60320 C19 to Type B Free End) is supplied with the PD1500A Rack and Safety Enclosure.
 - A triangle “T” wrench for manually releasing the Safety Hood if necessary.¹
 - Instrument LAN cables, a LAN Switch, a Power Distribution Unit (PDU), and all of the safety electronics are pre-installed in the rack.



The following instruments must be installed on the Rack and Safety Enclosure by a Keysight Application Engineer. These instruments are shipped separate from the Rack and Safety Enclosure:

- Either a:
 - a Keysight DSOS104A 4-Channel Oscilloscope (sits on top of the rack inside the clear Safety Enclosure). See “Install Oscilloscope in Safety Enclosure Hood” on page 33. The DSOS104A shipped with orders placed before February 2022.
- or
- a Keysight MXR108A 8-Channel Oscilloscope (sits on top of the rack inside the clear Safety Enclosure). The MXR108A may be shipped with orders placed after February 2022. The MXR108A can be used to upgrade the PD1500A later). Except where indicated, installation is the same for both oscilloscopes. See “Install Oscilloscope in Safety Enclosure Hood” on page 33.
- A DPT Test Fixture with Test Modules. “Install Test Fixture in the Safety Enclosure Hood” on page 45.

Additionally, you may have received several boxes that include the PD1500A Test Fixture and test modules, various cables, oscilloscope probes, and other miscellaneous parts.

¹ The “T” wrench is used only during initial installation of the PD1500A Rack and Safety Enclosure. Under normal use, the Safety Hood remains locked when the system is powered and functional. Refer to the *PD1500A Test Rack and Safety Enclosure Operation and General Maintenance Guide* for information.

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 PD1500A system for shipping per the following instructions.

NOTE

IMPORTANT: For service and calibration of individual instruments in the PD1500A test system, **DO NOT SHIP THE ENTIRE** Rack and Safety Enclosure to Keysight. Instead, remove the individual instrument(s), repack them in their original shipping container, 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.

A suitable shipping crate, preferably wood, is required to ship the PD500A Rack and Safety enclosure.

- 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 the oscilloscope and Test Fixture from the DPT rack work surface. These should be re-packaged in their original shipping boxes for shipping.
- 5 Secure all cables on the Work Surface
- 6 While it is not necessary to remove the other test instruments (the Heinzinger High Voltage Power Supply, SMU, and 33512B Waveform Generator) from the rack before shipping, you must insure that they are securely attached to the test rack.
- 7 Remove any loose pieces (installation bolts, cables, etc. before shipping.
- 8 Wrap the Rack and Safety Enclosure in plastic and foam before putting it in the shipping crate. This will protect the rack and safety hood from dust, dirt, and scratches during shipping.
- 9 Place the Rack and Safety Enclosure inside the shipping crate. Lock the casters so that the rack does not shift during transportation.

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.

Uncrate the Rack and Safety Enclosure

Re-crating the Rack and Safety Enclosure for Shipping

3 Install Oscilloscope in Safety Enclosure Hood

The Keysight 33512B Waveform Generator, B2902B SMU, and Heinzinger EVO High Voltage Power Supply are already installed inside the Double-Pulse Test Rack and Safety Enclosure.

The Keysight DSOS104A or MXR108A Oscilloscope¹ and the DPT Test Fixture sit on top of the Work Surface inside the Safety Hood and must be installed by the Keysight AE.

This chapter provides detailed instructions for installing the oscilloscope in the Rack and Safety Enclosure.

In this Chapter:

- Prepare the Rack and Safety Enclosure [page 33](#)
- Install Oscilloscope Inside the Safety Hood [page 34](#)
- Connect LAN, Power, and Trigger Cables to the Oscilloscope [page 35](#)
- Connect Probes to DSOS104A or MXR108A Oscilloscope [page 37](#)

Prepare the Rack and Safety Enclosure

NOTE

Do not remove the front, rear, or side panels from the enclosure. There are no user-serviceable parts inside.

NOTE

The Heinzinger EVO High Voltage Power Supply must have firmware revision **P001.005** or greater. Refer to the supply's user documentation to determine which version is currently installed. Contact Heinzinger for specific firmware updating information.

¹ Depending on availability, either the Keysight DSOS104 4-Channel Oscilloscope or Keysight MXR108 8-Channel Oscilloscope is supplied with the PD1500A.

Install Oscilloscope Inside the Safety Hood

Depending on availability, either a model DSOS104 A 4-Channel oscilloscope or an MXR108A 8-Channel oscilloscope (shipped with orders after February 2022. The MXR108A can be used to upgrade the PD1500A later) was provided with your PD1500A. Except where indicated, installation is the same for both oscilloscopes.

- 1 From the front of the rack, open the Safety Hood.
- 2 Set the oscilloscope on the far right of the work platform. Position the oscilloscope where it will have sufficient clearance inside the hood for airflow around the back and sides.



Minimum bottom clearance: No intrusion into the space under the oscilloscope as defined by the feet. Feet must rest on work surface.

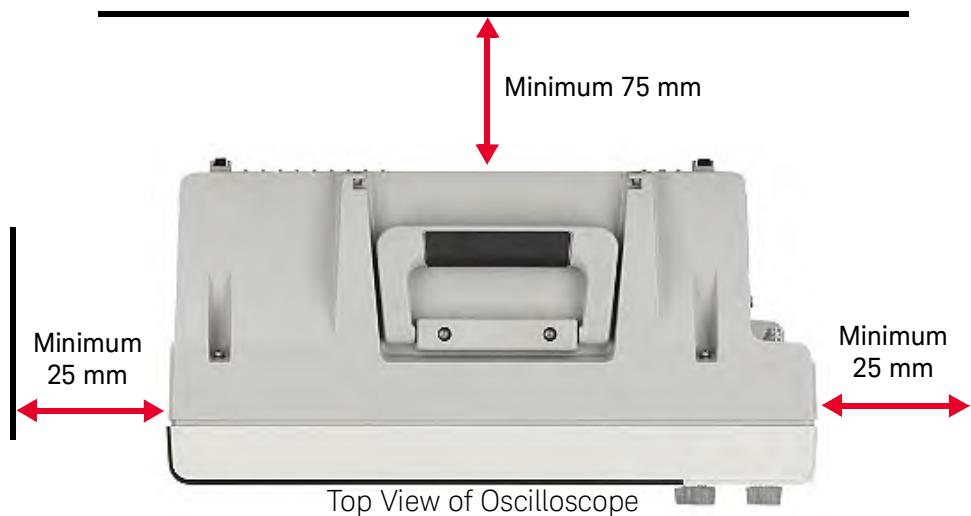


Figure 2 Placing the Oscilloscope Inside the Safety Hood -- Clearances (DSOS104A shown)

Connect LAN, Power, and Trigger Cables to the Oscilloscope

- 1 Connect the two LAN cables to the RJ-45 connectors. Connect the LAN cable marked **LAN System** to the top LAN connector; connect the LAN cable marked **LAN Switch** to the bottom LAN connector.
- 2 Connect the BNC cable to the oscilloscope **AUX Trigger IN (50Ω)** port on the right side panel of the oscilloscope.
- 3 Connect the power cord to the AC power input jack on the right side panel.

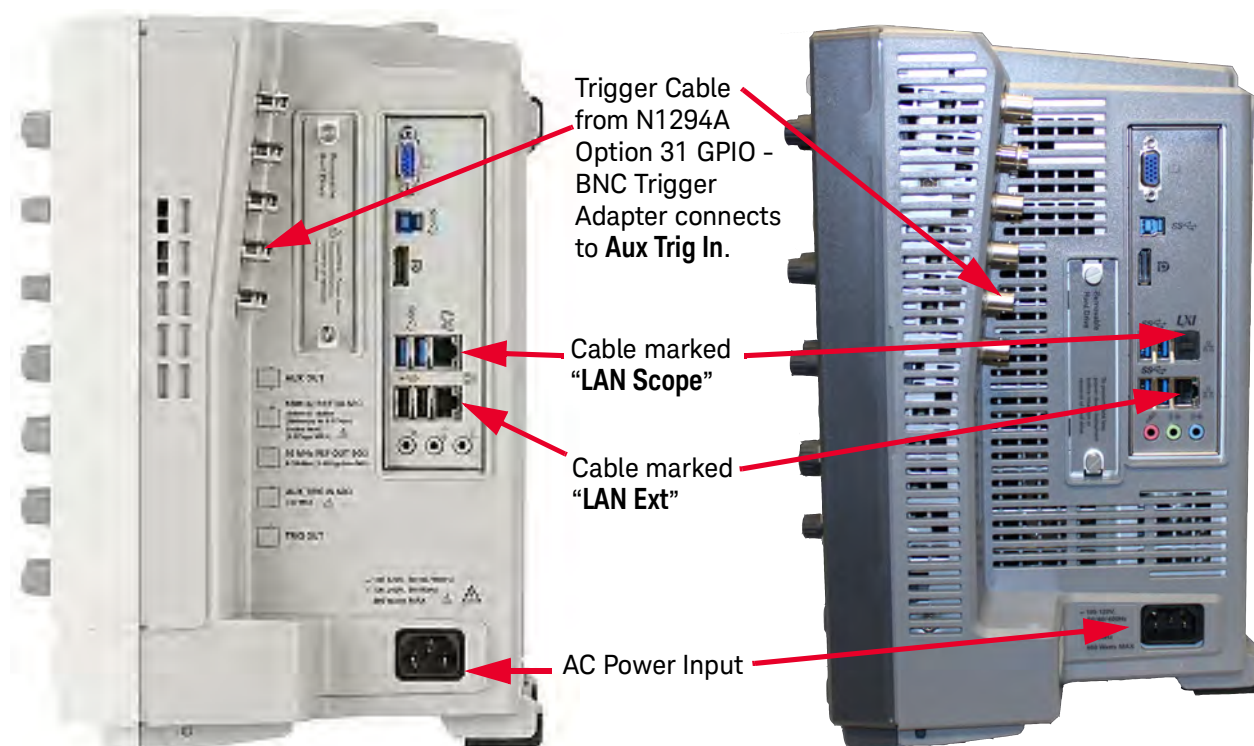


Figure 3 Right Side of DSOS104 Oscilloscope (DSOS104A shown on left, MXR 108A on right)

NOTE

For the two oscilloscope LAN cables, the one marked **Lan Scope** must go to the top LAN port on the oscilloscope. The cable marked **LAN Switch** or **LAN Ext** must go to the bottom LAN port on oscilloscope. If these are reversed, the Control Software on the Host Computer cannot communicate with the oscilloscope or other test equipment.

NOTE

You may need to upgrade your DSOS104A oscilloscope software. Do **not** use version 06.60.00403. Version 06.50.xxxxx and all previous versions have been tested and work without problems.

NOTE

You may need the oscilloscope keyboard and mouse for initial setup. Otherwise, do not plug a keyboard or mouse into the oscilloscope.

Tabs under the front feet of the oscilloscope can be flipped out to tilt the oscilloscope for easier viewing.



Figure 4 Latching the Front Feet (DSOS104A shown)

NOTE

Ensure the scope power cord, LAN cables, trigger BNC cable do not interfere with closing the safety hood.

Connect Probes to DSOS104A or MXR108A Oscilloscope

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

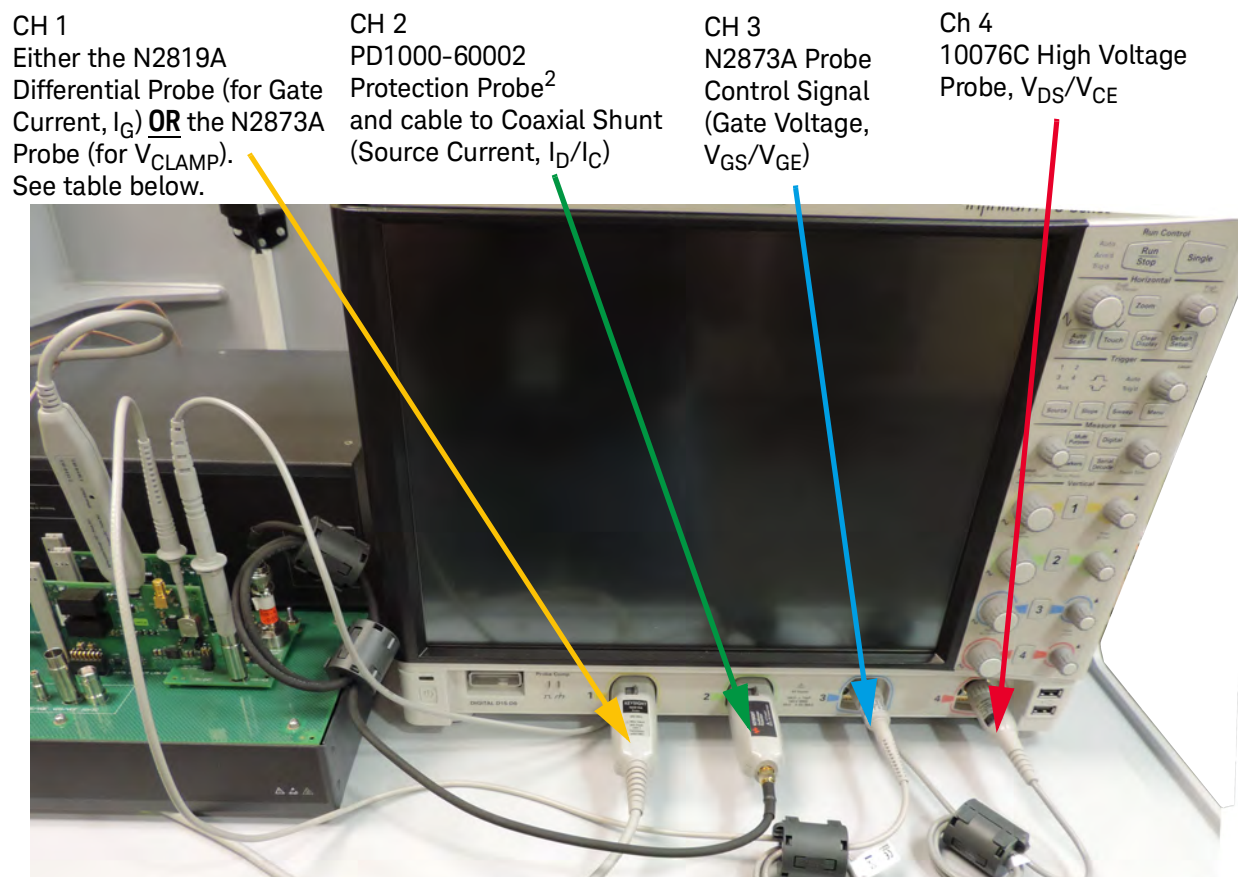


Figure 5 Oscilloscope Probe Connections (DSOS104A shown)

Oscilloscope Channel	Color	Oscilloscope Probe	Used to Measure	Connects to Test Module
1 ¹	Yellow	N2819A Differential Probe	Gate Current, I_G	Gate Driver Module
		Standard N2873A Probe	Clamp voltage, V_{CLAMP}	Clamp Module
2	Green	PD1000-60002 Protection Probe and cable to Coaxial Shunt ²	Source Current, I_D/I_C	Coaxial Shunt on DUT Module
3	Blue	Standard N2873A Probe	Gate Voltage, V_{GS}/V_{GE}	Gate Driver Module
4	Red	High Voltage 10076C Probe	Drain/Collector Voltage, V_{DS}/V_{CE}	DUT Module

¹ Only one of these two probes should be used in a DPT test. The N2819A Differential Probe is used when measuring Gate Current and Gate Charge. The standard N2873A probe is used with the Clamp Test Module to measure V_{CLAMP} .

² Use the 0.56 N-m (5 lb-in) 5/16 in. SMA Break-over torque wrench (provided with the PD1500A 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.

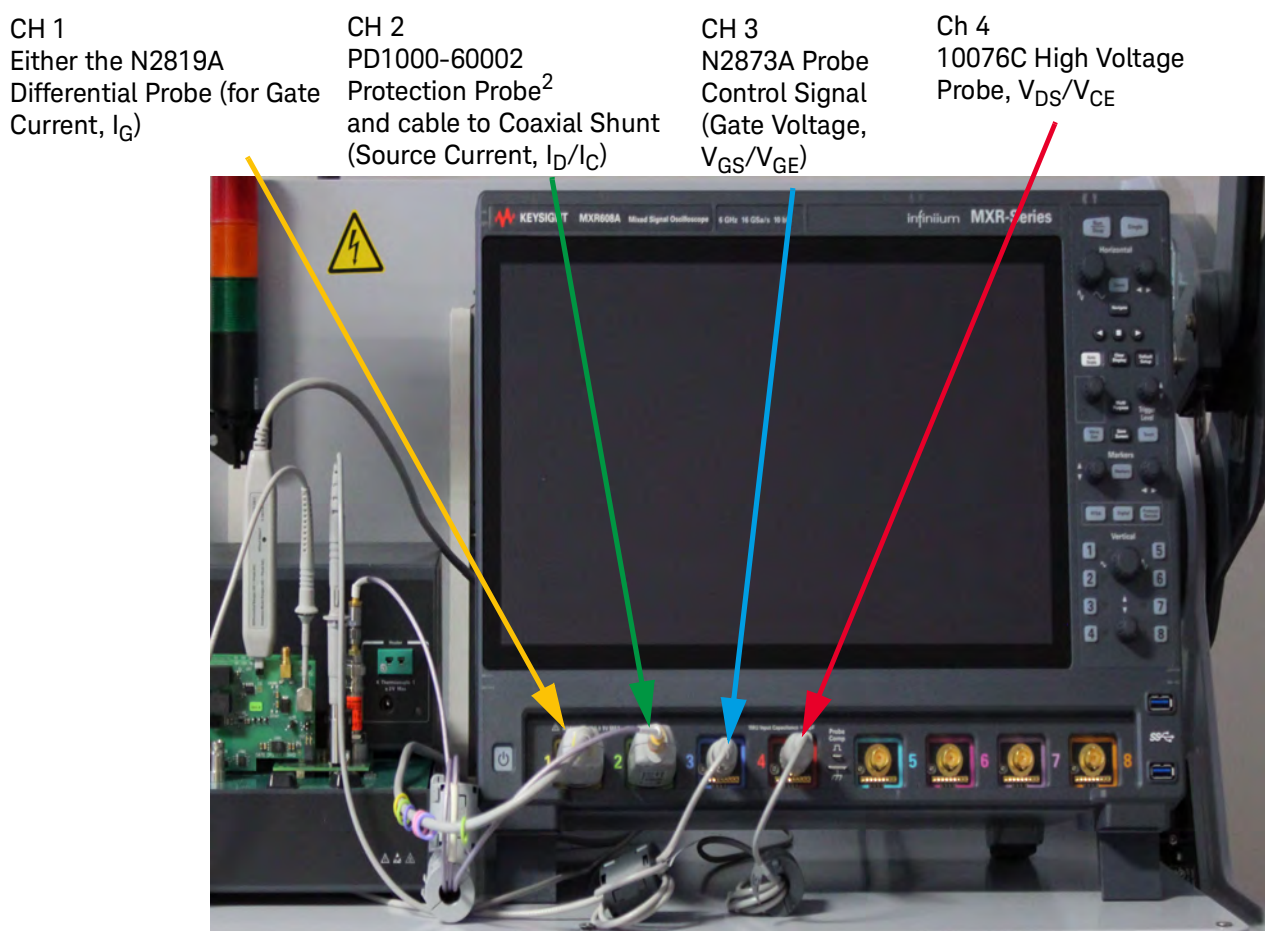


Figure 6 Oscilloscope Probe Connections (MXR108A shown)

Oscilloscope Channel	Color	Oscilloscope Probe	Used to Measure	Connects to Test Module
1 ¹	Yellow	N2819A Differential Probe	Gate Current, I_G	Gate Driver Module
		Standard N2873A Probe	Clamp voltage, V_{CLAMP}	Clamp Module
2	Green	PD1000-60002 Protection Probe and cable to Coaxial Shunt ²	Source Current, I_D/I_C	Coaxial Shunt on DUT Module
3	Blue	Standard N2873A Probe	Gate Voltage, V_{GS}/V_{GE}	Gate Driver Module
4	Red	High Voltage 10076C Probe	Drain/Collector Voltage, V_{DS}/V_{CE}	DUT Module

¹ Only one of these two probes should be used in a DPT test. The N2819A Differential Probe is used when measuring Gate Current and Gate Charge. The standard N2873A probe is used with the Clamp Test Module to measure V_{CLAMP} .

² Use the 0.56 N-m (5 lb-in) 5/16 in. SMA Break-over torque wrench (provided with the PD1500A 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.

The remaining four channels are unused. The MXR108A 8-channel oscilloscope can be used in future upgrades to the PD1500A Double-Pulse Test system.

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/ I_G or V_{CLAMP} is yellow, Channel 2/ I_{DS} is green, Channel 3/ V_{GS} is blue, and Channel 4/ V_{DS} is red.

CAUTION

Do not exceed the maximum input voltage rating on the oscilloscope.

The maximum input voltage for the 50 Ω input impedance setting is ± 5 V.

The maximum input voltage for the 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; the N2873A 10:1 probe supports 300 V_{rms} or ± 400 V_{max} (DC + V_{peak}). No transient over voltage allowed.

CAUTION

When measuring voltage over 30 V, use a 10:1 probe.

CAUTION

When a probe, adapter, or cable is attached to the oscilloscope, the oscilloscope's 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.

CAUTION

All Oscilloscope probes (except the N2819A Differential Probe) must have the common mode chokes installed on the probe cables.

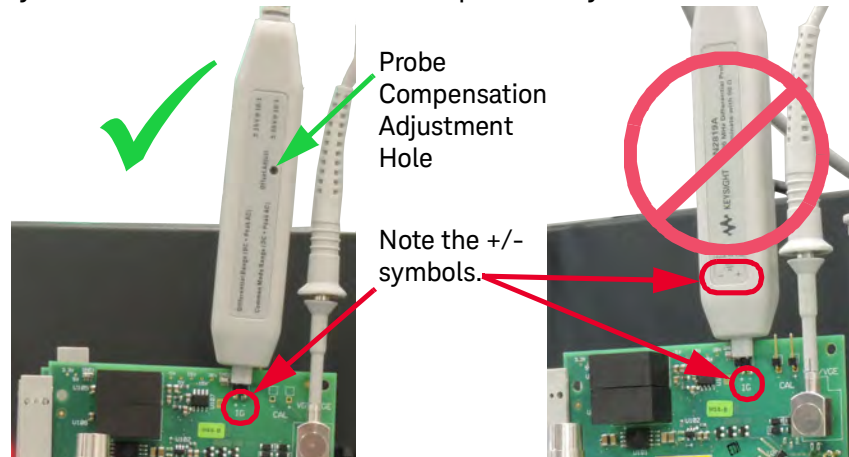
Connect Probes to the Double-Pulse Test Modules

Refer to Figure 7 below. Oscilloscope probes connect to the Test Fixture Modules as follows:

- The DUT Module uses the following oscilloscope probes:
 - BNC to SMA cable from the Coaxial Shunt Resistor (I_D/I_C) to the PD1000-60002 Oscilloscope Protection Probe.
 - 10076A High Voltage, 100:1 Probe to the V_{DS}/V_{CE} probe socket.
- The Low Side Gate Driver Module has two oscilloscope probe connections (see Figure 7 below):
 - N2873A 10:1 Probe connects to the V_{GS}/V_{CE} probe socket
 - N2819A Differential Probe connects to the I_G probe socket terminals
- Optionally, if the Clamp Circuit Test Module is used:
 - Do not install the N2819A Differential Probe on the I_G probe socket terminals of the Low Side Gate Driver Module.
 - Attach N2873A 10:1 probe to the V_{CLAMP} socket on the Clamp Module.

CAUTION

IMPORTANT: When installing the N2819A Differential oscilloscope probe on the I_G pins on the Low Side Gate Driver Module, the Probe Compensation Adjustment hole **must** face outward. The Keysight logo must face toward the module. Verify with the +/- symbols on the module and on the probe body.



NOTE

If you use the Clamp Circuit Module, do not install the N2819A Differential Probe. Instead, install one N2873A 10:1 Oscilloscope Probe connected to the Clamp Test Module (V_{CLAMP}) probe socket.

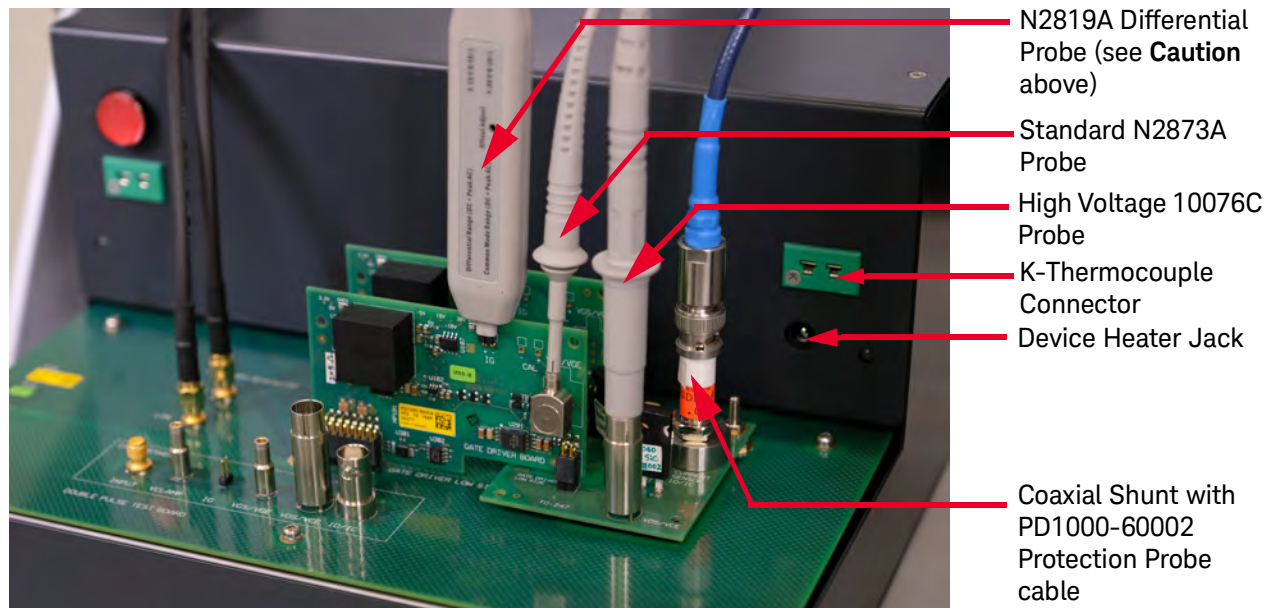


Figure 7 Connecting Oscilloscope Probes to the Test Modules (Clamp Circuit Module not shown)

Using the N2787A 3D Probe Positioner

The N2787A Probe Positioner was included to hold the N2819A Differential Probe in place.

- 1 Place the positioner base of the N2787A on top of the Test Fixture.
- 2 Tighten the jaws around the N2819A Differential Probe.
- 3 Move the probe into place on the I_G pins of the Gate Drive Module.
- 4 Tighten the Central Positioning Knob of the Probe Positioner.



Figure 8 Using the N2787A 3D Probe Positioner

Install Oscilloscope in Safety Enclosure Hood

4 Install Test Fixture in the Safety Enclosure Hood

In This Chapter:

- Placing the Test Fixture in the Safety Enclosure Hood [page 46](#)
- Connections on Back of Test Fixture [page 47](#)
- Connections on Front of Test Fixture [page 48](#)
 - Connect the Waveform Generator to the DPT Test Fixture [page 48](#)
- Optional Low-Side Device Heater [page 49](#)
 - Using the Low-Side Device Heater and Thermocouple [page 49](#)
 - Adding Kapton (polyimide) Tape to TO-247-3 and -4 Devices [page 51](#)
 - Using the Low-Side Device Heater and Thermocouple [page 49](#)
 - Device Heater Theory of Operation [page 51](#)
- Mounting the Coaxial Shunt Resistor [page 56](#)
- Identify Test Fixture Firmware Version [page 57](#)

Placing the Test Fixture in the Safety Enclosure Hood

- 1 From the front of the rack, open the Safety Hood.
- 2 Carefully place the Test Fixture on the Work Surface, just to the left of the oscilloscope.
- 3 Ensure the fixture is positioned so that you can close the safety hood.



Figure 9 Placing the Test Fixture inside the Safety Hood. DSOS104A Oscilloscope shown on right.

NOTE

There is a fan on the right side of the Test Fixture. Make certain there is adequate air flow. At least 2 inches between the Test Fixture and the Oscilloscope.

Connections on Back of Test Fixture

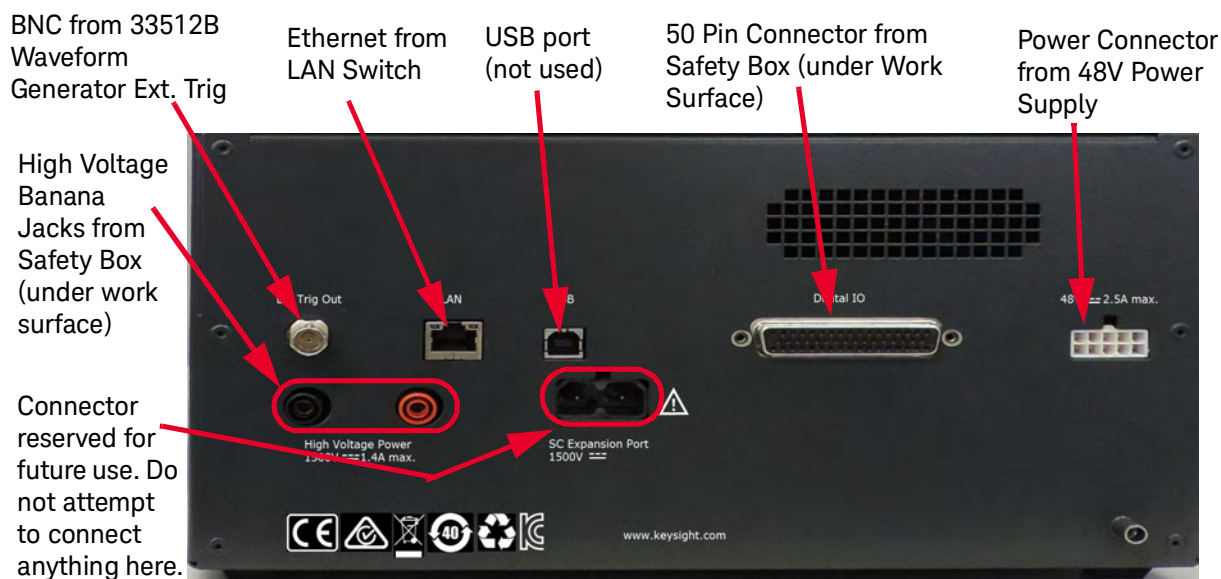


Figure 10 Back of Test Fixture and Cable Installation

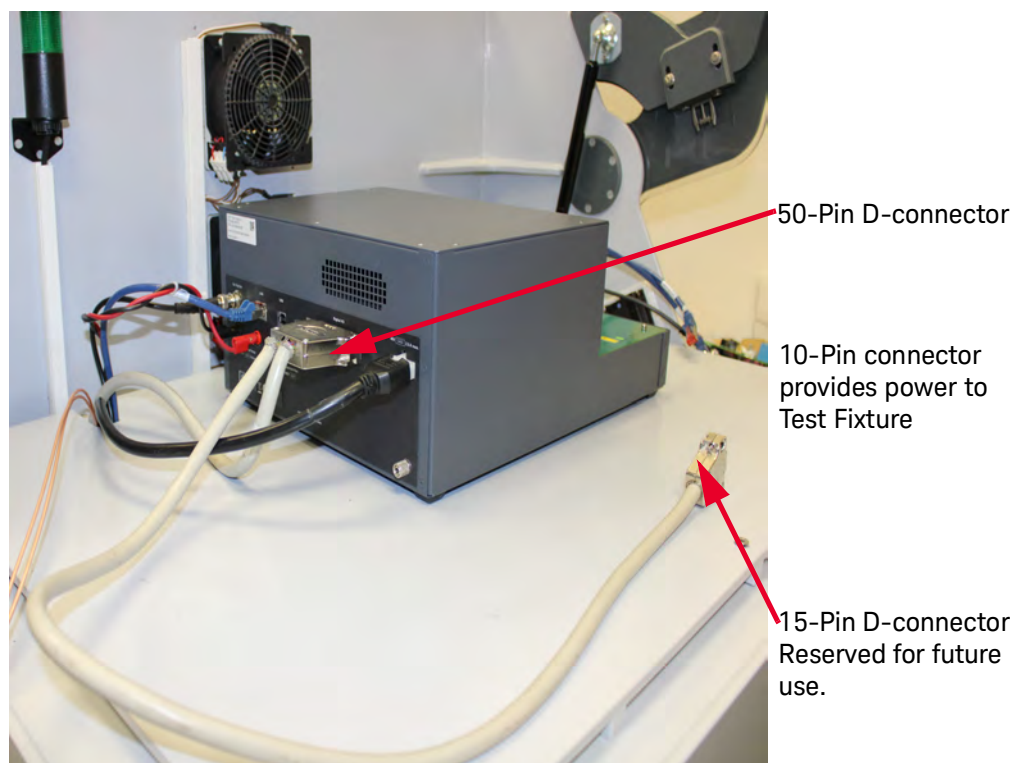


Figure 11 Back of Test Fixture with Cables

Connections on Front of Test Fixture

Before running the DPT tests, the Test Fixture must be connected to the test instruments and setup for the DPT test.

Connect the Waveform Generator to the DPT Test Fixture

Waveform Generator Channel 1 connects to the Low SMA Connector on the Test Fixture. Waveform Generator Channel 2 connects to the High SMA Connector on the Test Fixture.

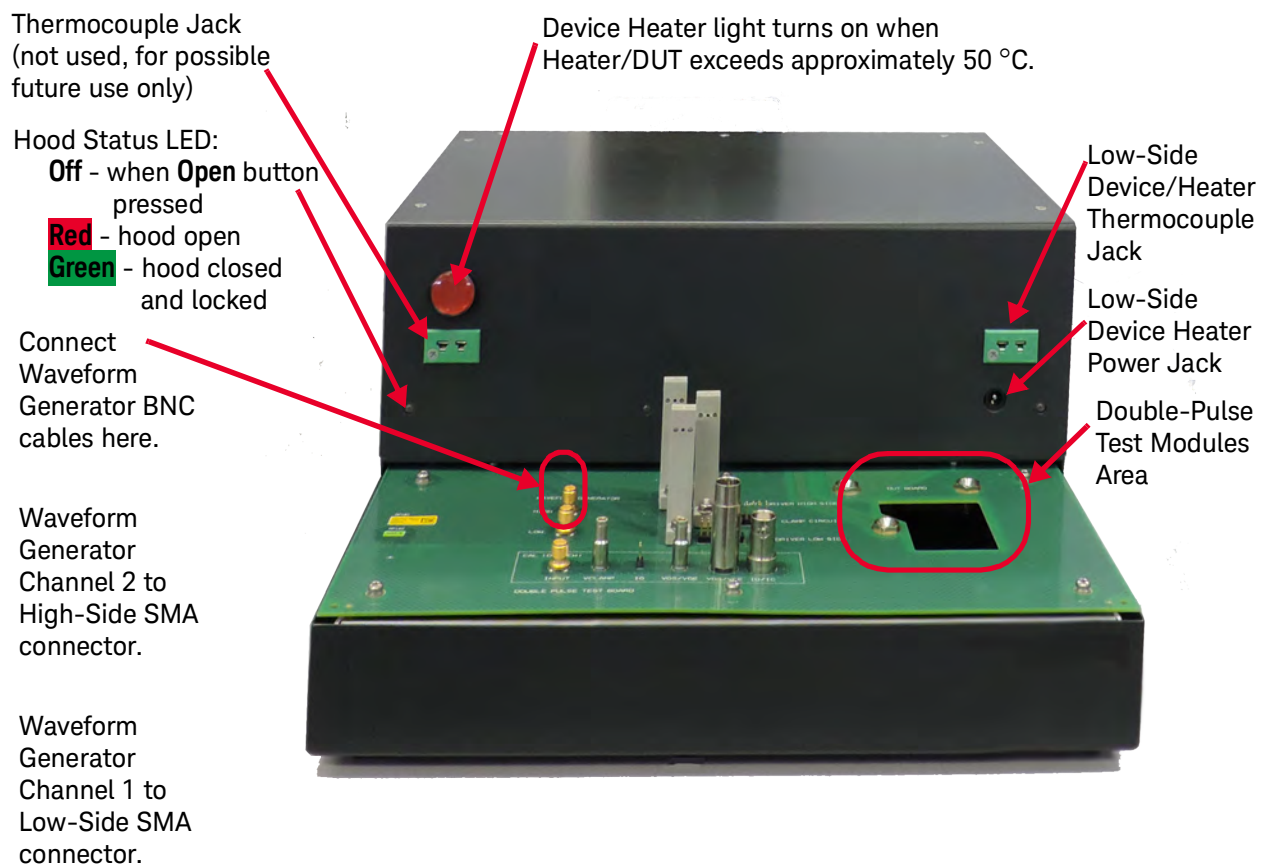


Figure 12 PD1000-68701 Test Fixture

NOTE

Use the 0.56 N-m (5 lb-in) 5/16 in. SMA Break-over torque wrench (provided with the PD1500A system) to tighten the SMA connector on the test fixture and the BNC-SMA cable to the PD1000-60002 Protection Probe. Failure to do so might cause extensive ringing in the DPT measurements. See Appendix B on [page 45](#) for detailed information.

Optional Low-Side Device Heater

Keysight provides a device heater, integrated thermocouple and clamps (PD1000-62001) to allow you to heat your device (ambient to +175 °C for TO-247 Devices¹) as the DPT system measures its characteristics. The device heater comes with an integrated Type K Thermocouple. Use the Device Clamps to attach the heater and Thermocouple to the device being tested.

PD1000-62001
Low-Side Device
Heater with Integrated
Type K Thermocouple
shown with Clamp



NOTE

Use of the device heater and thermocouple is optional in the DPT test system. However, if they are used, the heater and thermocouple must be installed prior to powering on the system. Reboot the PD1500A if the heater is not detected.

CAUTION

Hot Surface; DO NOT Touch! When the PD1500A device heater is used to heat the DUT, it becomes very hot. Do not touch the heater or the clamp. Do not allow flammable material (such as paper) to come into contact with the heater while it is hot.

Second Thermocouple Jack on Test Fixture

An optional second Thermocouple jack is present on the left side of the PD1000-68701 test fixture. This jack is not functional and is reserved for possible future use only.

Using the Low-Side Device Heater and Thermocouple

When making a Double-Pulse Test measurement with the Low-Side Device Heater activated and a valid temperature specified, the Control Software automatically initiates the measurement when the heater reaches the specified temperature. However, there are several details to consider:

- DUT temperature affects the following: T_{on} transition time, T_{on} and Turn off delay time, Turn on dv/dt , Turn on and Turn off di/dt ,
- Are the heater and thermocouple properly connected to the DUT?

¹ Requires Software version 2020.820 or later, Test Fixture Firmware A.01.03 or later. Ambient to +175 °C for TO-247 device packages only; ambient to +150 °C for SMD devices.

- Are the heater and thermocouple connected to the Test Fixture?
- Is the heater activated in the PD1000A DPT Control Software?

You may want the heater to settle at the specified temperature before initiating the DPT measurement. Don't forget that the heater needs to heat a large thermal mass including the DUT itself and the aluminum clamp.

After the heater reaches the specified temperature, it may take a few seconds for the internal die of the device itself to reach that temperature.

What happens if the heater fails to achieve the specified temperature?

This appendix explains how the device heating system and various temperature settings in the Control Software work together.

NOTE

Use of the heater/thermocouple is optional. However, they must be connected to the Test Fixture before powering-up the PD1500A system.

NOTE

Heater temperatures between 150 °C and 175 °C are valid only for TO-247 device packages. Do not use temperatures above 150 °C for D²PAK devices.

CAUTION

Hot Surface; DO NOT Touch! When the PD1500A device heater is used to heat the DUT, it becomes very hot. Do not touch the heater, clamp, or DUT. Do not allow flammable material (such as paper) to come into contact with the heater while it is hot.

CAUTION

Inspect the heater/thermocouple assembly before every use. If the assembly shows any sign of wear or is cracked, discard it immediately and obtain a replacement. The metal clamp contacts the FET Drain or IGBT Collector; if the heater assembly is damaged, it may contact the metal clamp and apply a very high voltage to the heater circuitry causing damage.

Adding Kapton (polyimide) Tape to TO-247-3 and -4 Devices

Keysight recommends wrapping one layer of Kapton (polyimide) tape (for example, Keysight part number 0460-3128, 0.75 inch wide, 2.7 mil thick) around the TO-247 device before attaching the heater bracket.

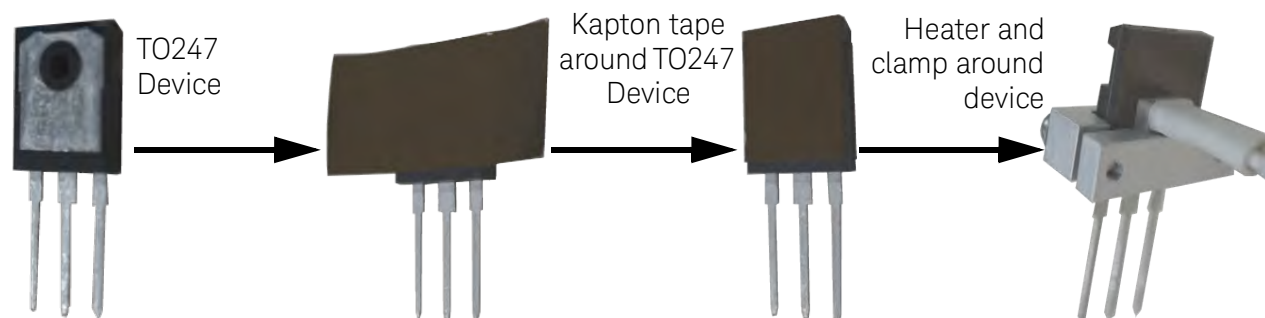


Figure 13 Adding Kapton Tape to a TO-247 Device

Device Heater Theory of Operation

If the device heater operated in a pure vacuum, the heating curve would be a simple straight line -- you apply a certain amount of energy to the heater and it heats to the desired temperature. But in a real-world test system, there are more issues involved. The heater heats not only itself, but also the DUT, the aluminum clamp, plus a small amount of heat is lost to the air.

Therefore, a control circuit applies energy to the heater, monitors its temperature (via a K-type thermocouple) and tries to regulate at the desired temperature. In the PD1500A, the temperature is sampled approximately 10 times per second. The heater itself has a theoretical capacity to heat itself at a rate up to 175 °C per second. In 1/10 of a second then, the heater can raise its temperature approximately 15 °C. So, if you set a small temperature increase, let's say 10 °C, then in 1/10 of a second, the heater can overshoot your desired temperature by 5 °C. Again, it is slightly less than that because heat is transferred to the device, the clamp, surrounding air, etc.

The heater has no capacity to actively "cool" a device; it can only provide heat. Therefore, to lower the temperature, the system must allow the heater to cool and allow the heat to dissipate. This may take a few minutes.

If you set a large temperature change, for example, from 22 °C to 150 °C, then it may take several seconds to arrive at the desired temperature. Again, there is the possibility of slight temperature overshoot.

Figure 15 below shows the fields in the Hardware Configuration used to set the Temperature Tolerance and Settling Time. In Figure 15, **Desired Temperature** is set in the main screen of the DPT control software. Several temperatures may be set with a semicolon list (for example, 25;50;100;150).

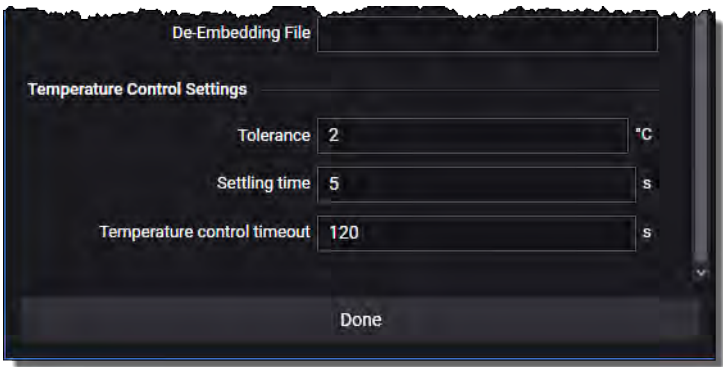


Figure 14 Hardware Configuration Temperature Control Settings

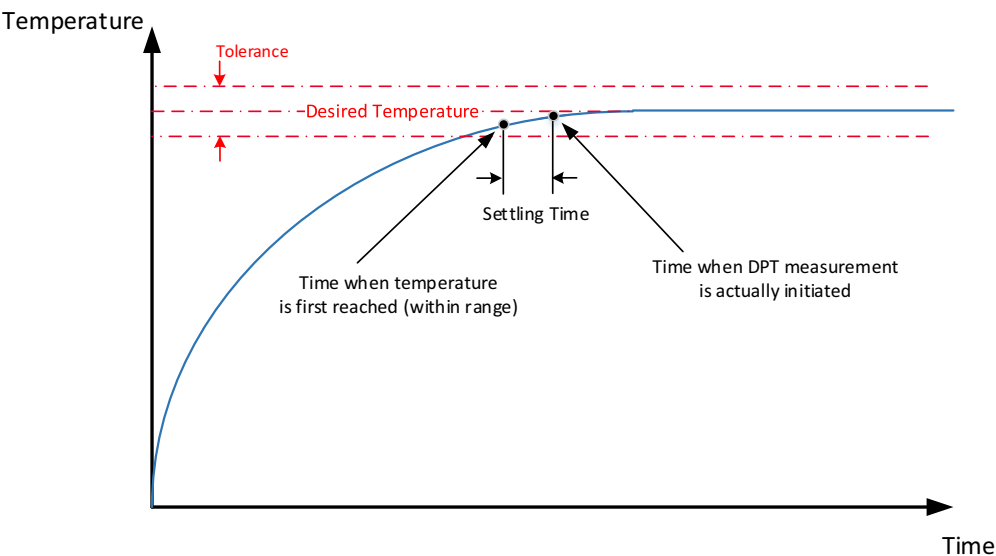


Figure 15 PD1500A Device Heater Timing

Heater Stability

The following table lists typical (not guaranteed) temperature deviation after the specified time. **Settings > Hardware Configuration > Tolerance** set to 2 °C.

Specified Temperature	Temp. after 30 seconds	Temp after 1 min.	Temp after 2 min.	Temp after 5 min.	Delta after 5 minutes
TO-247 Devices					
30 °C	29.67 °C	29.71 °C	29.73 °C	29.73 °C	-0.27 °C
50 °C	49.47 °C	49.50 °C	49.51 °C	49.51 °C	-0.49 °C
100 °C	99.06 °C	99.10 °C	99.12 °C	99.15 °C	-0.96 °C
150 °C	148.72 °C	148.76 °C	145.75 °C	148.79 °C	-1.21 °C
D2PAK-7 Devices					
30 °C	31.30 °C	29.80 °C	29.81 °C	29.81 °C	-0.19 °C
50 °C	49.52 °C	49.56 °C	49.28 °C	49.58 °C	-0.42 °C
100 °C	99.23 °C	99.22 °C	99.23 °C	99.23 °C	-0.77 °C
150 °C	148.93 °C	148.91 °C	148.91 °C	148.94 °C	-1.06 °C

Using the Device Heater

There are two parts to configuring the PD1500A Device Heater:

- Configuring the Temperature Control Settings
- Activating the (optional) Low-Side Heater and specifying Temperatures to test the DUT

NOTE

If you want to use the heater and thermocouple, they must be connected to the Test Fixture before powering-up the PD1500A system.

Configuring Temperature Control Settings (Hardware Configuration)

In the **Settings > Hardware Configuration > Fixture** for Double-Pulse Test Control menu, set the following:

Tolerance: Specify a range (\pm) around the specified temperature for triggering the DPT measurement. For example, if you specify making a DPT measurement at 100 °C and a 1 °C Tolerance, then the measurement is triggered somewhere between 99 °C and 101 °C.

Settling Time: Specify a time period (in seconds) to wait after the heater reaches the specified temperature (within the specified Tolerance) before triggering the DPT measurement.

Temperature Control Timeout: Specify the maximum time period (in seconds) to wait for the device to reach the specified temperature before triggering the measurement. If the device does not reach the specified temperature within this time period, the Double-Pulse Test aborts.

For example, to go from ambient temperature (~25 °C) to 100 °C with a 2 °C Tolerance may take up to 60 seconds. To go from Ambient to 100 °C with a 1 °C Tolerance may take up to 90 seconds.

Activating the Heater and Setting Test Temperatures

Activate Low-Side Heater: (checkbox) Turns the heater circuit on or off for the Low-Side device.

Temperatures: Enter a single value or a semicolon (;) delimited list of temperatures to heat the device to when running the DPT tests. This box is grayed-out unless **Activate Low-Side Heater** is checked.

NOTE

When the heater/DUT temperature exceeds approximately 50 °C, the large red light on the Test Fixture turns on.

Table 1 lists several examples and expected results when using the PD1500A Heater and Thermocouple. It assumes the following test conditions:

Gate High Voltage: 18 V

Gate Low Voltage: -2 V

V_{DS} : 300 V

I_D : 10 A

Tolerance: 20%

Temperature Range: 1 °C

Temperature Timeout: 30 S.

Table 1 Measurements Using Heater and Thermocouple

Temperature(s) Specified (in PD1000A Software)	Heater Activated (in PD1000A Software)	Thermocouple Connected to Test Fixture	Heater Connected to Test Fixture	Expected Result
50 °C	YES	YES	YES	Test runs normally at a temperature between 49 °C and 51°C. Temperature is recorded.

Table 1 Measurements Using Heater and Thermocouple (continued)

Temperature(s) Specified (in PD1000A Software)	Heater Activated (in PD1000A Software)	Thermocouple Connected to Test Fixture	Heater Connected to Test Fixture	Expected Result
50;60 °C	YES	YES	YES	Both tests run normally at temperature: First test between 49 °C and 51 °C. Second test between 59 °C and 61 °C. Temperatures are recorded.
50 °C	NO	YES	YES	Test runs normally but with no heating. Device temperature is recorded.
50 °C	NO	YES	NO	Test runs normally but with no heating. Device temperature is recorded.
50 °C	NO	NO	NO	Test runs normally but with no heating. No temperature (NaN ¹) is recorded.
50 °C	YES	NO	NO	Test aborts with the error message, <i>“Failed to read temperature. Is a thermocouple connected?”</i>
50 °C	YES	YES	NO	Test aborts with the error message, <i>“The heater did not respond. Is the heater connected?”</i>
50 °C	YES	NO	YES	Test aborts with the error message, <i>“Failed to read temperature. Is a thermocouple connected?”</i>

¹TNaN means “Not a Number” – valid number (temperature) is missing.

Mounting the Coaxial Shunt Resistor

Two characterized coaxial shunt resistors are available for the PD1500A:

- PD1000-61901, 0.01 Ω
- PD1000-61902, 0.1 Ω

The coaxial shunt must be installed on the DUT modules. It must be removed and re-installed when changing DUT modules. It also must be removed and shipped to a Keysight Service Center for annual characterization.

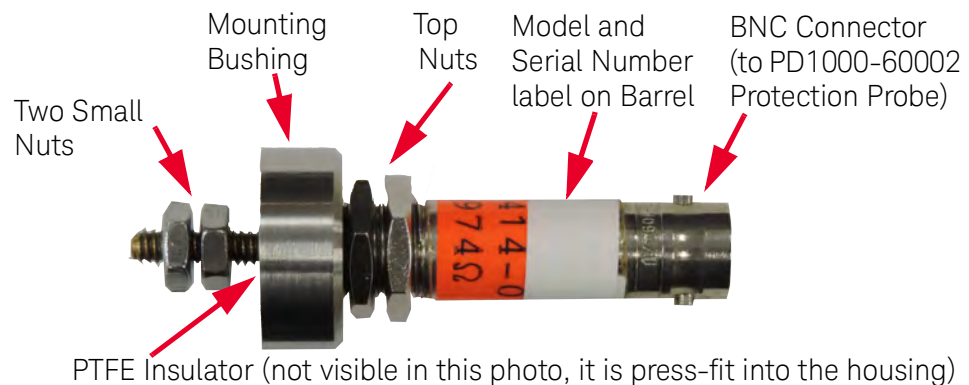
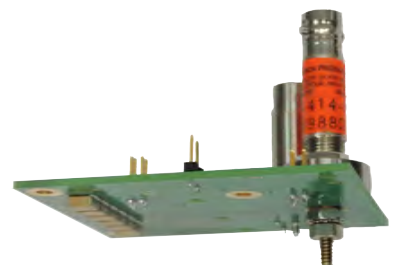


Figure 16 Coaxial Shunt Resistor

- 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 DUT 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 DUT Module.
- 6 Screw the Mounting Bushing to the bottom, against the DUT 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.

Identify Test Fixture Firmware Version

In the PD1000A Control Software:

- 1 Select the **Double-Pulse Test Control** tab.
- 2 Click on the **Settings** icon at the top of the screen.
- 3 Select **Hardware Configuration for Double-Pulse Test Control**.
- 4 Select the **Hardware Configuration > Hardware** tab opens the following dialog.

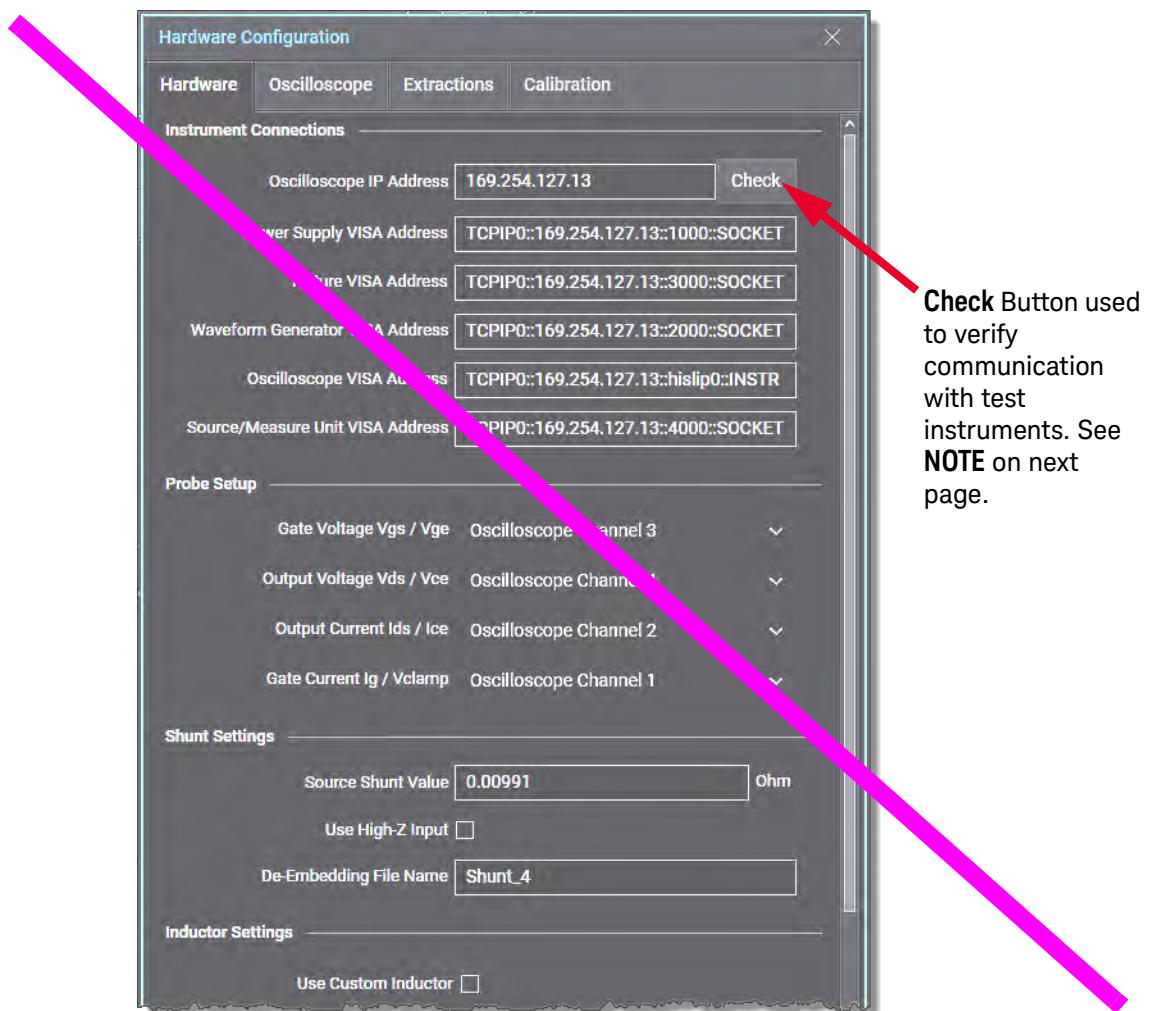
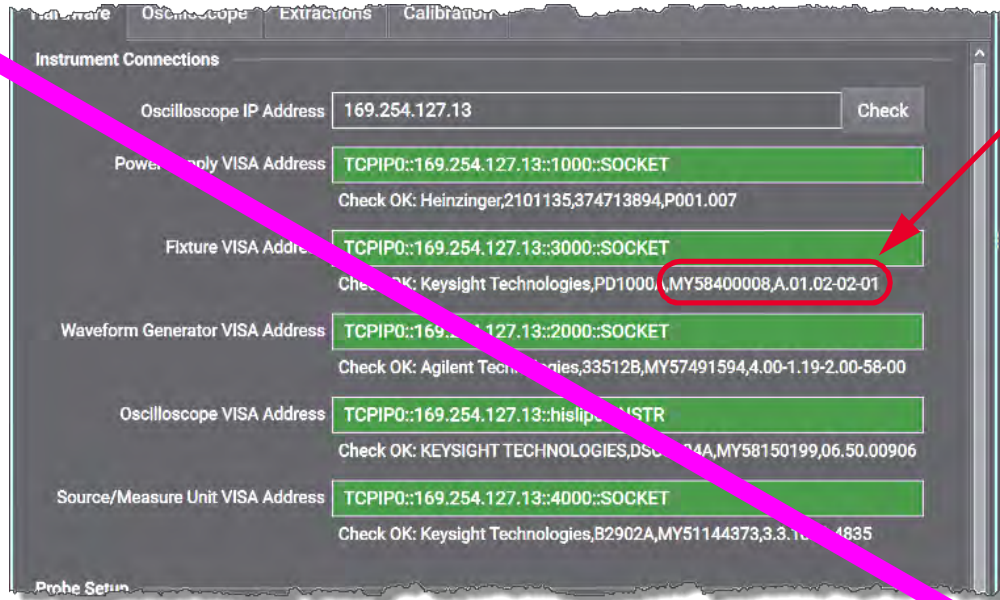


Figure 17 Double-Pulse Test Hardware Configuration Screen

- 5 Click the **Check** button to verify that the Control software can communicate with all of the DPT system instruments. After a few moments, all of the addresses should turn green and the Test Fixture serial number and firmware code appear:



If any or all of them are red, it indicates a failure to communicate.

NOTE

IMPORTANT: If you are using a laptop computer, turn the **Wireless Network Connection** off in the laptop before attempting to connect to the PD1500A system.

Contact your local Keysight Application Engineer to update the Test Fixture firmware.

5 Turn-on and Software Installation

After installing all of the DPT hardware in the Rack and Safety Enclosure, you need to Install and configure the DPT System Control Software and then verify the installation:

In this Chapter:

- Step 1: Connect LAN and Power Cable to Rack [page 60](#)
- Step 2: Install System Software on Host PC [page 62](#)
 - Install IO Libraries Suite on Host PC [page 62](#)
 - Download PD1000A System Control Software [page 62](#)
- Step 4: Obtain and Install Coaxial Shunt Resistor De-Embedding File [page 66](#)
 - Obtain the Shunt De-embedding file [page 67](#)
 - Install the De-Embedding Transfer File on the Oscilloscope [page 68](#)

NOTE

IMPORTANT: If you are using a laptop computer, turn the **Wireless Network Connection off** in the laptop before attempting to connect to the PD1500A system.

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.

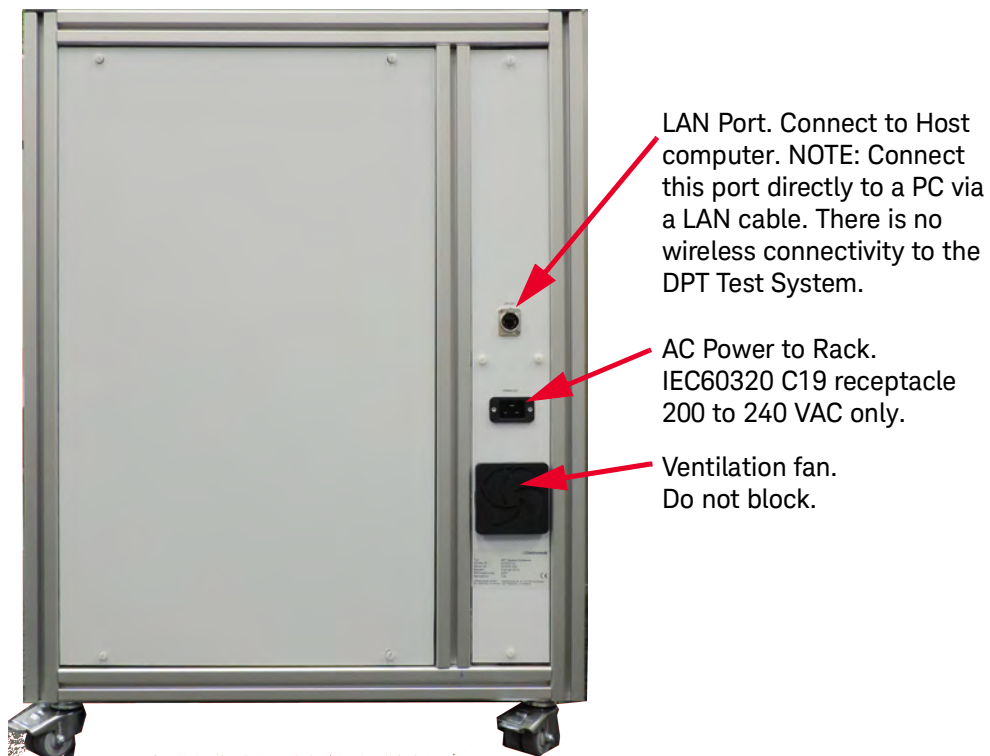


Figure 1 Right side of DPT Rack showing LAN and Power Connections

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 “Electrical and Environmental Requirements” on page 18.
- 3 Ensure the **Emergency Stop** button is pulled out.
- 4 Turn the large round knob on the DPT Rack and Safety Enclosure to the right (vertical) to power 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).

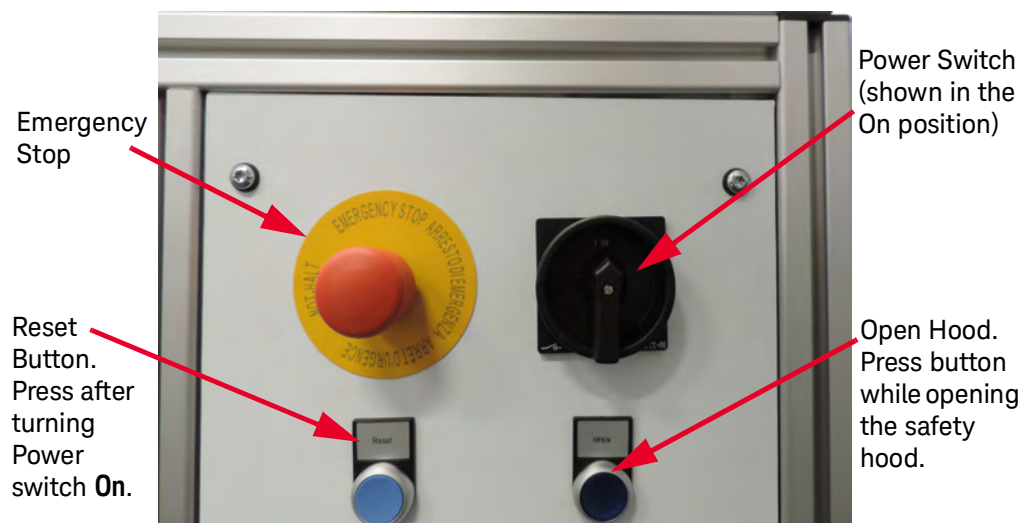


Figure 2 Rack and Safety Enclosure Front Panel Controls (Power switch shown in the On position)

Light Tower Inside the Safety Hood

Green Light -- High voltage is off. It is safe to open the Safety Hood

Amber Light -- Emergency Shut-down button has been pushed. Pull the Emergency Off button out and press the RESET button.

Red Light -- Safety Hood is locked and cannot be opened. High Voltage may be present.

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 Hood is 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

Run the Connection Expert utility of IO Libraries Suite and ensure the host PC can communicate with each test instrument. Connection Expert lists the VISA address of each instrument which is needed when configuring the hardware for the tests.

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

NOTE

The PD1500A Double-Pulse Tester software is one part of the PD1000A Power Device Measurement System for Advanced Modeling Control Software.

This Software Guide applies to and describes features present in PD1000A Control Software version 2022.321 and later. Refer to the software **Settings > About** for the software version.

IMPORTANT: PD1000A Software released after March 2022, (version 2022-321 and later) require firmware version A.02.04 in the Test Fixture. Refer to “Identify Test Fixture Firmware Version” on page 57 to determine the firmware version of your Test Fixture. Contact our local Keysight AE for updated firmware if necessary.

Software Licensing

Software licenses are required for the following PD1000A/PD1500A features:

License ID	Description	Notes
PD1010B	PD1000A On-State/Off-State S-Parameter Test	Replaces eh PD1010A. Not required for PD1500A Double-Pulse Test.
PD1020A	Double-Pulse Test Control	A perpetual fixed license for DPT test software. This license enables the software on the host controller PC the license is originally assigned to; without a time limit. License checked when starting a Double-Pulse Test.
PD1021A	Double-Pulse Test Off Line Mode Also requires the <i>infiniium_demoall</i> Infiniium Offline software to be installed and licensed.	License checked when opening the context menu in the Measurement History. If no license is present, the “Run Extractions...” in the Measurement History context menu is disabled.
PD1030A	GaN Test Features	License checked when starting a Double-Pulse Test with a GaN device selected.

NOTE

You must install the Keysight PathWave License Manager software on your host controller PC (if it was not previously installed by other Keysight software).

Keysight PathWave License Manager.

Do not use Keysight License Manager 6. The PathWave License Manager does not use the PCSERNO host ID. You must use the “Computer Ethernet Address Host.” Choose a host ID that corresponds to your PC’s permanent network card. This is easiest to identify when your PC is disconnected from all other networking interfaces, e.g., docking stations for laptops, etc.

All aspects of the PD1000A Control Software can be installed and used for 30 days without a license. However, after 30 days a permanent software license is required to continue running On State/Off State S-Parameter tests and DPT tests. For software and licensing information, go to:

www.keysight.com/find/PD1500A.

Step 3: Set Oscilloscope VISA Address

Use the touch-screen on the oscilloscope to obtain its IP Address.

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

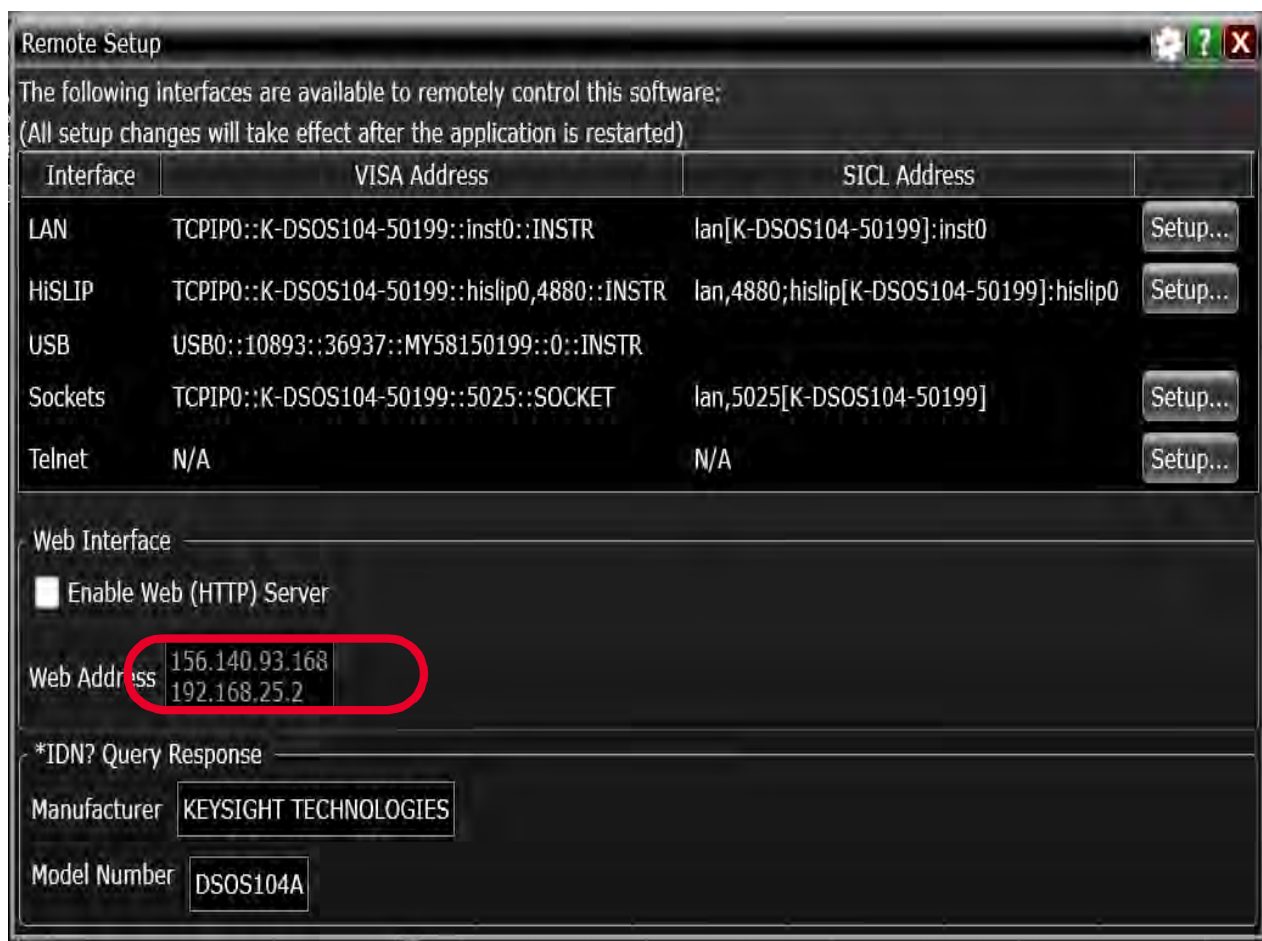


Figure 3 Remote Setup -- Web Interface

- 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. Do **NOT** use the 192.168.25.2 address.
- 4 On the oscilloscope, run the Connection Expert utility in Keysight IO Libraries Suite to specify the addresses and verify communication with the other test instruments.
- 5 Select the Infiniium Oscilloscope from the list of instruments
- 6 Note the Oscilloscope IP address. In the example above, it is: **10.114.10.186**.

Instrument Verification

- Each of the test instruments should appear in the list of instruments.
- Run **Interactive IO** to verify communication with the instruments.

Set AC Line Frequency and Date/Time on the B2902 SMU

The Keysight B2902 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 4: Obtain and Install Coaxial Shunt Resistor De-Embedding File

For maximum DPT accuracy, the PD1000-61901 10 m Ω and the PD1000-61902 100 m Ω 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.

Verify D9020ASIA License on the Oscilloscope

Keysight's D9020ASIA Advanced Signal Integrity Software license should be installed on the Oscilloscope and the license activated at the factory. Verify the installation and activation with the following procedure. License activation instructions and certificate are provided with your Oscilloscope.

To verify that the license is installed and activated:

- 1 On the oscilloscope select: **Help > About Infiniium**.
- 2 Look for **InfiniiSim Advanced**.

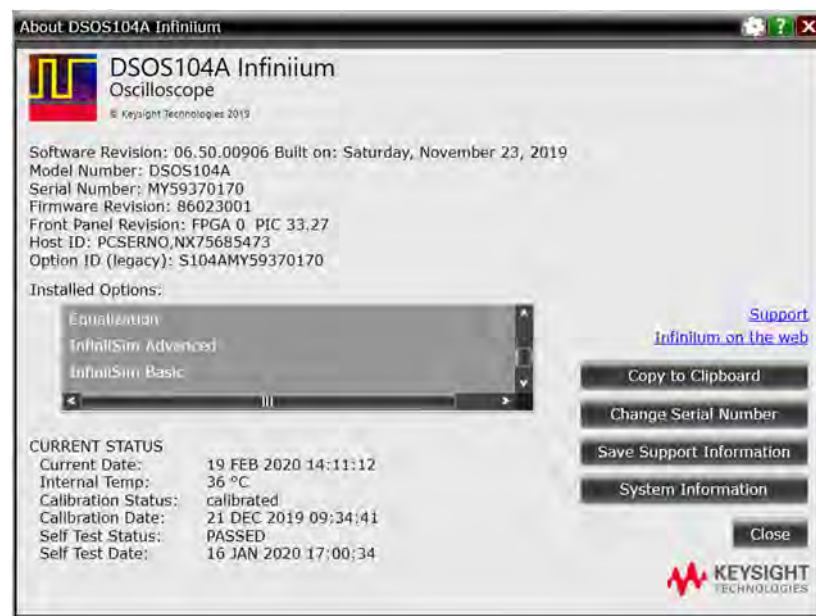


Figure 4 PD1000A De-Embedding License is Activated

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: 0960-3431¹.
- 2 Go to Keysight Infoline Support Portal: www.keysight.com/find/infoline.
- 3 Enter the shunt's product (model) number (0960-3431) and its serial number (for example, 0004). Click the **Go** button.
- 4 Select **Calibration Documents** tab.
- 5 Select the Certificate Number (for example, KEYSIGHT-AES-3965040).
- 6 Click the "shunt ".zip file. 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: 0004.tf2.
- 7 Unzip the file to a temporary location.

```

Created 18-Mar-2019 21:17:52
# hz TF ma
! #DSO ATF_FILE_VERSION A 01.00
! #DSO DEFAULT_FREQUENCY_RESOLUTION AUTO ! Uses InfiniSim's automatic uniform-frequency resampling algorithm.
! #DSO TRANSFER_FUNCTION_DEFINITION_STRING Preset=preGp6;
! #DSO TRANSFER_FUNCTION_DEFINITION_STRING AnalysisMode=TwoPort;
! #DSO TRANSFER_FUNCTION_DEFINITION_STRING MeasCktDef.ObservNode="r";MeasCktDef.Transmitter.ZT1=5.000000e+01;MeasCktDef.Receiver.ZT1=5.000000e+01;MeasCktDef.Transmitter.Nam
! #DSO TRANSFER_FUNCTION_DEFINITION_STRING SimCktDef.ObservNode="r";SimCktDef.Transmitter.ZT1=5.000000e+01;SimCktDef.Receiver.ZT1=5.000000e+01;SimCktDef.Transmitter.Nam
! 2-Port Transfer Function Data
! freq magTF21 angTF21
0.00000000e+00 5.36564453e+03 +0.00000000e+00
2.50000000e+05 5.36564452e+03 +6.58871090e+00
5.00000000e+05 5.33497458e+03 +3.42363796e+00
7.50000000e+05 4.85276640e+03 -4.25269398e+00
1.00000000e+06 5.25431457e+03 +2.20410160e+00
1.25000000e+06 5.00992998e+03 -2.21650380e+00
1.50000000e+06 5.51271601e+03 -2.41390861e+00
1.75000000e+06 5.59229282e+03 +1.14144810e+00
2.00000000e+06 5.62341536e+03 -1.15641228e+00
2.25000000e+06 5.59357329e+03 +4.18081581e+00
2.50000000e+06 4.96550619e+03 -8.22841370e+00
2.75000000e+06 5.54094996e+03 +4.55092611e+00
3.00000000e+06 4.93183932e+03 -3.85809046e+00
3.25000000e+06 5.13149778e+03 -5.09581514e+00
3.50000000e+06 5.97428251e+03 -6.17243534e+00
3.75000000e+06 5.49941865e+03 -1.25518808e+01
4.00000000e+06 4.81458241e+03 -4.56856881e+00
4.25000000e+06 4.96696168e+03 -3.73358134e+00
4.50000000e+06 4.95210507e+03 -6.43402915e+00
4.75000000e+06 5.39853865e+03 -7.16716447e+00
5.00000000e+06 5.98872124e+03 -4.25392852e+01

```

Figure 5 Portion of a .TF2 Sample File

¹ 0960-3431 is the Keysight part number for the uncalibrated shunt itself. If you need to order additional shunts, order Keysight part number PD1000-61901. This includes a characterized shunt, mounting bushing, serial number, and installation instructions.

Install the De-Embedding Transfer File on the Oscilloscope

NOTE

For new PD1500A systems, the de-embedding file was installed in the oscilloscope at the factory with the file name:

MY5840xxx.tf2

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

- 1 The De-embedding file should be in the folder: **C:\Users\Public\Documents\Infiniium\Filters** on the oscilloscope.

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 *PD1500A Control Software Guide* for additional information.

NOTE

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

6 PD1500A Double-Pulse Test Si/SiC AutoCalibration

In this chapter:

Oscilloscope Probe Compensation	page 71
System Calibration Procedure (Autocal)	page 76
Gate Voltage Calibration – V_{GS}/V_{GE} Probe	page 77
Gate Voltage Source Calibration – V_{GS} Output	page 79
Gate Current Calibration – I_G Probe	page 80
Gate On-Resistance Calibration – R_G Value: Standard Gate Drive Modules	page 82
High Voltage Probe Calibration – V_{DS}/V_{CE} Probe	page 82
Clamp Circuit Probe Calibration – V_{CLAMP} Probe	page 83
PD1000-60002 Protection Probe Calibration – I_D/I_C from Shunt	page 84
Coaxial Shunt Resistor Characterization	page 85
Oscilloscope Probe Deskew	page 86

NOTE

IMPORTANT: The calibration procedures in this chapter are for the Si/SiC DUT, Gate Drive modules and probes. For GaN Test Board calibration, contact your local Keysight Application Engineer for instructions relevant to your specific Test Board.

There are several calibration-related procedures that should be performed regularly. These procedures should be performed anytime the ambient temperature changes $\pm 5^\circ\text{C}$, anytime the oscilloscope probes or anything in the test system are changed.

- **Oscilloscope Probe Compensation**
- **DPT System Calibration**
- **Oscilloscope Probe Deskew**
- **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, 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**. Be careful to follow all instructions.

The software reads the EEPROMS on the Gate Drive Modules and selects the appropriate calibration procedures. Calibration procedures for the Standard Gate Drive Modules (PD1000-66540, -66542, -66544, -66546, -66541, -66543, -66545, -66547) are different than they are for the General Purpose ± 28 V Gate Drive Modules (PD1000-66848, -66850, -66852, -66854, -66856, -66858, -66860, -66849, -66851, -66853, -66855, -66857, -66859, -66861). This chapter describes the calibration procedures for the Standard Gate Drive Module.

The General Purpose ± 28 V Gate Drive Modules are configured as either Single-Path or Split-Path for the Gate resistors. The calibration procedures differ depending on the resistor configuration. Refer to the PD1000 Control Software Online help file for detailed calibration information.

Oscilloscope Probe Compensation

As the first step calibrating the Double-Pulse Test system, the oscilloscope probes must be adjusted for low frequency compensation. For this, the 10076C and N2873A passive probes have built-in compensation RC divider networks. The N2819A Active Differential Probe requires offset compensation.

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

All equipment required for compensation and calibration were provided with the PD1500A test system. This includes:

- Spring hook and ground clips for passive oscilloscope probes.
- 5 cm Extension Leads and either Pincer or Micro IC clips for the N2819A Differential probe.
- Low Frequency Compensation trimmer/adjustment tools (small non-metallic screwdriver).

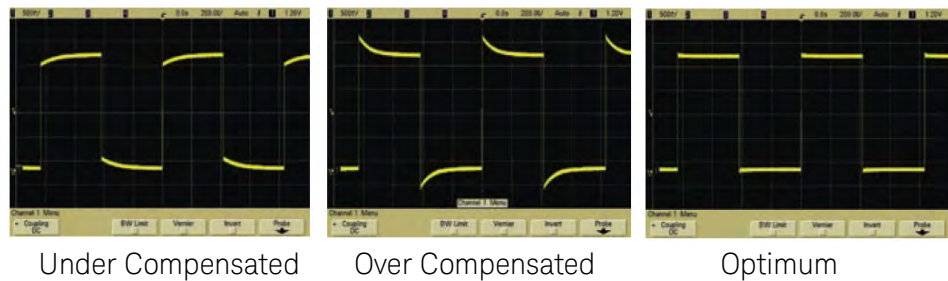
Low Frequency Compensation for the 10076C and N2873A Probes

The Infiniium S-Series 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 the square wave reference terminal.

- 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 calibration output (a square wave label is seen near this output).
- 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.

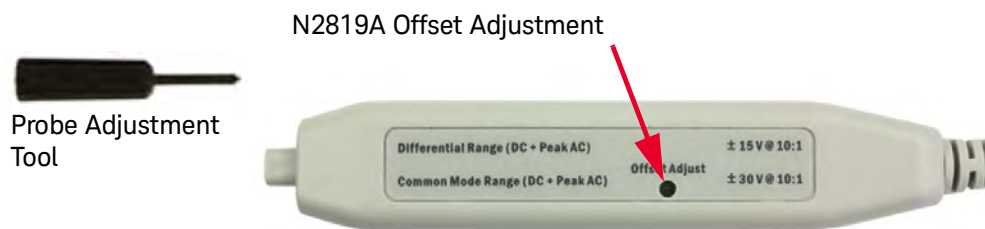


NOTE

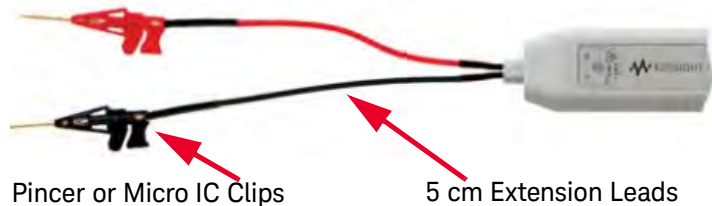
Due to the 100:1 divider of the 10076C High Voltage Probe, the signal will appear to be very noisy. Therefore, it is beneficial to enable averaging in the **Setup > Acquisition** menu for suppressing this noise. Setting the number of averages to 16 will result in a clean signal.

Offset Compensation for the N2819A Differential Probe

The N2819A Active Differential Probe also requires offset compensation. This is described below and in the [N2818/9A Differential Probe User Guide](#). Use the trimmer tool supplied with the probe to perform the offset zero calibration.



- 1 Connect the probe to an oscilloscope channel input.
- 2 Using the probe's 5 cm Extension Leads and the Pincer or Micro IC Clip connection accessories, short the + and - inputs together.



- 3 Press **Control > Autoscale** on the oscilloscope.
- 4 Press the channel button for the probe and set the oscilloscope channel to DC Coupled mode.

- 5 Set the oscilloscope to **Averaging** mode (**Setup** > **Acquisition...** > **Averaging Enabled**, x8 or higher) to reduce oscilloscope noise, if needed.
- 6 Set the vertical scale of the oscilloscope to 100 mV/div.
- 7 Using the offset adjustment tool that comes with the probe, adjust the probe offset voltage to zero volts.

In the Compensation & Calibration section of the Control Software, software, click the **Skip** button when you have completed the probe compensation.

Si/SiC System Calibration Procedure (Autocal)

CAUTION

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

CAUTION

IMPORTANT: After calibration and before running any Double-Pulse Test, make certain the Low-Side Gate Drive Modules have the V/NC jumper installed and the I/NO jumper removed. Remove all cables from the B2902 SMU.

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

- 1251-2277 Banana to BNC Adapter, quantity 1.
- 8121-2816 BNC to SMA Cable, 1 m, 50 Ω , quantity 1.
- U1168B Standard Probe Kit, quantity 2. Used with Gate Resistance and the Clamp Module calibration measurements.
- 2.54 mm jumpers (a package of 10 was provided with the DPT system).

Requirements

- Perform the Oscilloscope Probe Offset Compensation as the first step in the calibration.
- Unless instructed, both High-Side and Low-Side transistors should be removed from the DUT module (if possible).
- Install both High-Side and Low-Side Gate Drive modules, with the same resistance value (R_G) on the Test Fixture.
- The PD1000-66805 Clamp Module is required only for the Clamp Module calibration procedure. Otherwise, remove it.
- Perform the oscilloscope probe Deskew as the last calibration step.

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

The ± 28 V Gate Drive modules have a different calibration procedure. Please read the instructions in this chapter carefully.

STD for Standard Gate Drive Modules
 ± 28 for ± 28 V Gate Drive Modules

±28 V Gate Modules

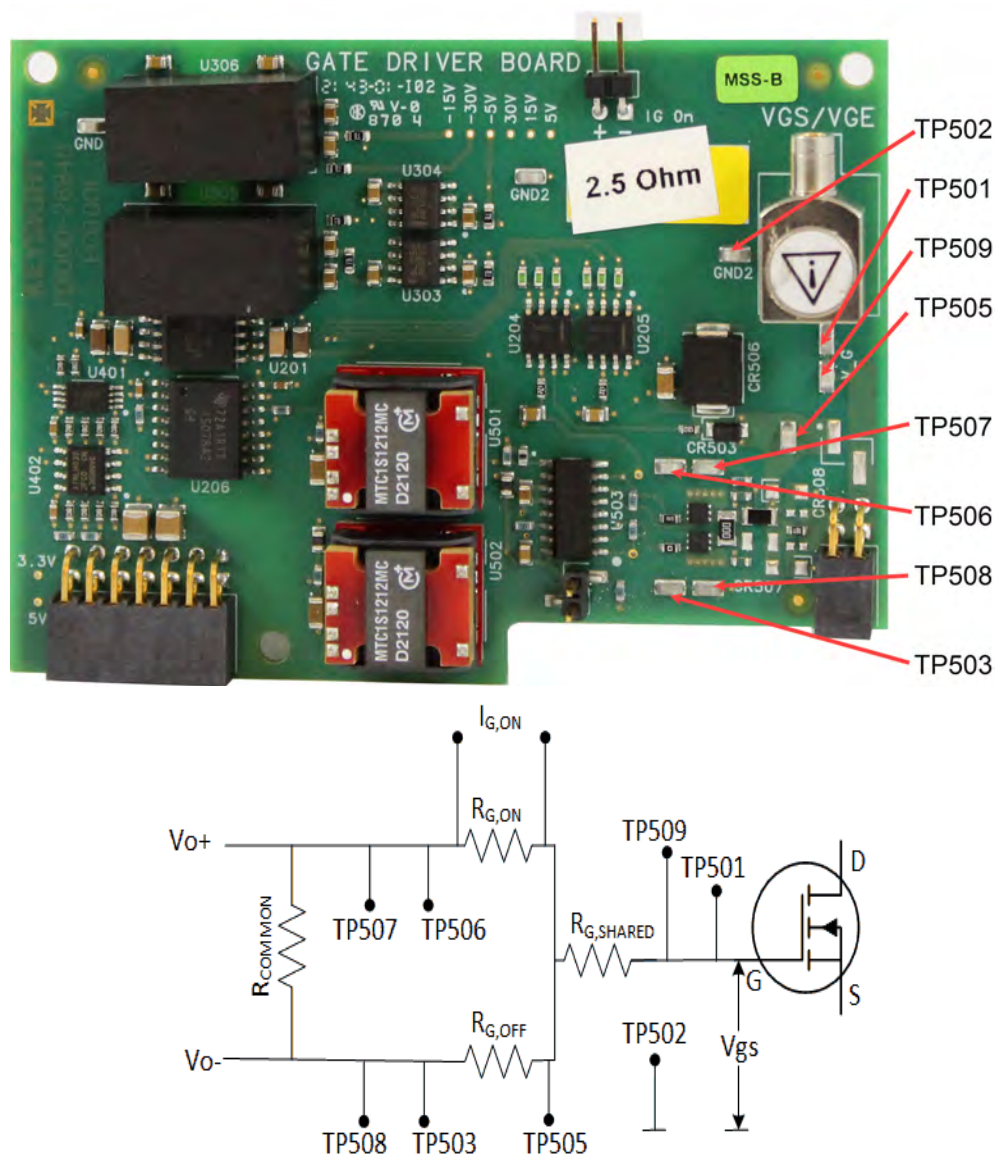


Figure 6 Test Points used in the ±28 V Gate Module Calibration

Module Initialization

All Keysight gate drive modules except the PD1000-66848 Low-Side and PD1000-66849 High-Side gate drive modules come from the factory already calibrated. The PD1000-66848 and -66849 High-Side Gate Drive modules can be configured with either single-path or split-path gate resistors. These two modules are considered **'blank'** until initialized. For module initialization see "Initializing PD1000-66848 and -66849 Modules for Calibration" on page 90. After initialization, proceed with module calibration.

Gate Voltage Calibration – V_{GS}/V_{GE} Probe: Standard Gate Drive Modules

STD

Hardware Setup:

- Remove the I/NO Jumper on the Low-Side Gate Drive Module.
- Remove the V/NC Jumper on the Low-Side Gate Drive Module.
- Connect the N2873A V_{GS}/V_{GE} Gate Voltage Probe to the Low-Side Gate Drive Module.
- Connect the BNC to Banana Adapter to the BNC to SMA calibration cable.
- Connect the SMA end of the cable to the SMA connector on the Low-Side Gate Drive Module.
- Connect the banana plug cable to Channel 1 Force terminals of the B2902 SMU (2-wire measurement).
- The Safety Enclosure hood may be left open.

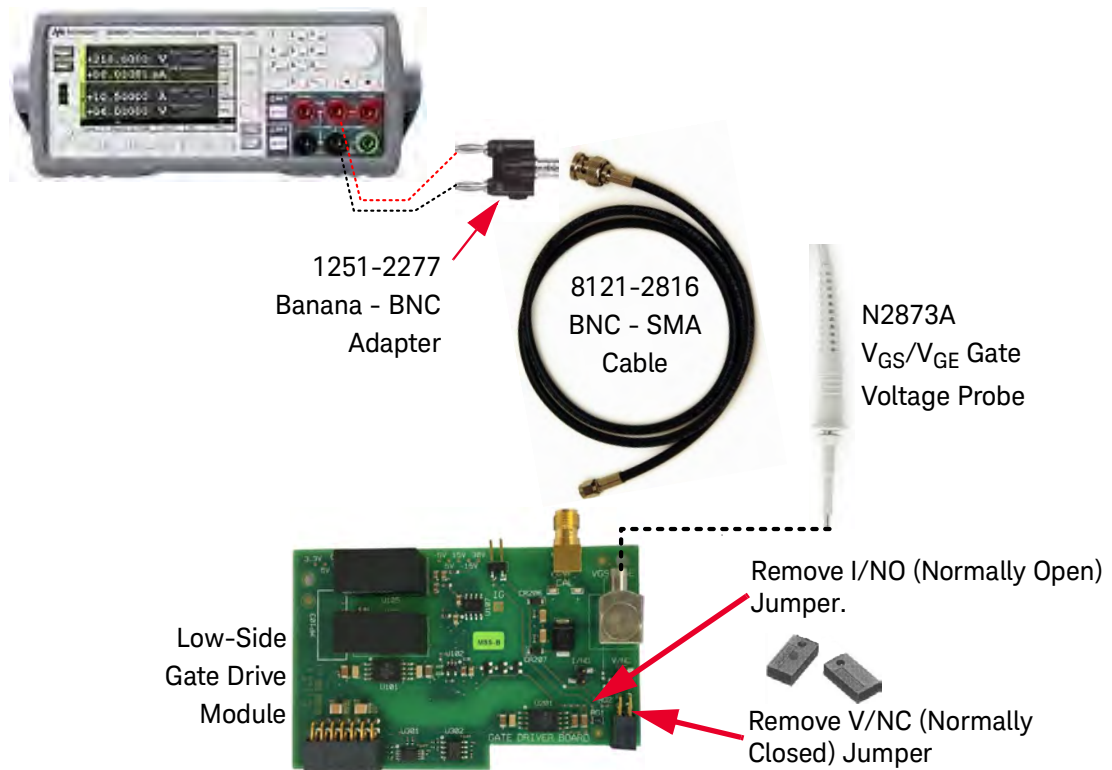


Figure 7 Setup for Gate Voltage Calibration - Standard Gate Drive Modules

Procedure: After setting up the hardware as described above, click **Start** to perform the calibration and continue to the Gate Voltage Source Calibration.

NOTE

A strip of 10 header jumpers (Keysight part number 1258-0225) were supplied with your PD1500A for use during calibration.

Gate Voltage Calibration – V_{GS}/V_{GE} Probe: ± 28 V Gate Drive Modules

Use the following procedure for both Common-Path and Split-Path Gate Resistor configurations.

± 28

Hardware Setup:

- Connect the N2873A V_{GS}/V_{GE} Gate-Voltage-Probe into the V_{GS}/V_{CE} connector Deskew section of the Test Fixture.
- Connect the SMA-connector of the BNC-to-SMA cable to the SMA INPUT connector Deskew section of the Test Fixture.
- Connect the Banana-BNC adapter to BNC-end of the BNC-to-SMA cable.
- Connect the Banana-plug of Banana-BNC adapter into the Channel 1 FORCE-terminals of the SMU.
- The Safety Enclosure hood may be left open.



Figure 8 Setup for Gate Voltage Calibration – ± 28 V Gate Drive Modules

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

Gate Voltage Source Calibration – V_{GS}/V_{GE} Output: Standard Gate Drive Modules

STD

Hardware Setup:

- Remove the I/NO Jumper on the Low-Side Gate Drive Module.
- Install the V/NC Jumper on the Low-Side Gate Drive Module.
- Connect the BNC to Banana Adapter to the BNC to SMA calibration cable.
- Connect the banana plug cable to Channel 1 Force terminals of the B2902 SMU (2-wire measurement).
- Connect the SMA end of the cable to the SMA connector on the Low-Side Gate Drive Module.
- The Safety Enclosure hood may be left open.

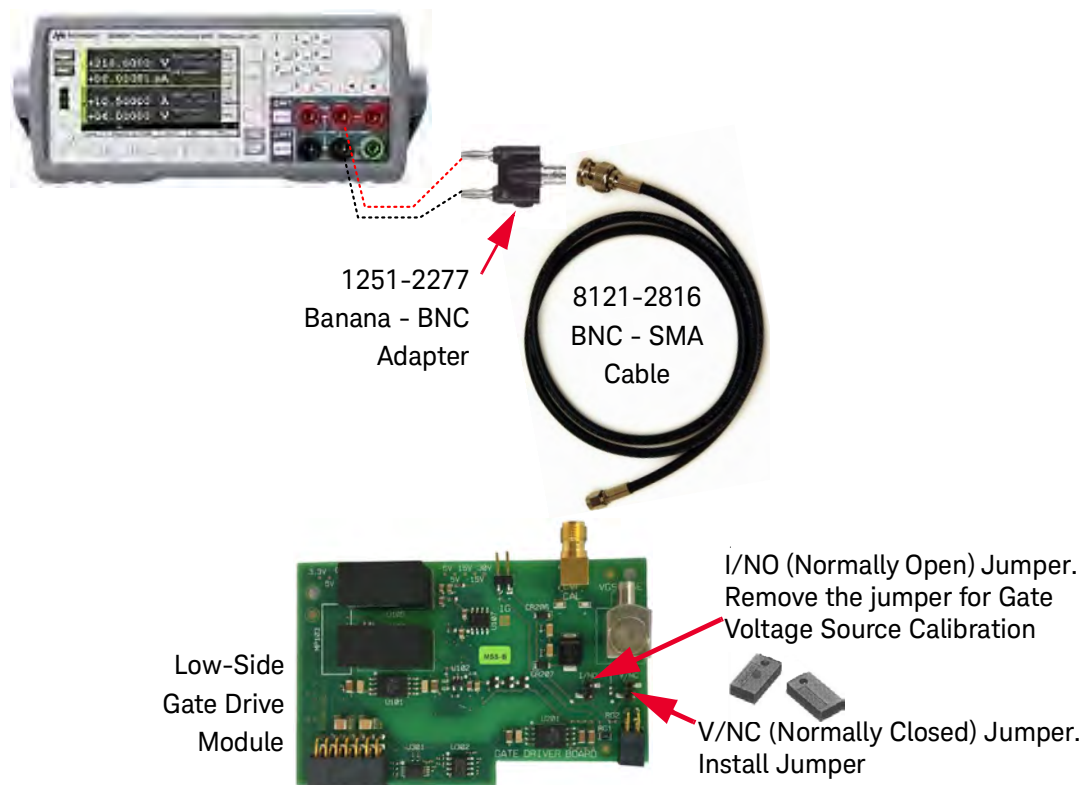


Figure 9 Setup for Gate Voltage Calibration - Standard Gate Drive Modules

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

NOTE

A strip of 10 header jumpers (Keysight part number 1258-0225) were supplied with your PD1500A for use during calibration.

Gate Voltage Source Calibration – V_{GS}/V_{GE} Output: ± 28 V Gate Drive Modules

 ± 28 **Hardware Setup:**

Use the following procedure for both Common-Path and Split-Path Gate Resistor configurations.

- Connect the N2819A Differential Oscilloscope Probe to the I_G On Pins on the Low-Side Gate Driver Module. Carefully observe polarity when installing the probe.
- Connect red Test-Hook Banana plug to FORCE-High-terminal on the B2902 SMU.
- Connect red Test-Hook to Low-Side Gate Driver Module TP501.
- Connect black Test-Hook Banana plug to FORCE-Low terminal on the B2902 SMU.
- Connect black Test-Hook to Low-Side Gate Driver Module TP502.
- The Safety Enclosure hood may be left open.

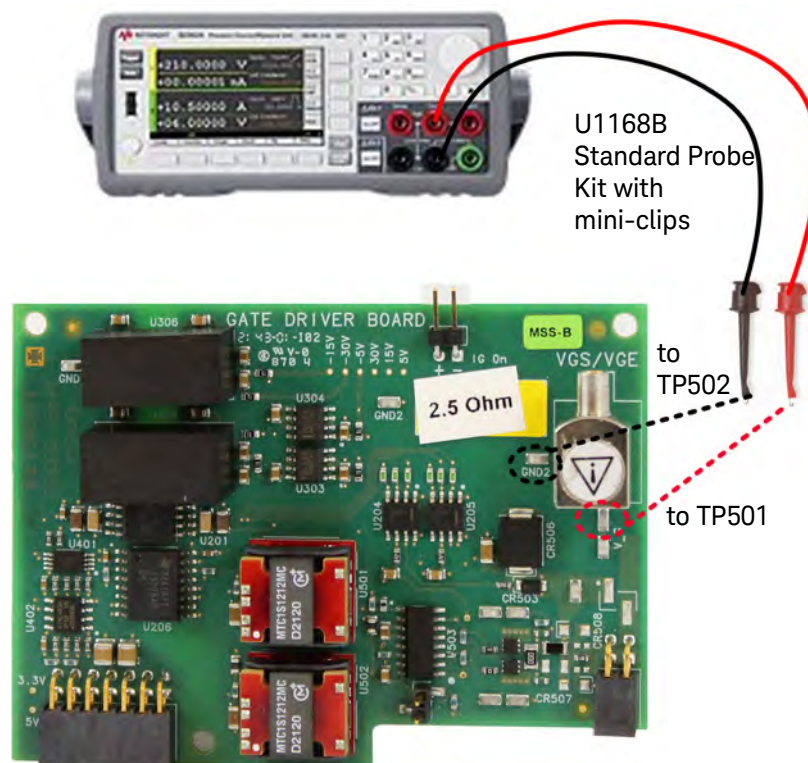


Figure 10 Setup for Gate Voltage Calibration – ± 28 V Gate Drive Modules

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

Gate Current Calibration – I_G Probe: Standard Gate Drive Modules

STD

Hardware Setup:

- Install the I/NO Jumper on the Low-Side Gate Drive Module.
- Install the V/NC Jumper on the Low-Side Gate Drive Module.
- Connect the N2819A Differential Oscilloscope Probe to the I_G pins on the Low-Side Gate Drive Module. Carefully observe polarity when installing probe.
- Connect the U1168B Calibration Cable between the Channel 1 Force terminals of the B2902 SMU (2-wire measurement) and the + and - CAL eyelet terminals on the Low-Side Gate Drive Module.
- The Safety Enclosure hood may be left open.

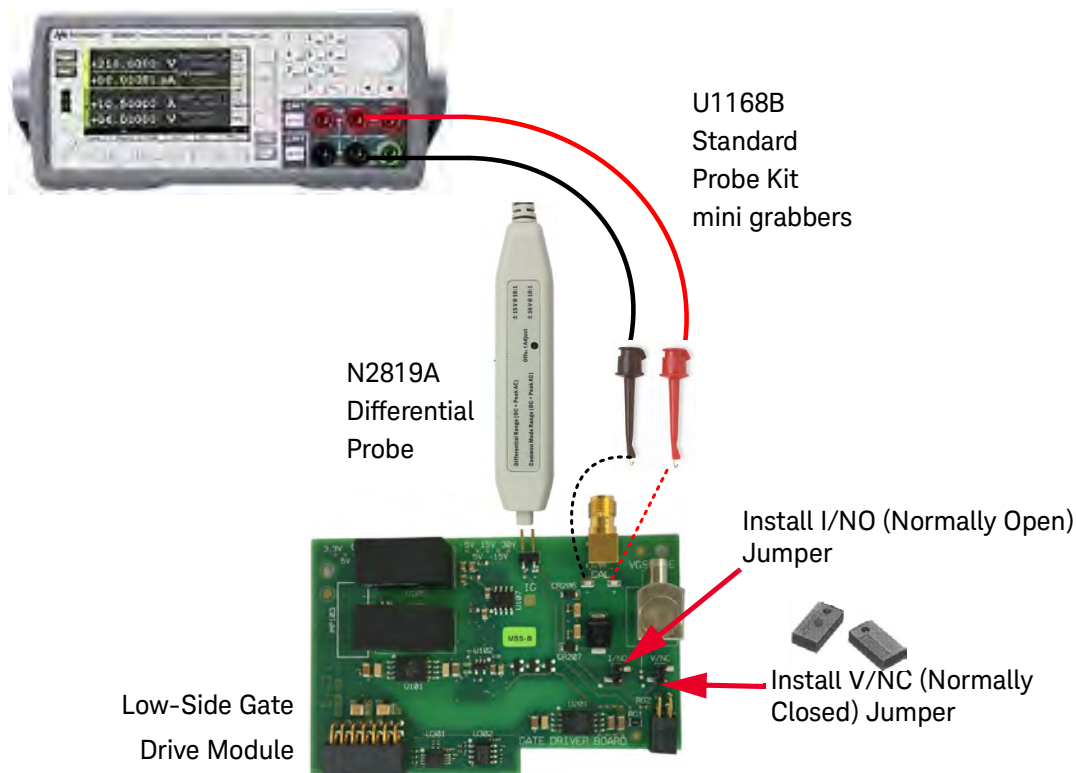


Figure 11 Setup for Gate Current Calibration – Standard Gate Drive Modules

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

NOTE

A strip of 10 header jumpers (Keysight part number 1258-0225) were supplied with your PD1500A for use during calibration.

Gate Current Calibration – I_G Probe: ± 28 V Gate Drive Modules**±28****Hardware Setup:**

Use the following procedure for both Common-Path and Split-Path Gate Resistor configurations.

- Connect the N2819A Differential Oscilloscope Probe to the $I_{G,ON}$ Pins on the Low-Side Gate Driver Module. Carefully observe polarity when installing the probe.
- Connect red Test-Hook Banana plug to FORCE-High-terminal on the B2902 SMU.
- Connect red Test-Hook to Low-Side Gate Driver Module TP505.
- Connect black Test-Hook Banana plug to FORCE-Low terminal on the B2902 SMU.
- Connect black Test-Hook to Low-Side Gate Driver Module TP507.
- The Safety Enclosure hood may be left open.

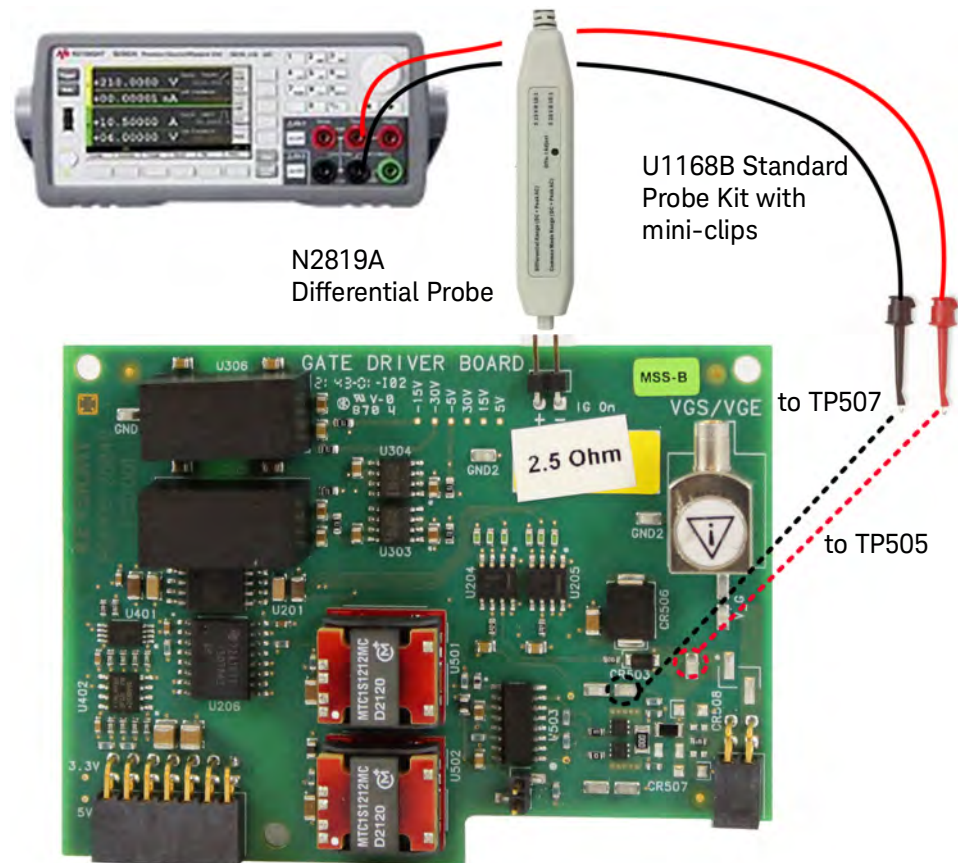


Figure 12 Setup for Gate Current Calibration for ± 28 V Gate Drive Modules

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

Gate On-Resistance Calibration – R_G Value: Standard Gate Drive Modules

This step is required when installing custom gate resistors on the Low-Side Gate Drive modules.

STD

Hardware Setup:

- Install the I/NO Jumper on the Low-Side Gate Drive Module.
- Install the V/NC Jumper on the Low-Side Gate Drive Module.
- Install both calibration cables to connect the B2902 SMU to the Low-Side Gate Drive module.
- The Safety Enclosure hood may be left open.

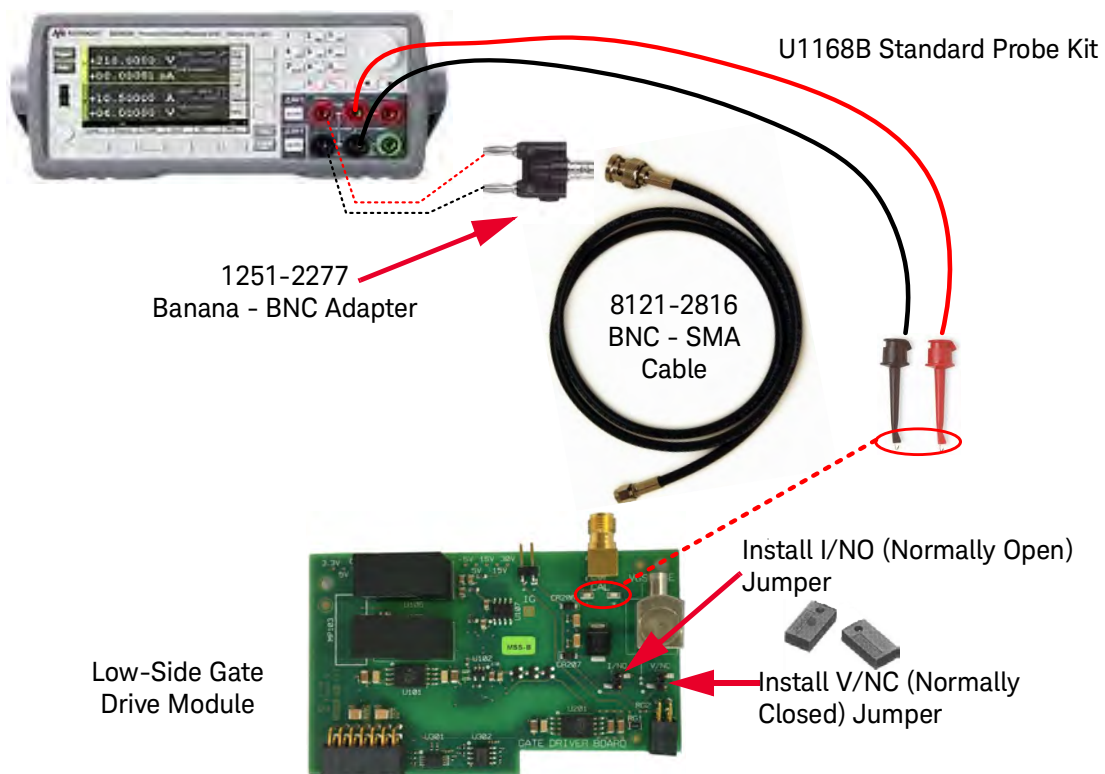


Figure 13 Setup for the Gate Resistance Calibration 4-Wire Measurements – Standard Gate Drive Modules

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

CAUTION

IMPORTANT: After the R_G Calibration, the I/NO jumper must be removed from the Low-Side Gate Drive Module.

NOTE

There is no calibration for the 0Ω Gate Drive modules or the High-Side Gate Drive modules.

Gate On-Resistance Calibration – R_G Value: ± 28 V Gate Drive Modules

Use the following procedure for Common-Path Gate Resistor configuration and for Split-Path **RG,ON** calibration. There is a separate procedure for **RG,OFF** Calibration for Split-Path Gate Resistor calibration (see next page).

±28

Hardware Setup:

Using one set of the U1168B Test Probe kits:

- Connect red Test-Hook Banana plug to FORCE-High-terminal (red) on the B2902 SMU. Connect Test-Hook to Gate Drive Module TP506.
- Connect black Test-Hook Banana plug to FORCE-Low-terminal on the B2902 SMU. Connect Test-Hook to Gate Drive Module TP501.

Using a second set of the U1168B Test Probe kits:

- Connect red Test-Hook Banana plug to Sense-High-terminal (red) on the B2902 SMU. Connect Test-Hook to Gate Driver Module TP507.
- Connect black Test-Hook Banana plug to Sense-Low-terminal on the B2902 SMU. Connect Test-Hook to Gate Driver Module TP509.
- The Safety Enclosure hood may be left open for this calibration step.

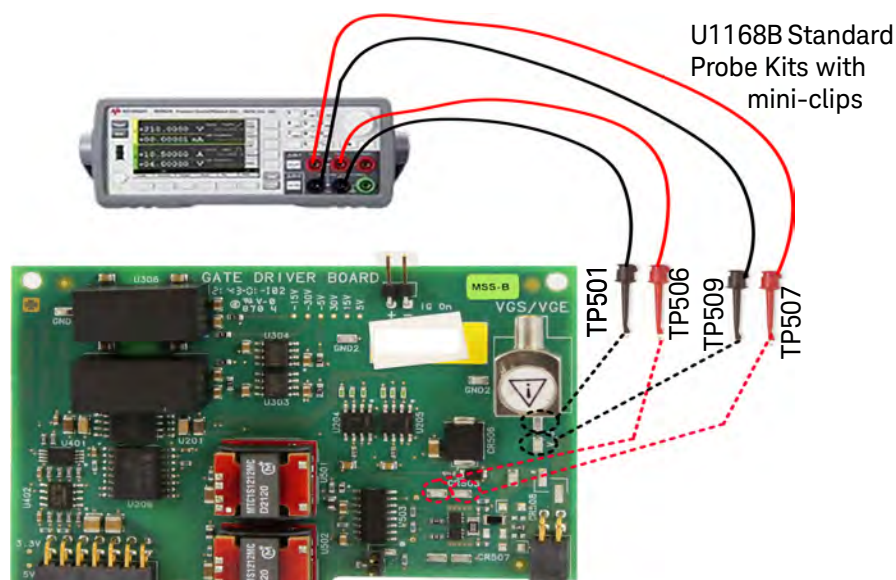


Figure 14 Setup for the Gate Resistance Calibration 4-Wire Measurements ± 28 V Gate Drive Modules (Single-Path and $R_{G,ON}$ Split-Path)

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

NOTE

There is no calibration for the 0Ω Gate Drive modules or the High-Side Gate Drive modules.

Gate Off-Resistance Calibration – R_G Value: ± 28 V Gate Drive Modules (Split-Path $R_{G,OFF}$)

Use the following procedure for Split-Path **RG,OFF** calibration only. There is a separate procedure for **RG,ON** Calibration for Split-Path Gate Resistor calibration.

± 28

Hardware Setup:

Using one set of the U1168B Test Probe kits:

- Connect red Test-Hook Banana plug to FORCE-High-terminal (red) on the B2902 SMU. Connect Test-Hook to Gate Drive Module TP501.
- Connect black Test-Hook Banana plug to FORCE-Low-terminal on the B2902 SMU. Connect Test-Hook to Gate Drive Module TP503.

Using a second set of the U1168B Test Probe kits:

- Connect red Test-Hook Banana plug to Sense-High-terminal (red) on the B2902 SMU. Connect Test-Hook to Gate Drive Module TP509.
- Connect black Test-Hook Banana plug to Sense-Low-terminal on the B2902 SMU. Connect Test-Hook to Gate Drive Module TP508.
- The Safety Enclosure hood may be left open for this calibration step.

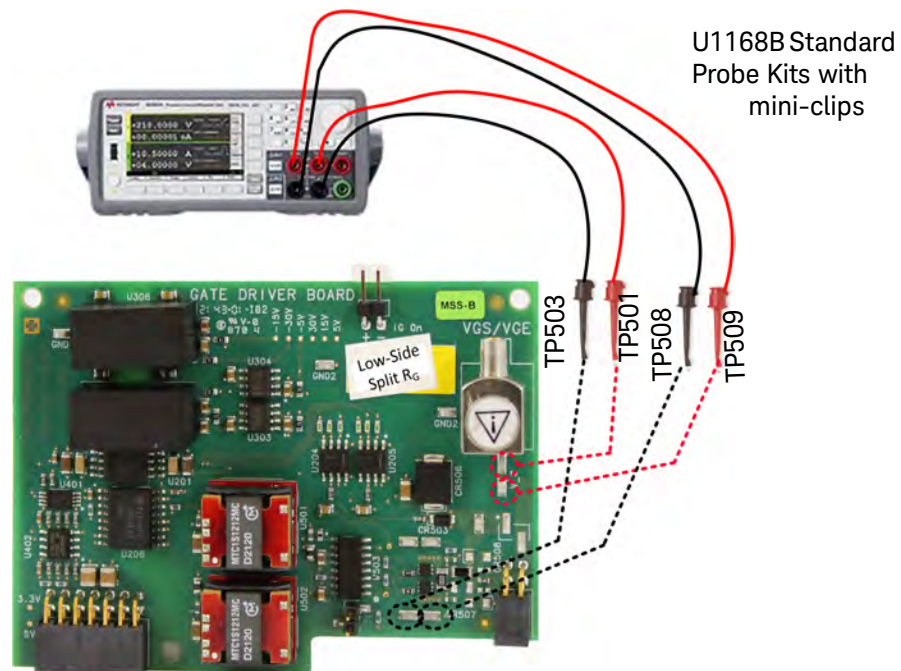


Figure 15 Setup for the Gate Resistance Calibration 4-Wire Measurements ± 28 V Gate Drive Modules ($R_{G,OFF}$ Split-Path)

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

High Voltage Probe Calibration – V_{DS}/V_{CE} Probe

STD ±28

Hardware Setup:

- Install a High-Side Gate Drive Module (0 Ω Gate Resistor)
- Install a 1200 V FET (for example, the SCT2080KE FET supplied with the PD1500A) in the High-Side position of the DUT module.
- Remove any FET in the Low-Side position of the DUT Module.
- Remove (do not install) the Low-Side Gate Drive Module.
- Connect the 10076C High Voltage Probe to the DUT Module.
- Remove all other cables and oscilloscope probes.

CAUTION

Safety Enclosure hood must be closed for this test.

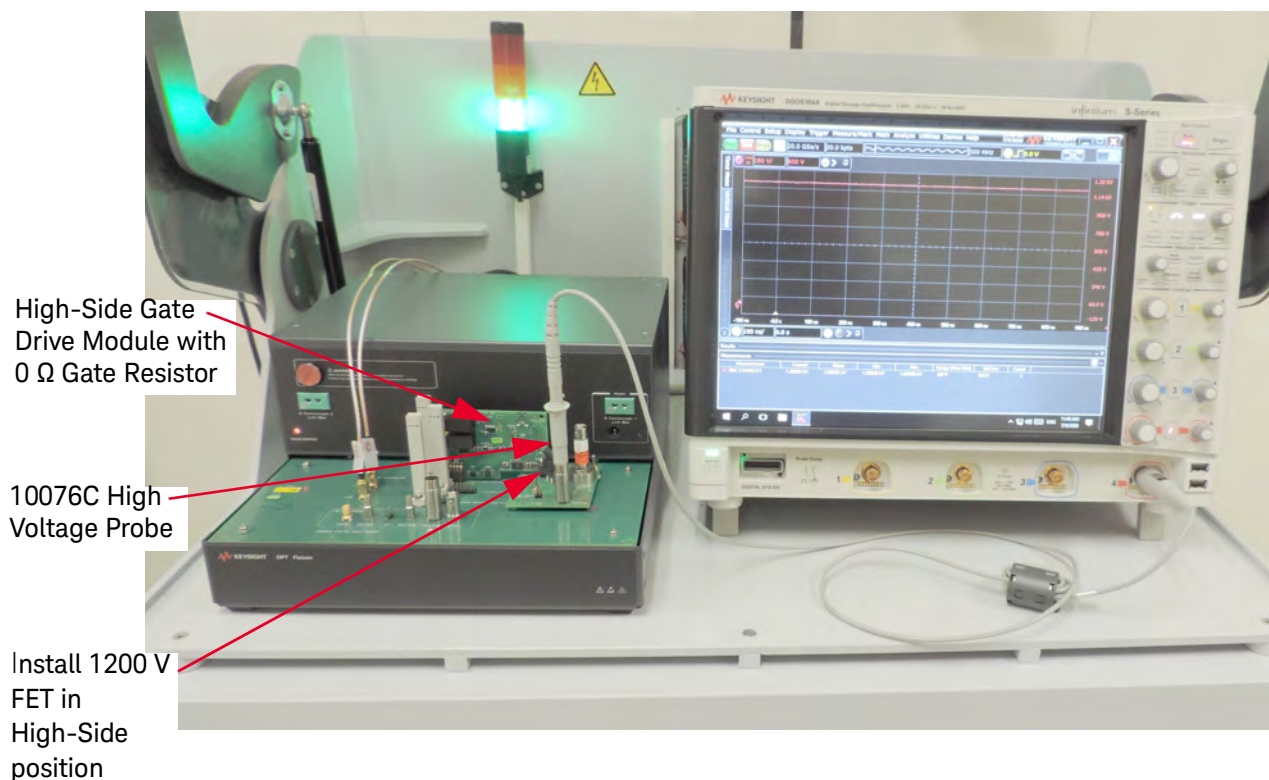


Figure 16 Setup for High Voltage Probe Calibration (DSOS104A Oscilloscope shown)

Procedure: After setting up the hardware as described above, click **Start** to perform the calibration.

Clamp Circuit Probe Calibration – V_{CLAMP} Probe

STD ±28

Hardware Setup: See Figure 17 below.

- Install the PD1000-66805 Clamp Circuit Module in the PD1500A Test Fixture. If you are not using or calibrating the Clamp Module, press the **Skip** button to skip this step and proceed to the Protection Probe Calibration.
- Connect the N2873A V_{GS}/V_{GE} Clamp Voltage Probe to the top of the Clamp Circuit Module.
- Using the U1168B Standard Probe Kit, connect banana plugs to Channel 1, Force output of the B2902 SMU.
- On the other end of the test cables, attach two mini clips (one red, one black).
- Connect the mini clips to the **CAL** pins on the Clamp Circuit Module.
- The Safety Enclosure hood may be left open.

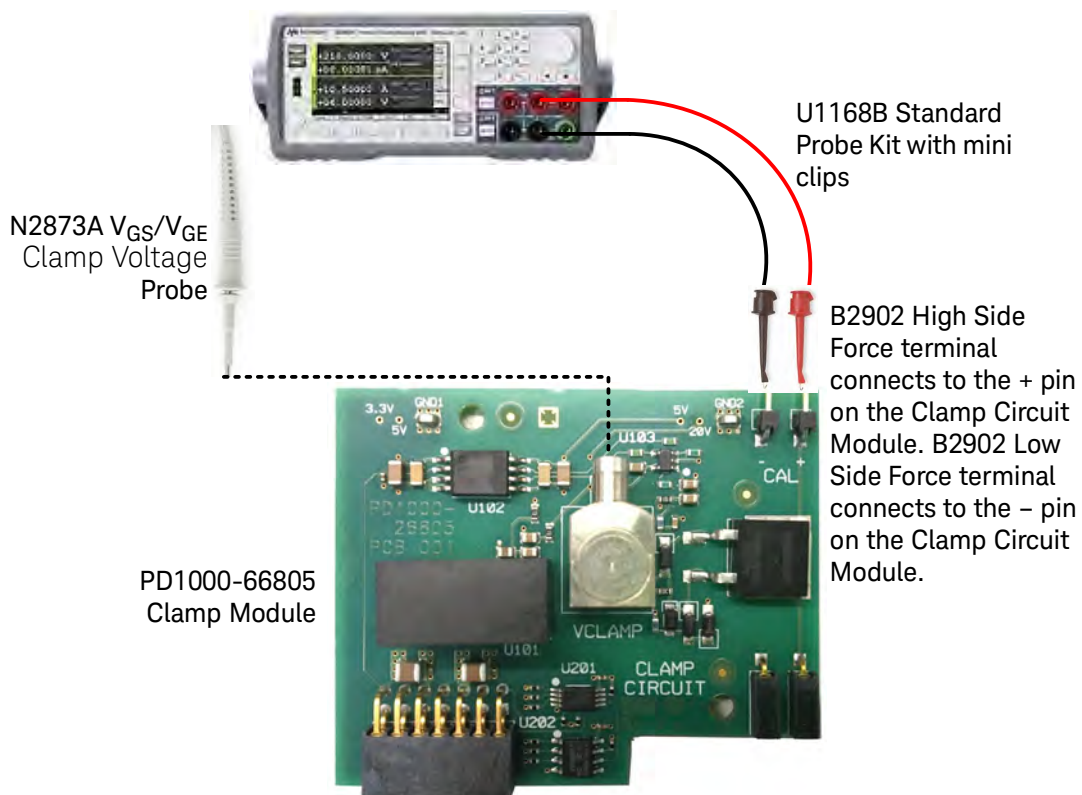


Figure 17 Setup for Clamp Circuit Probe Calibration

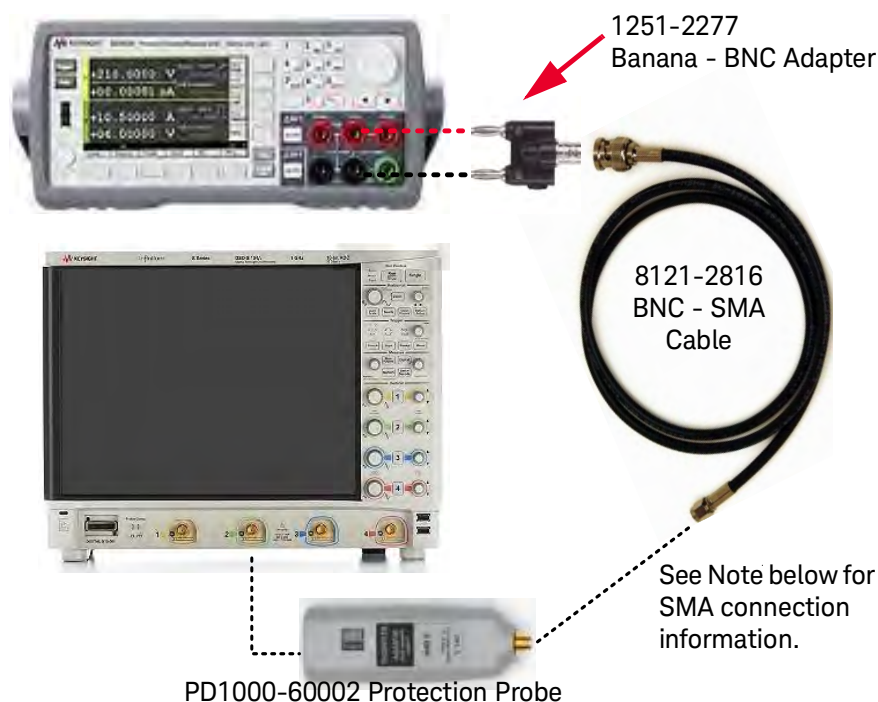
Procedure: After setting up the hardware as described above, click **Start** to perform the calibration and then continue to the next step.

PD1000-60002 Protection Probe Calibration – I_D/I_C from Shunt

STD ±28

Hardware Setup: Refer to Figure 18 below.

- Connect the PD1000-60002 Protection Probe to Oscilloscope Channel 2.
- Connect the BNC to Banana Adapter to the BNC to SMA cable.
- Connect the SMA end of the cable to the SMA connector on the PD1000-60002 Protection Probe. Use the 0.56 N-m (5 lb-in) 5/16 in. SMA Break-over torque wrench (provided with the PD1500A system) to tighten the cable to the PD1000-60002 Protection Probe.
- Connect the banana plug cable to Channel 1 Force terminals of the B2902 SMU (2-wire measurement).
- The Safety Enclosure hood may be left open for this calibration step.

**Figure 18** PD1000-60002 Protection Probe Calibration Setup

Procedure: After setting up the hardware as described above, click **Start** to perform the calibration and then continue to the next step.

NOTE

Use the 0.56 N-m (5 lb-in) 5/16 in. SMA Break-over torque wrench (provided with the PD1500A system) to tighten the cable to the PD1000-60002 Protection Probe. Failure to do so might cause extensive ringing in the DPT measurements. See appendix for SMA connector care and connection information.

Oscilloscope Probe Deskew

Connect Probes to Deskew Fixture

After the Oscilloscope Probe Compensation and System Calibration, the last step is to run Deskew. Deskew has the greatest impact on both On and Off Delay times and hence affects the total Switching Time. Both On and Off Switching Energies are also affected.

Hardware Setup

Because the oscilloscope has only four input channels and the DPT test fixture uses only four oscilloscope probes at a time, then only four probes may be de-skewed at one time. Typically, either the N2819A Differential Probe (for measuring I_G) or the N2873A (V_{CLAMP}) probe are used in a DPT test; rarely are they both used at the same time. Deskew the probes that you will be using in your test. Figure 20 below shows the typical configuration for de-skewing the oscilloscope probes.

- 1 Locate the Deskew oscilloscope probe connectors on the main Test Fixture. See Figure 19 below.
- 2 Remove the SMA cable from the Low Side SMA connector on the Test Fixture and connect it to the **Cal (Deskew) Input** SMA connector.

Connect Low-Side (Channel 1) of Waveform Generator to Cal (Deskew) Input

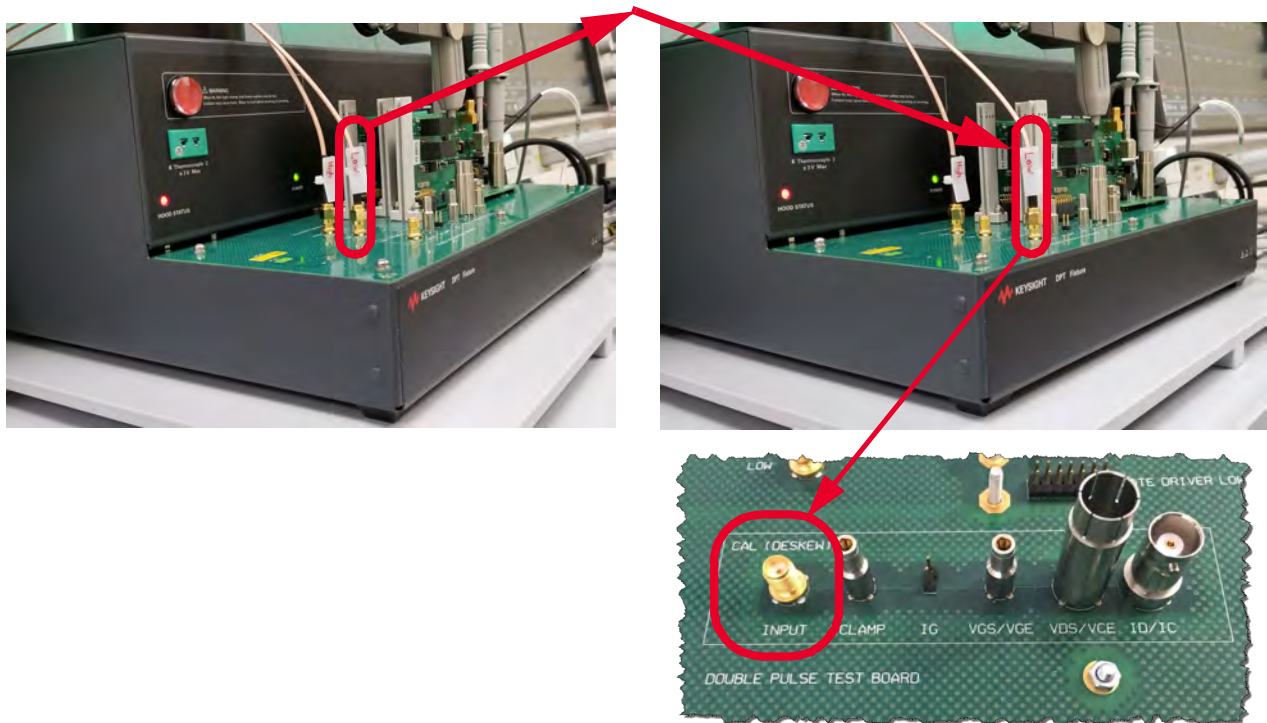


Figure 19 33512B Function Generator Connected to Deskew Fixture

3 Connect the oscilloscope probes to the Deskew section of the Test Fixture.

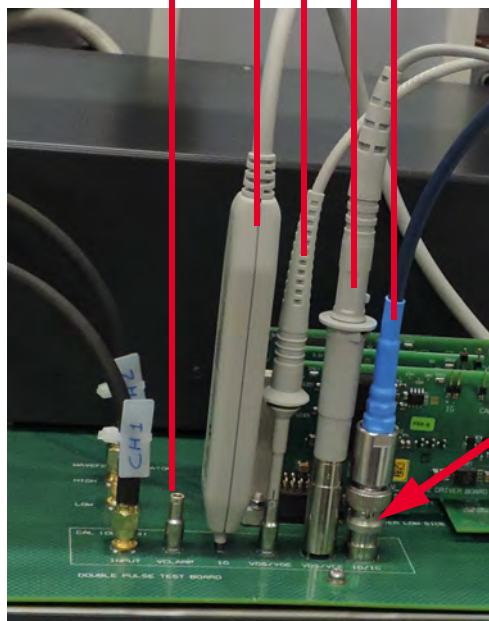
The N2873A V_{CLAMP} Probe would connect here for Deskew instead of the N2819A Differential Probe

N2819A I_G Differential Probe

N2873A V_{GS}/V_{GE} Probe

10076A High Voltage V_{DS}/V_{CE} Probe

I_D/I_C (PD1000-60002) Probe Cable



The BNC connector (I_D/I_C) on the far right is for the PD1000-60002 Oscilloscope Protection probe cable that would normally connect to the Coaxial Shunt Resistor on the DUT Test Module.

Figure 20 Oscilloscope Probes Connected to Deskew Fixture

NOTE

IMPORTANT: The N2918A Differential Probe must face to the left; the Keysight logo must face toward the V_{CLAMP} probe connector.

Procedure:

- 1 After setting up the oscilloscope probes in the Deskew fixture, click **Start** to perform Deskew calibration.
- 2 When complete, return the oscilloscope probes to the appropriate connectors on the DUT and Test Modules.
- 3 Return the SMA cable from the **Cal (Deskew) Input** SMA connector to the **Low Side** SMA connector on the Test Fixture.

CAUTION

IMPORTANT: After calibration and before running any Double-Pulse Test, make certain the Low-Side Gate Drive Modules have the V/NC jumper installed and the I/NO jumper removed. Remove all cables from the B2902 SMU.

Initializing PD1000-66848 and -66849 Modules for Calibration

The initialization procedure is very similar for both Common-Path and Split-Path configured modules. the following example shows the Split-Path initialization.

Only the Keysight PD1000-66848 Low-Side and PD1000-66849 High-Side gate drive modules can be configured with split-path gate resistors (R_G). The module is considered 'blank' until initialized. Additional calibration steps are necessary to calibrate the off-path.

Initialization of the module, for split-path configuration has a sequence of requests for the Low-Side Gate Drive Module only (PD1000-66848)! The High-Side Gate Drive Module is initialized with the same nominal values. The following example sequence configures with $R_{G,ON} = 5\ \Omega$, $R_{G,SHARED} = 5\ \Omega$, $R_{G,OFF} = 8.0\ \Omega$.

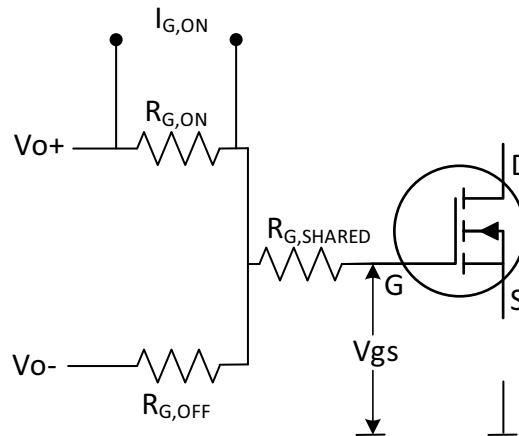


Figure 21 Split-Path Gate Resistors

For this example:

$$\text{Nominal On-Resistance} = R_{G,ON} + R_{G,SHARED} = 5 + 5 = 10\ \Omega$$

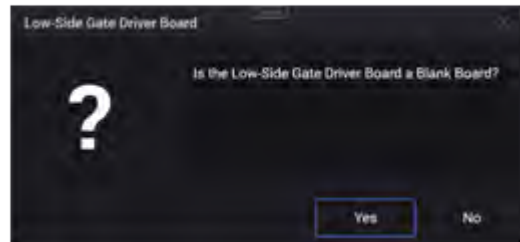
$$\text{Nominal Shunt-Resistance} = R_{G,ON} = 5\ \Omega$$

$$\text{Nominal Off-Resistance} = R_{G,OFF} + R_{G,SHARED} = 8 + 5 = 13\ \Omega$$

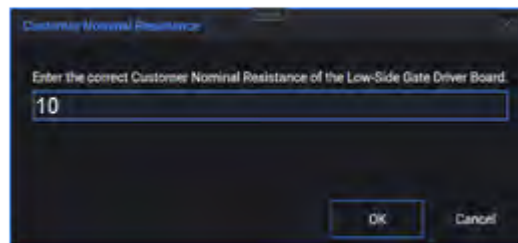
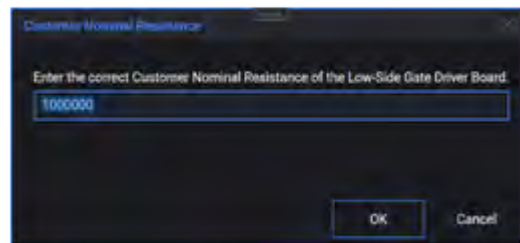
NOTE

$R_{G,ON}$ and $R_{G,SHARED}$ gate drive resistors should be the same value. The resistors are in series and form the complete gate drive resistor. For example, if both resistors are $25\ \Omega$, the total gate drive resistor value is $50\ \Omega$. $R_{G,OFF}$ may be a different value.

Initialize New Data EEPROMs for Split-Path Gate Drive Module

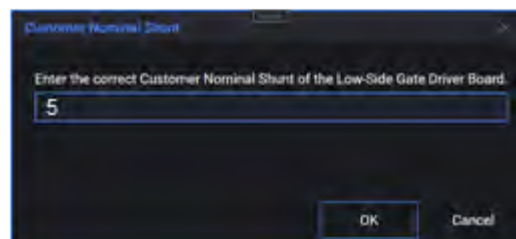
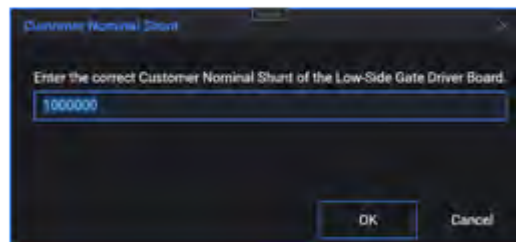


If the module is a blank board (has never been initialized), click **Yes**. If it has been initialized before, click **No**.



Enter the Nominal On-Resistance Value. In our example, enter **10**.

Click **Ok**.

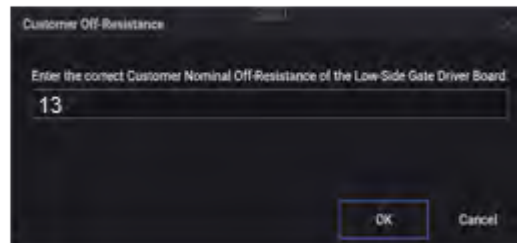


Enter the Nominal Shunt Value. In our example, enter **5**.

Click **Ok**.



If the gate drive module is configured with Split-Path gate resistors, click **Yes**. If it is configured a a Single- or Common-path, click **NO**.



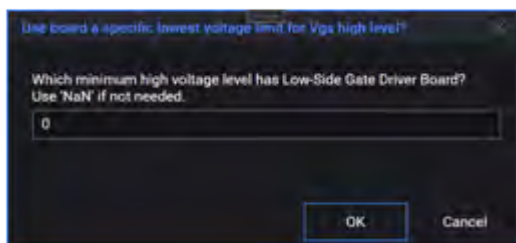
Enter the Nominal Off-Resistance Value. In our example, enter *13*.

Click **Ok**.



For maximum high voltage level, use the predefined value (28).

Click **Ok**.



For minimum high voltage level, use the predefined value (0).

Click **Ok**.



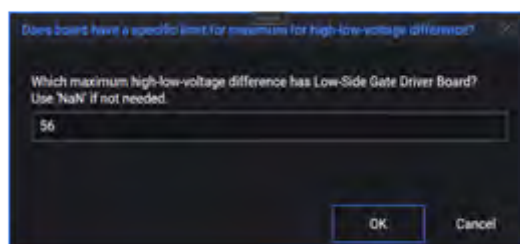
For maximum low voltage level, use the predefined value (0).

Click **Ok**.



For minimum low voltage level, use the predefined value (-28).

Click **Ok**.



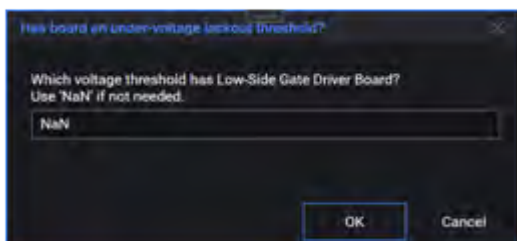
For maximum high-low voltage difference, use the predefined value (56).

Click **Ok**.



For minimum high-low voltage difference, use the predefined value (1).

Click **Ok**.



For the voltage threshold of the Low-Side Gate Drive module, use the predefined value (NaN).

Click **Ok**.

The module is now initialized and ready for complete Calibration.

EEPROM Values for Split-Path Gate Drive Modules

If a Low-Side gate drive board is configured with split-path output , there are the additional fields *Customer Nominal Off Resistance* and *Customer Actual Off Resistance*.

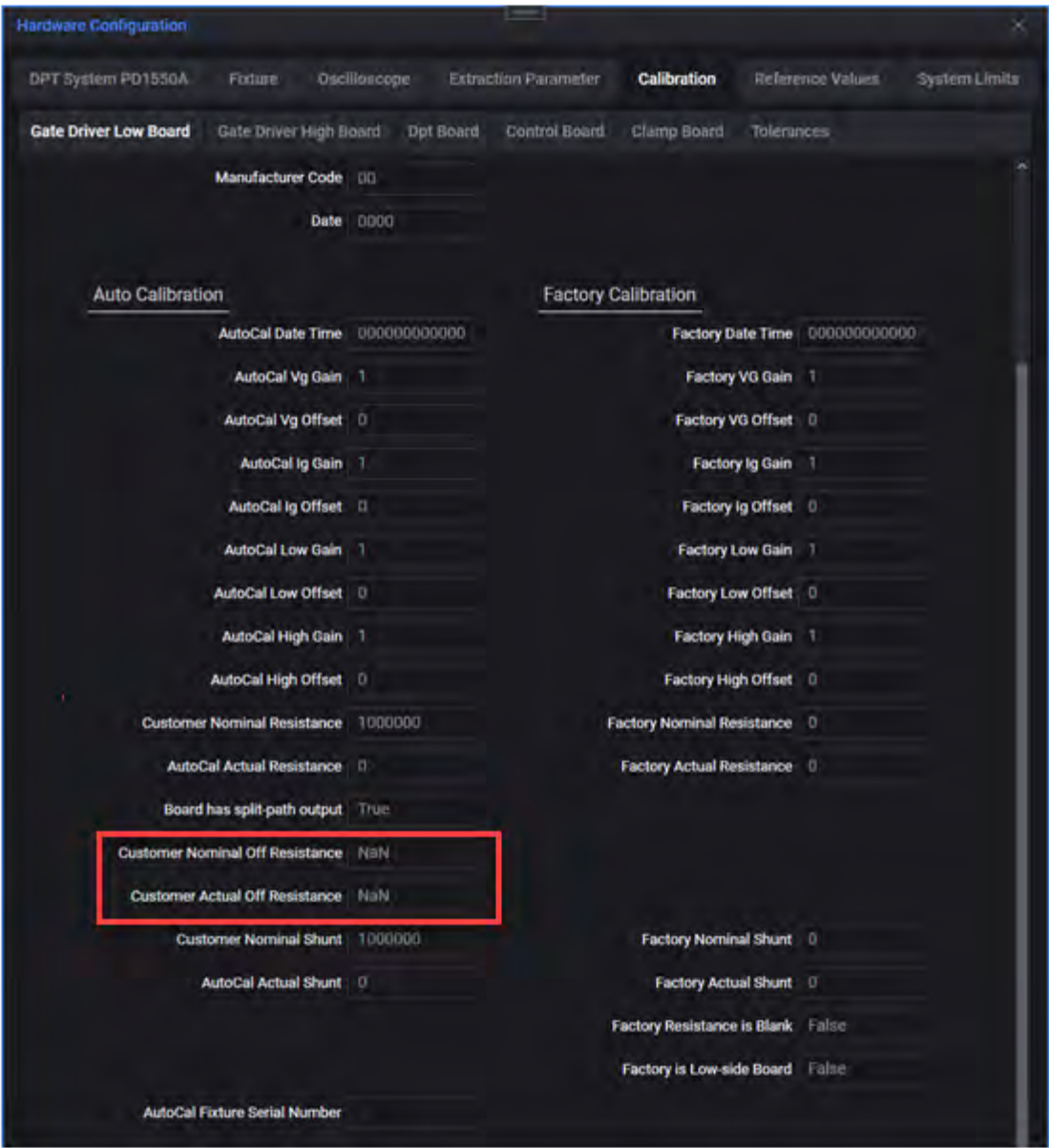


Figure 22 EEPROM Values for Split-Path Gate Drive Module

Nominal values will be input manually; actual values are measured during calibration process.

Coaxial Shunt Resistor Characterization

There is no separate calibration for the PD1000-61901 10 m Ω and the PD1000-61902 100 m Ω Coaxial Shunt Resistors. The De-embedding characterization file installed in the DSOS104 Oscilloscope provides the necessary accuracy.

NOTE

The PD1000-61901 Coaxial Shunt Resistor should be removed from the DUT Test Module and shipped to a Keysight Service Center for characterization. This should be done annually.

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 DSOS104 oscilloscope.

Install the De-Embedding Transfer File on the DSOS104 Oscilloscope

- 1 From the temporary location where you unzipped the de-embedding file, copy the .tf2 file to the DSOS104 Oscilloscope. Place it in the folder:
`C:\Users\Public\Documents\Infiniium\Filters`.

NOTE

On the DSOS104 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 PD1500A systems, the de-embedding file was installed in the DSOS104 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 ID/IC** in the DPT Control Software Hardware Configuration screen is the channel that the Coaxial Shunt De-embedding is applied to.

A Simplified System Diagrams and Schematics

This appendix shows simplified wiring diagrams for the DPT system.

In this Chapter:

Basic AC Power and LAN Wiring for the DPT Instruments in the Rack [page 98](#)

DPT System Wiring Simplified Diagram [page 99](#)

Connect Probes to DSOS104A or MXR108A Oscilloscope [page 100](#)

Simplified DPT Test Schematic [page 102](#)

Simplified Reverse Recovery Test Schematic [page 103](#)

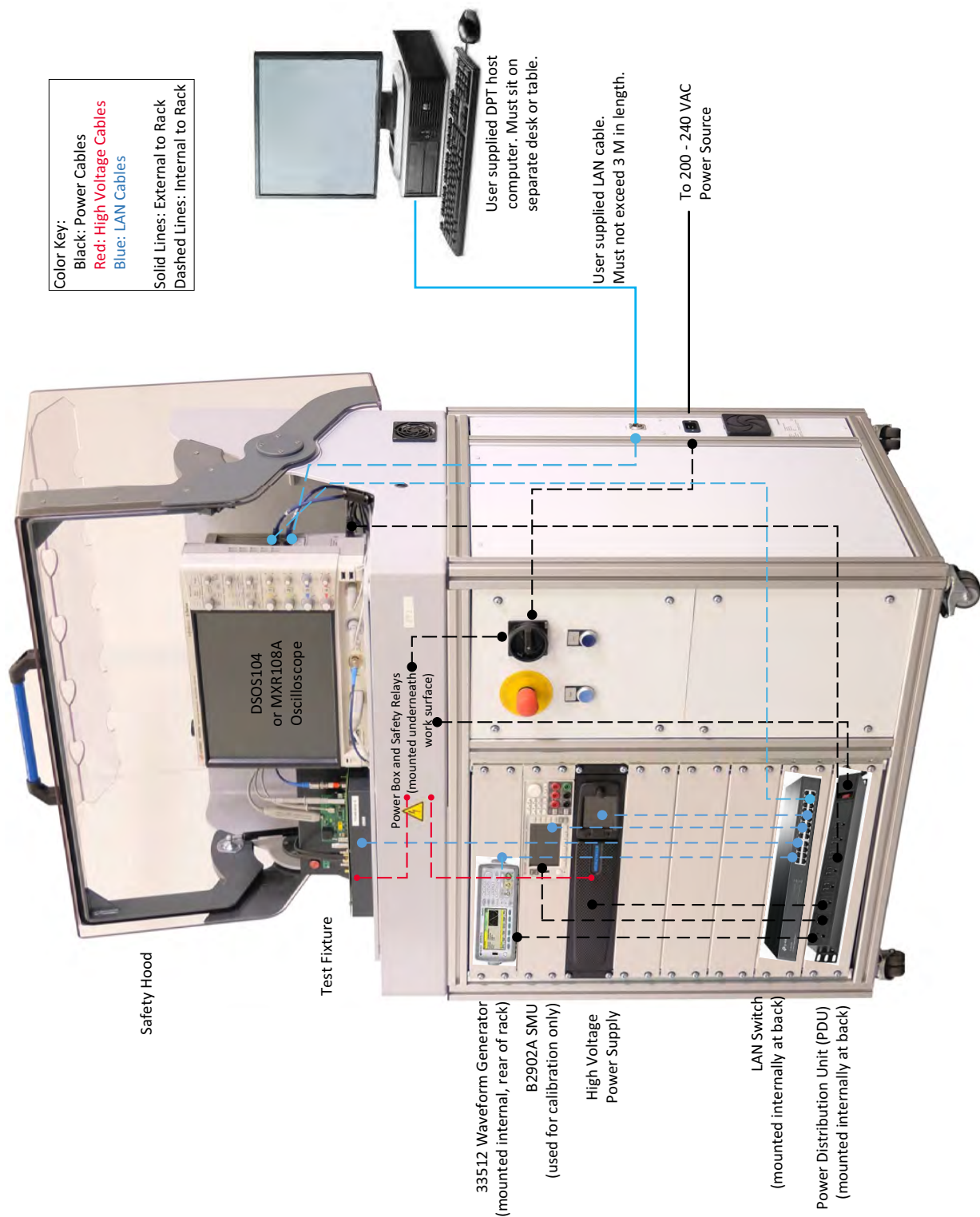


Figure 1 Basic AC Power and LAN Wiring for the DPT Instruments in the Rack



Figure 2 DPT System Wiring Simplified Diagram

Connect Probes to DSOS104A or MXR108A Oscilloscope

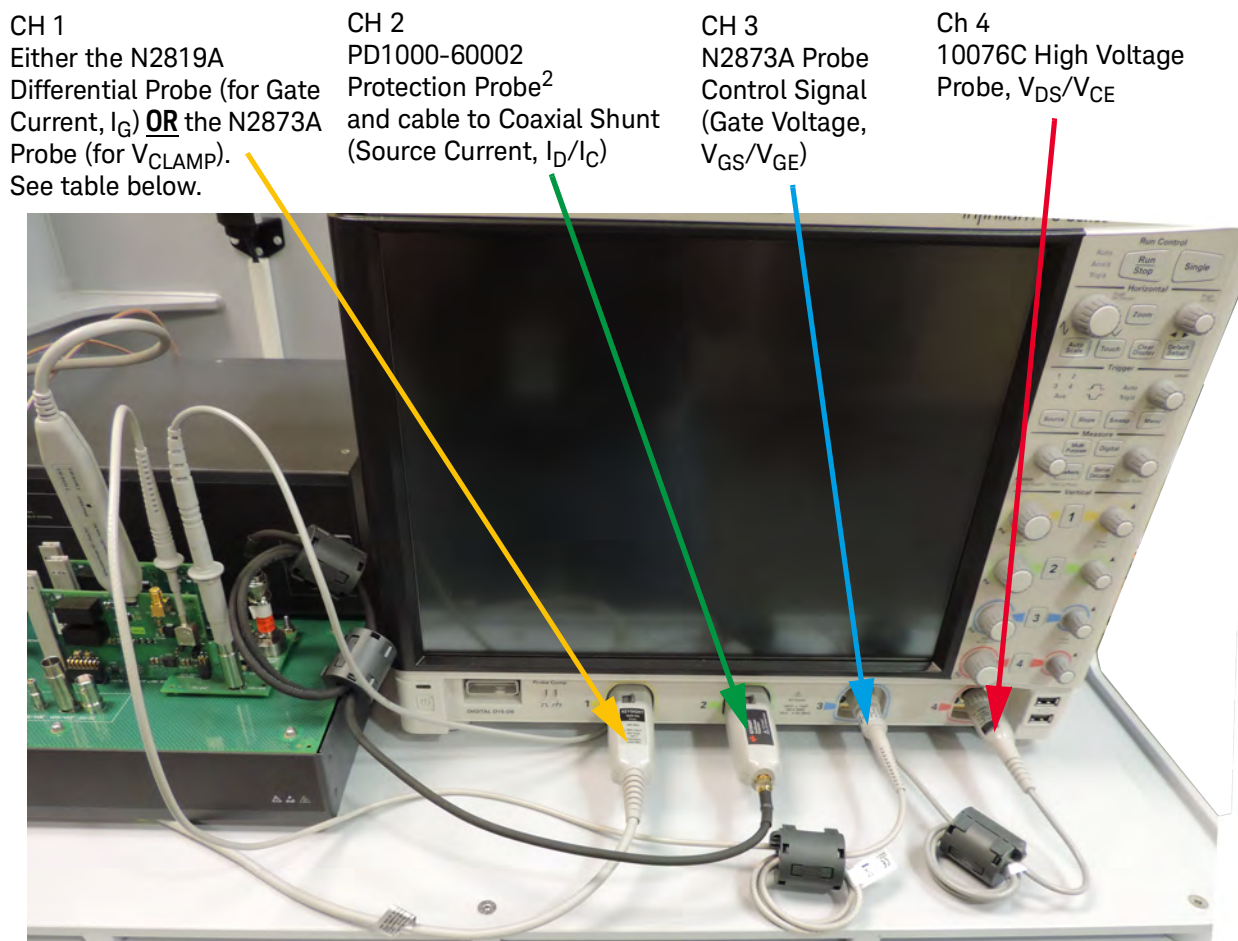


Figure 3 Oscilloscope Probe Connections (DSOS104A shown)

Oscilloscope Channel	Color	Oscilloscope Probe	Used to Measure	Connects to Test Module
1 ¹	Yellow	N2819A Differential Probe	Gate Current, I_G	Gate Driver Module
		Standard N2873A Probe	Clamp voltage, V_{CLAMP}	Clamp Module
2	Green	PD1000-60002 Protection Probe and cable to Coaxial Shunt ²	Source Current, I_D/I_C	Coaxial Shunt on DUT Module
3	Blue	Standard N2873A Probe	Gate Voltage, V_{GS}/V_{GE}	Gate Driver Module
4	Red	High Voltage 10076C Probe	Drain/Collector Voltage, V_{DS}/V_{CE}	DUT Module

¹ Only one of these two probes should be used in a DPT test. The N2819A Differential Probe is used when measuring Gate Current and Gate Charge. The standard N2873A probe is used with the Clamp Test Module to measure V_{CLAMP} .

² Use the 0.56 N-m (5 lb-in) 5/16 in. SMA Break-over torque wrench (provided with the PD1500A 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.

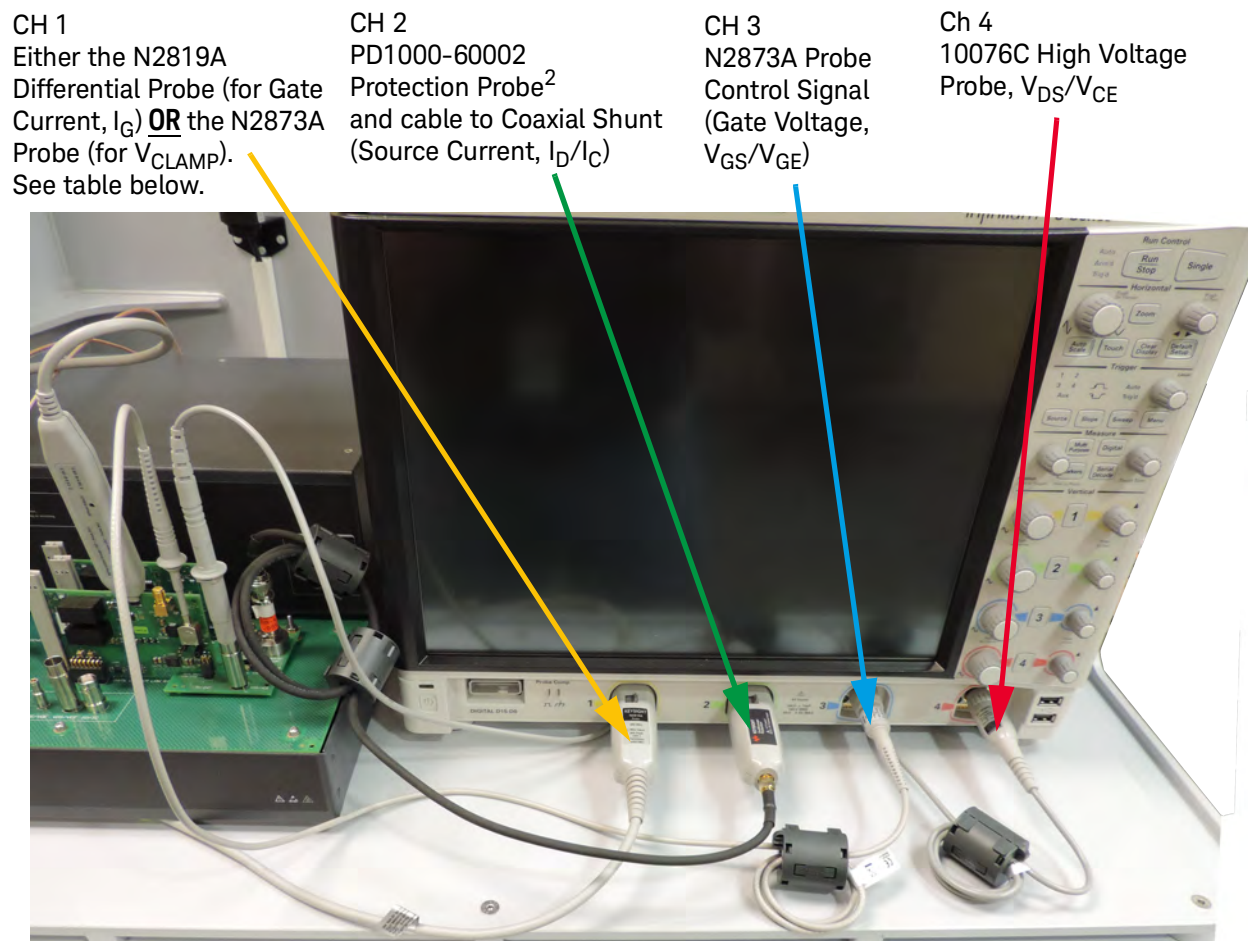


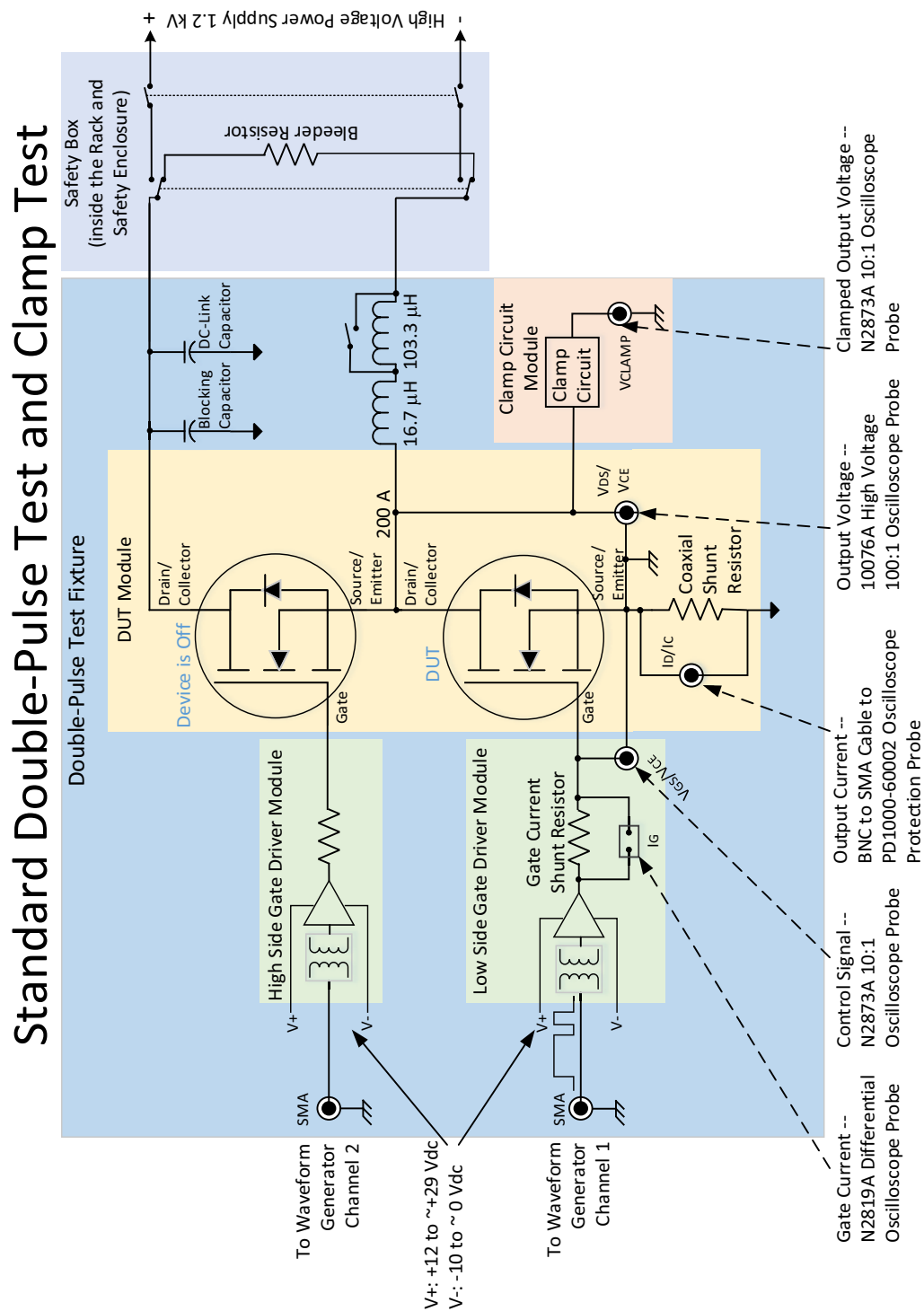
Figure 4 Oscilloscope Probe Connections (MXR108A shown)

Oscilloscope Channel	Color	Oscilloscope Probe	Used to Measure	Connects to Test Module
1 ¹	Yellow	N2819A Differential Probe	Gate Current, I_G	Gate Driver Module
		Standard N2873A Probe	Clamp voltage, V_{CLAMP}	Clamp Module
2	Green	PD1000-60002 Protection Probe and cable to Coaxial Shunt ²	Source Current, I_D/I_C	Coaxial Shunt on DUT Module
3	Blue	Standard N2873A Probe	Gate Voltage, V_{GS}/V_{GE}	Gate Driver Module
4	Red	High Voltage 10076C Probe	Drain/Collector Voltage, V_{DS}/V_{CE}	DUT Module

1 Only one of these two probes should be used in a DPT test. The N2819A Differential Probe is used when measuring Gate Current and Gate Charge. The standard N2873A probe is used with the Clamp Test Module to measure V_{CLAMP} .

2 Use the 0.56 N-m (5 lb-in) 5/16 in. SMA Break-over torque wrench (provided with the PD1500A 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.

Simplified DPT Test Schematics

**Figure 5** Simplified DPT Test Schematic

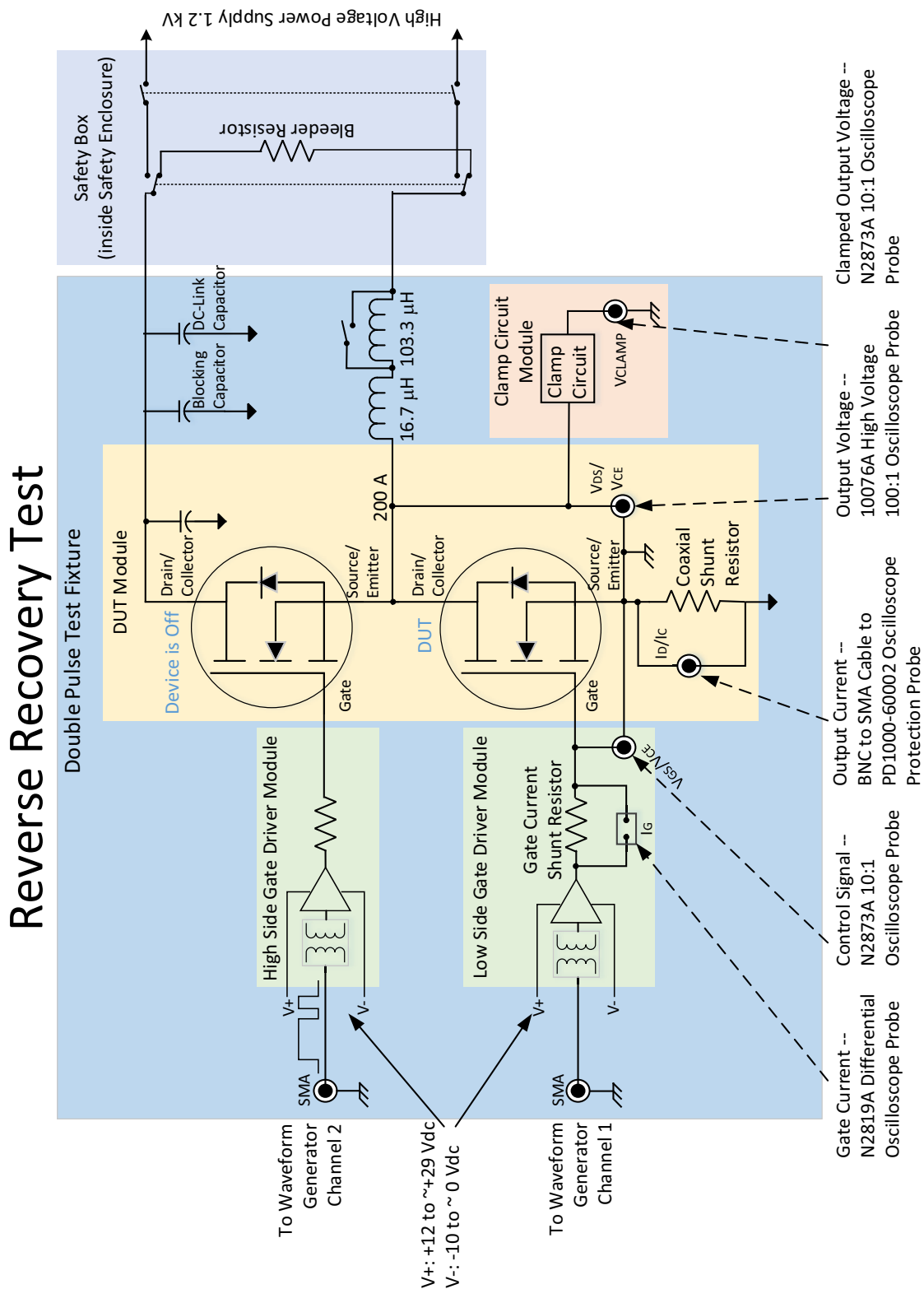


Figure 6 Simplified Reverse Recovery Test Schematic

B SMA Connectors

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 PD1500A Accessory Kit.



Figure 7 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.

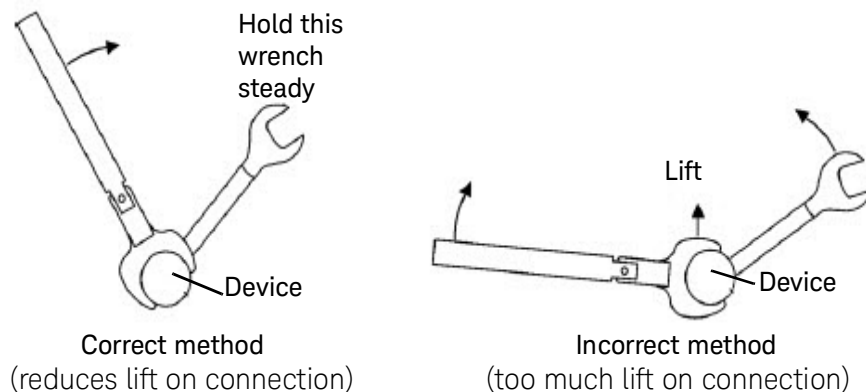


Figure 8 Wrench Positions

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

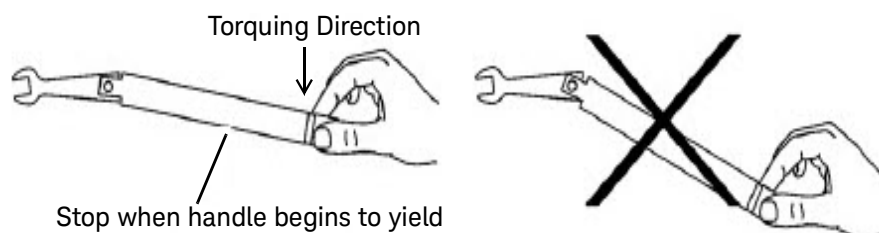


Figure 9 Using the Torque Wrench

- 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.



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