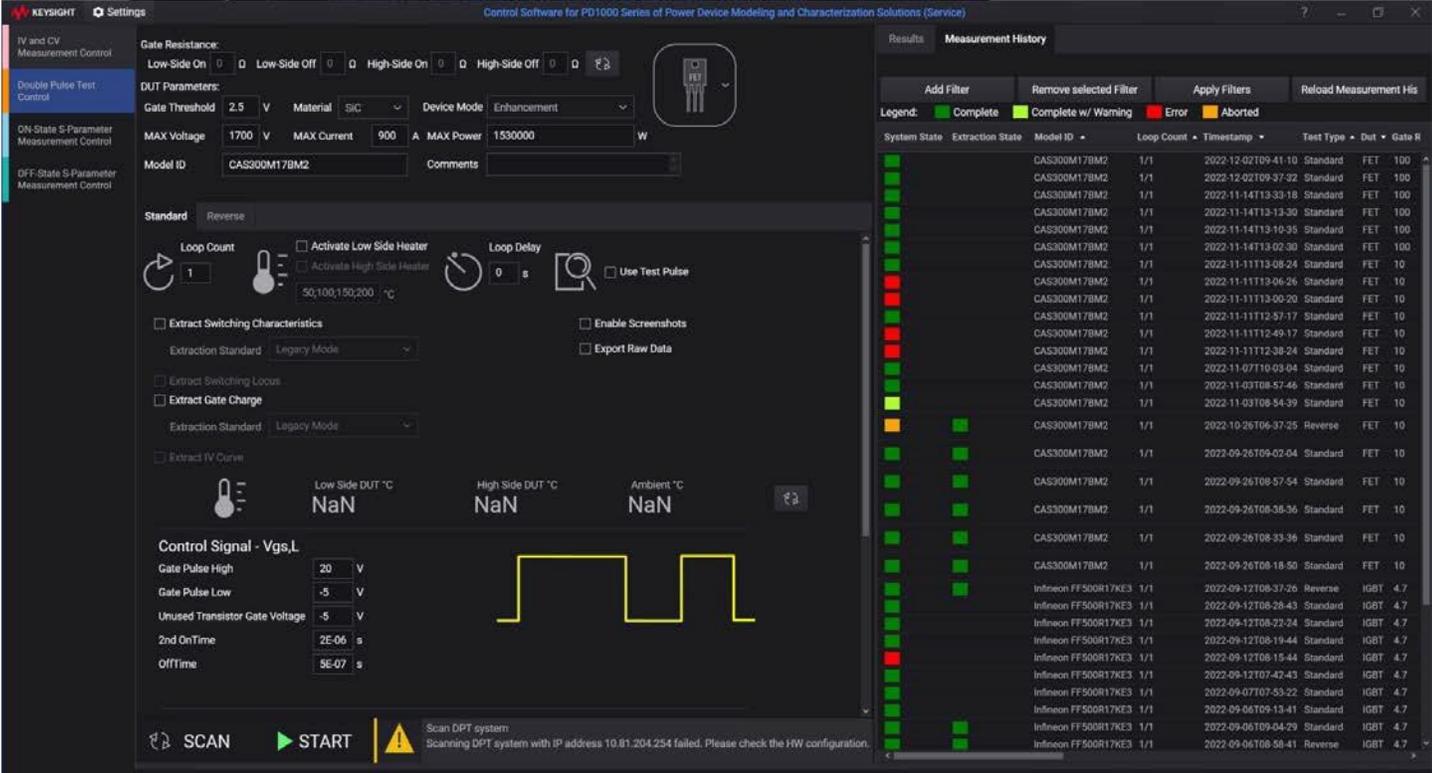


PD1550A Advanced Dynamic Power Device Analyzer

Control Software Guide



Provides detailed information to configure and use the PD1000A Control Software for PD1550A Double-Pulse Test characterization measurements. Manual applies to PD1000A Control Software version 2023.324 and later.

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Sales and Technical Support

To contact Keysight for sales and technical support, refer to the support links on the following Keysight websites:

www.keysight.com/find/PD1500A

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

www.keysight.com/find/assist (world-wide contact information for repair and service)

Declaration of Conformity

Declarations of Conformity for this product and for other Keysight products may be downloaded from the Web. Go to <http://keysight.com/go/conformity> and click on “Declarations of Conformity.” You can then search by product number to find the latest Declaration of Conformity.

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Safety Information

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

General

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

Before Applying Power

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

Ground the Instrument

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

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

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

Do Not Operate Near Flammable Liquids

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

Cleaning

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

Do Not Remove Instrument Cover

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

Keep away from live circuits

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

DO NOT operate damaged equipment

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

DO NOT block the primary disconnect

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

Do Not Modify the Instrument

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

In Case of Damage

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

Measurement Limits

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

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

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

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

Safety and Regulatory Symbols

CAUTION

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

WARNING

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

Products display the following:



CAUTION. Refer to documentation for safety information.



Earth Ground.



Chassis Ground.



Alternating Current (AC).



Direct Current (DC).



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



Indicates that antistatic precautions should be taken.



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



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



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



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



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



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



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



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



R-R-Kst-SP21786

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

A 급 기기 (업무용 방송통신기자재) 이 기기는 업무용 (A 급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라 며 , 가정외의 지역에서 사용하는 것을 목적으로 합니다.



Waste Electrical and Electronic Equipment (WEEE)

The crossed-out wheeled bin symbol indicates that separate collection for Waste Electrical 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 [keysight.com/go/takeback](https://www.keysight.com/go/takeback) über Ihre Rücknahmehoptionen 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.

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

Italian

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

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

Spanish

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

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

Safety Summary

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

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

WARNING



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

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

CAUTION

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

NOTE

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

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

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

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

DANGEROUS PROCEDURE WARNINGS

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

BEFORE APPLYING POWER

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

GROUND THE RACK

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

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

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

DO NOT REMOVE COVERS

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

IN CASE OF DAMAGE

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

USE ONLY THE SPECIFIC ACCESSORIES

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

CLEANING

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

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1 Introduction

This guide provides complete software configuration and operation information for the *PD1550A Dynamic Power Device Analyzer/Double Pulse Tester* (or DPT System) Control Software. Refer to the *PD1000A Control Software Help* file for additional information regarding using the other features of the Control Software.

In this chapter:

- Test Equipment and Accessories Used in the PD1550A [page 16](#)
- PD1550A Double-Pulse Test Documentation [page 23](#)
- Host Computer System Requirements [page 24](#)
- System Installation and Support [page 24](#)

NOTE

The PD1500A/PD1550A Double-Pulse Test software is one part of the PD1000A Power Device Measurement System for Advanced Modeling Control Software.

IMPORTANT: This version of the Software Guide applies to and describes features present in PD1000A Control Software version 2022.324 and later. Refer to the software **Settings > About** for the software version.

WARNING

Never attempt to disable, bypass or obstruct the safety latches on the front or rear doors or any of the safety switches. High voltage and current are present when running a Double-Pulse or Reverse Recovery test.

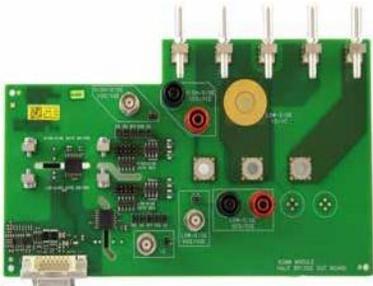
Test Equipment and Accessories Used in the PD1550A

The PD1550A Double-Pulse Test Solution includes several test instruments. These test instruments were installed at the Keysight factory.

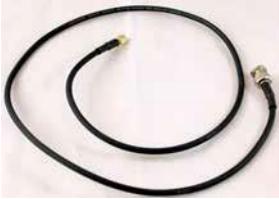
Your shipment should include the following:

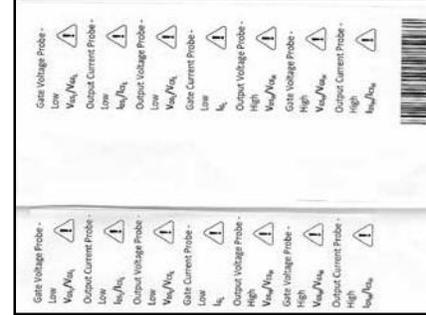
- PD1550A DPT Rack and Safety Enclosure (the following test instruments are pre-installed in the PD1550A system rack):
 - Keysight MXR108A 8-Channel Oscilloscope
 - Keysight 33512B Waveform Generator
 - Keysight B2902B Precision Source/Measurement Unit
 - Heinzinger EVO High Voltage Power Supply, (PD1080A-FG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

Accessories included with the PD1550A

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

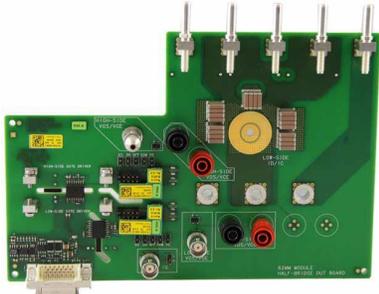
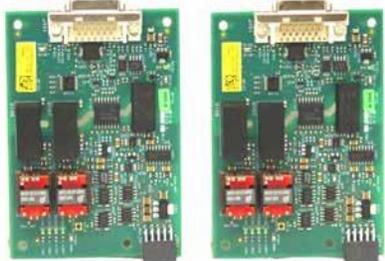
Description and Keysight Part Number	Quantity	Graphic
1854-2245 62 mm IGBT Half-Bridge Test Module (Infineon FF500R17KE4 or equivalent)	1	
1855-3111 62 mm MOSFET Half-Bridge Test Module (CREE [Wolfspeed] CAS300M17BM2 or equivalent)	1	
PD1550-61901 0.05 Ω (50 mΩ) Shunt , (PD1072A-FG for repair and Cal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

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

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

PD1550A Accessories (not included)

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

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

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

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

Optional (not required) PD1550A Accessories

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

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

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

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

PD1550A Double-Pulse Test Documentation

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

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

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

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

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

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

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

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

www.Heinzinger.com High Voltage Power Supply Model EVO

NOTE

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

Host Computer System Requirements

Table 1 Host Controller Hardware and Software Requirements

Operating System	Requirement
OS versions:	Windows 10, 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.	

System Installation and Support

The PD1550A system should be installed by a qualified Keysight Application Engineer. Contact your local Keysight Sales and Service office for information regarding the installation. Refer to the individual instrument documentation and help files provided with your system for warranty and support information. Hardware support (repairs and calibration) is provided separately for each of the individual test instruments in the system.

NOTE

In general, you should turn off the PD1550A system when it will not be used for long periods of time. This prevents a problem with the Heinzinger HV power supply. If the system has been left on and cannot communicate with the HV power supply, do the following:

1. Shut down the PD1550A DPT system.
2. Disconnect the PD1550A from the ac power socket.
3. Wait a few minutes.
4. Reconnect the PD1550A system to the ac power socket.
5. Turn on the PD1550A DPT system.

2 Software Installation

In this Chapter:

Install Software on Host PC [page 26](#)

Install Keysight IO Libraries Suite on your Host PC [page 26](#)

Download PD1000A Control Software [page 26](#)

Software Licensing [page 27](#)

NOTE

Keysight IO Libraries is required to configure and control the system test instruments from the PD1000A Control Software. It is free software and available at: www.keysight.com/find/iosuite

Install Software on Host PC

To communicate with the PD1550A test equipment, Keysight I/O Libraries Suite must 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 Keysight IO Libraries Suite on your Host PC

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

Download PD1000A Control Software

PD1000A Control Software for PD1000 Series of Power Device Modeling and Characterization Solutions. This is the software that controls the test equipment to make the characterization measurements. The PD1000A Control Software may be downloaded from Keysight at any time. Download the software from either of the following websites: www.keysight.com/find/PD1000A or www.keysight.com/find/PD1550A.

Refer to the *PD1000A Control Software* help file for detailed information on using the PD1550A Control Software.

NOTE

The PD1550A Double-Pulse Test software is part of the *PD1000A Control Software for PD1000 Series of Power Device Modeling and Characterization Solutions*. Install **PD1000A Control Software Version 2023-04-04 (2023.324, or later)** to control the PD1550A DPT hardware.

Software Licensing

Software licenses are required for the following PD1000A/PD1550A features:

License ID	Description	Notes
PD1010B	PD1000A On-State/Off-State S-Parameter Test	Replaces the PD1010A. Not required for PD1500A or PD1550A Double-Pule Test.
PD1020A with Infiniium On-line	Double-Pulse Test Control	Required for PD1500A or PD1550A Double-Pule Test. 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 Offline Mode Requires the 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.
D9010BSEO	Infiniium Offline - Base Software	Requires PD1021A License
PD1030A	Required for testing GaN devices.	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 and GaN selected in the device drop-down menu.

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 PCSENO 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/PD1550A.

3 Set-up the Double-Pulse Test

In this Chapter:

Test Circuit Diagrams [page 29](#)

Connect Probes to Oscilloscope [page 30](#)

Connect Probes for High-Side DUT Measurements [page 35](#)

For detailed information on using the PD1550A Double-Pulse Test Rack and Safety Enclosure, refer to the *PD1550A Test Rack and Safety Enclosure Operation Guide*.

Test Circuit Diagrams

The following simplified schematics illustrate the overall PD1500A Double-Pulse Test (DPT) test procedure and the oscilloscope probe connection points. The names used on the oscilloscope connection points match the names used in the *DPT Control Software Hardware Configuration* setup dialog.

The internal inductor is selected automatically based on device test current and voltage specified for the test. If the specified Drain Source current (I_{DS}) is less than or equal to $(1.2 \times \text{Applied Voltage})$ then the selected inductance is 25 μH . If the current is greater than $(0.2167 \times \text{Applied Voltage})$ then the selected inductance is 600 μH . Otherwise, the selected inductance is 100 μH .

When charging the inductor during the first pulse, the voltage across the DC-Link capacitor drops slightly. This is known as the “Droop.” For currents up to 100 A, there is enough energy stored in the capacitor so that the voltage drops no more than 5%. For currents up to 200 A the drop may be as large as 10%.

Connect Probes to Oscilloscope

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

CH 1
PD0031A Probe (or
PMK PD1802A
Probe) for Low-Side
Gate Current, $I_{G,L}$

CH 2
PD1000-60002
Protection Probe²
and cable to Coaxial Shunt
(Source Current, $I_{D,L}/I_{C,L}$)

CH 3
PD0031A Probe (or
PMK PD1802A Probe)
for Low-Side Gate
Voltage, $V_{GS,L}/V_{GE,L}$

Ch 4
PD0001A Probe for
Low-Side Output Voltage,
 $V_{DS,L}/V_{CE,L}$



Ch 5
Optional. PD0001A Probe
for High-Side Output
Voltage, $V_{DS,H}/V_{CE,H}$

Ch 6
Do **not** connect
oscilloscope probe.
Reserved for $V_{GS,H}/V_{GE,H}$
from Isolated Probe Unit.
See below and PD1550A
Software User Guide.

Ch 7
Do **not** connect
oscilloscope probe.
Reserved for $I_{D,H}/I_{C,H}$
measurements. See
below and PD1550A
Software User Guide.

Ch 8
Not Used. Reserved
for future use.

Figure 1 PD1550A Oscilloscope Probe Connections

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

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

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

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

NOTE

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

NOTE

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

CAUTION

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

CAUTION

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

CAUTION

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

Connect Oscilloscope Probes to DUT Interface Module

NOTE

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

Refer to Figure 2 below. Oscilloscope probes connect to the Test Interface Module as follows:

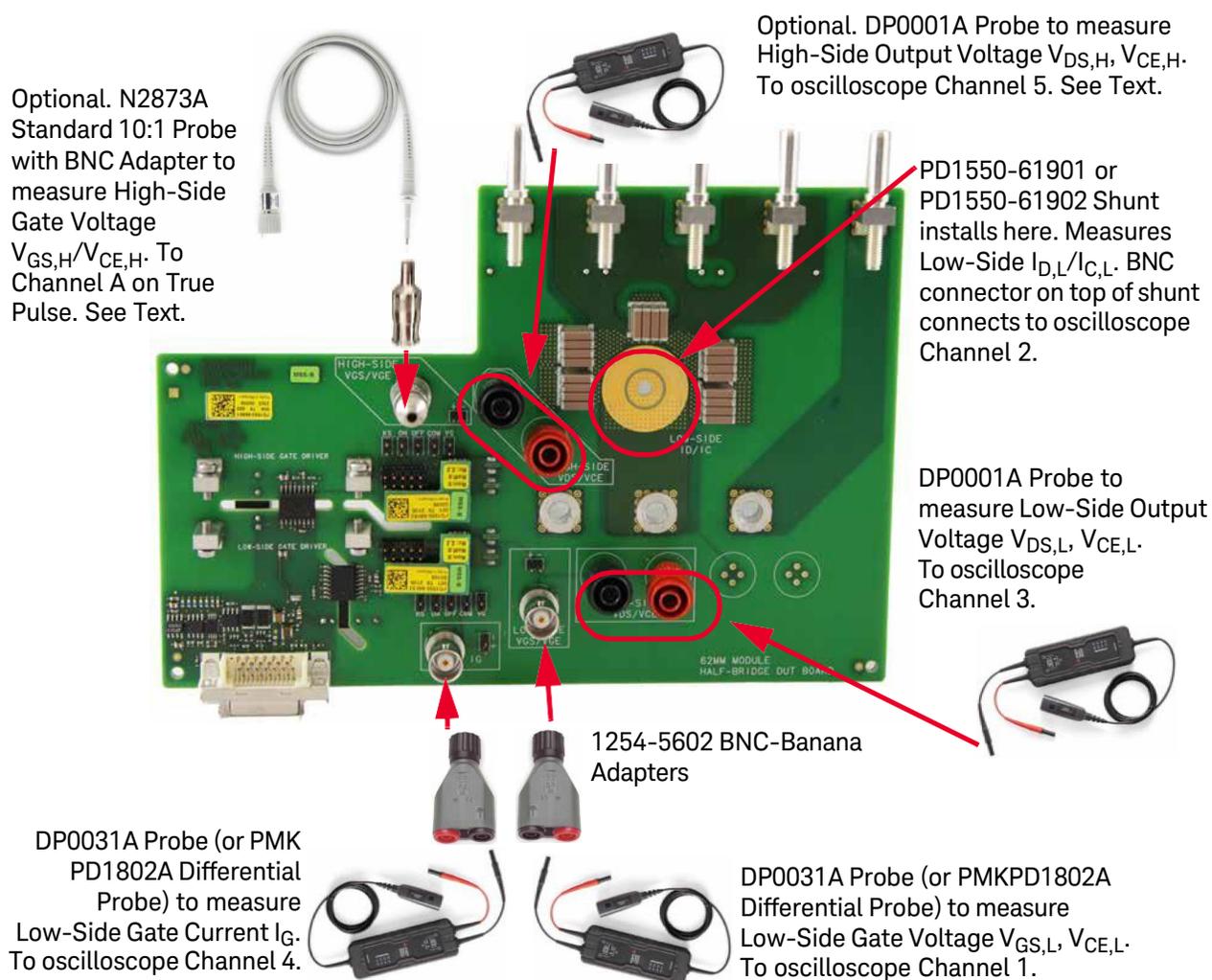


Figure 2 Oscilloscope Probe Connections to 62 mm Interface Module

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

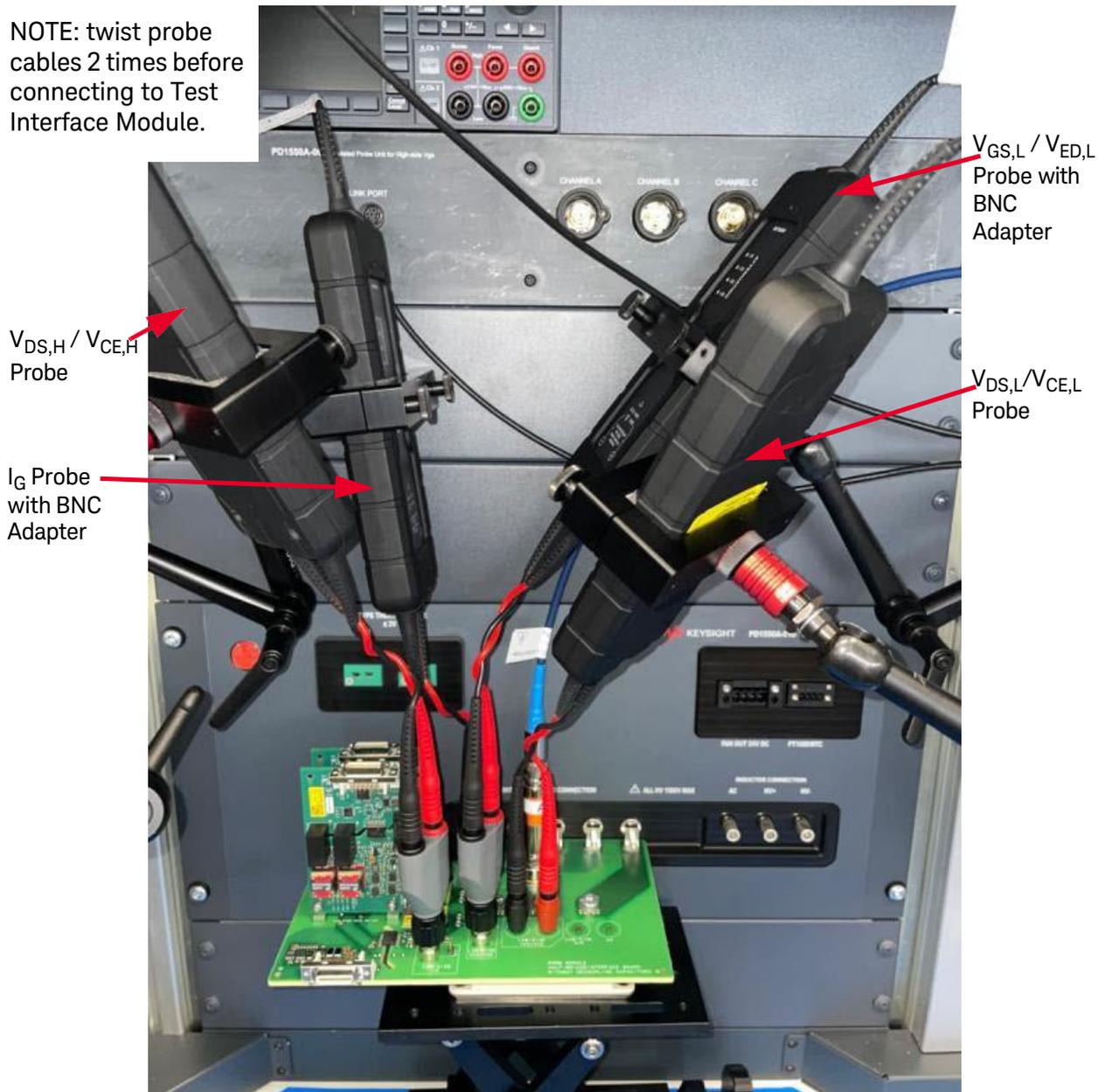


Figure 3 Connect Probes to Test Interface Module

Connect Probes for High-Side DUT Measurements

High-Side Gate Voltage

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

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

High-Side Drain/Collector Current

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

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



Figure 4 N2873A Probe to High-Side Gate Voltage $V_{GS,H}/V_{CE,H}$. and Channel A on True Pulse

Keysight Isolated Probe Unit

NOTE

The Link Port on the Keysight Isolated Probe Unit is not used. All green LEDs next to individual channels should be green. There is also a green power LED and a red LED that indicates a trigger has occurred.

4 Double-Pulse Test Device Characterization Tests

In this Chapter:

Testing GaN Devices	page 37
Settings in the PD1000A Control Software	page 39
Global Settings	page 39
Hardware Configuration for Double-Pulse Test Control	page 41
Fixture Tab	page 44
Oscilloscope Tab	page 46
Measurement Preparation – Calibration & Compensation	page 49
Oscilloscope Probe Compensation	page 49
PD1550A System Calibration	page 49
Standard Double-Pulse Characterization Test	page 50
Reverse Recovery Test	page 51
Set Double-Pulse Test Parameters	page 52
Run the Characterization Test	page 62
Results Tab	page 64
Measurement History Tab	page 65
Frequently Asked Questions	page 69

Testing GaN Devices

This chapter is primarily concerned with testing Si or SiC devices using the standard PD1550A-010 Test Fixture and standard Interface Modules. If you will be testing GaN devices, either HEMT, GIT or Cascode, contact your local Keysight Application Engineer for help in designing a customized test board for the PD1550A Test Solution.

NOTE

A software license is required to use the PD1000A software to test GaN devices on the PD1550A Test Solution.

Obtain Oscilloscope IP 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.

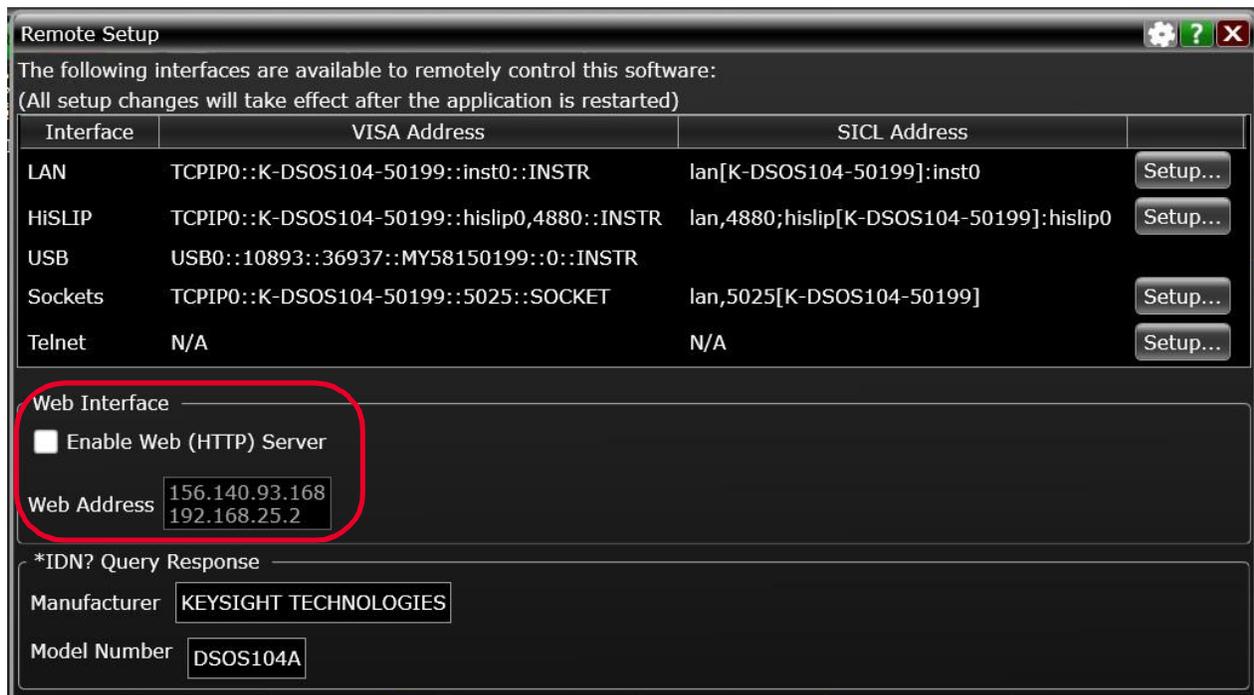


Figure 5 Remote Setup -- Web Interface

- 3 Locate the **Web Interface** field. In the example screen capture 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 Record this address, it will be used later during the Hardware Setup.

Settings in the PD1000A Control Software

- 1 From the Host PC's Windows **Start** button, select:
Keysight > Keysight PD1000A Control.
- 2 In the PD1000A Control Software, select **Double-Pulse Test Control.**

NOTE

IMPORTANT. VISA addresses for all of the Double-Pulse Test test instruments (Oscilloscope, Waveform Generator, Test Fixture, etc.) must be established before configuring or running DPT tests.

Click on the **Settings** icon at the top of the screen.

Global Settings

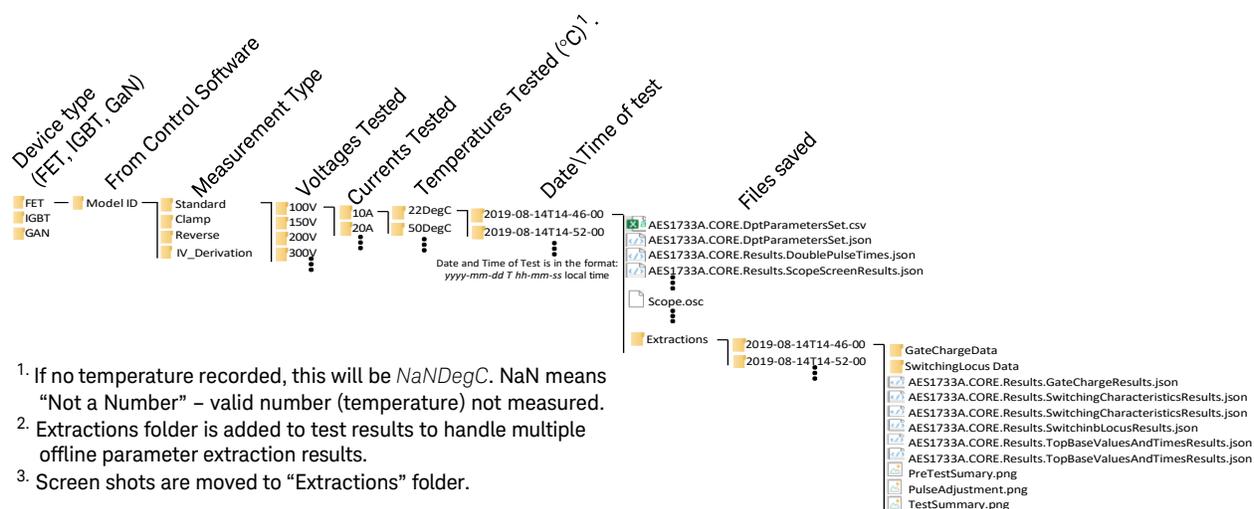
This opens the **Global Settings** dialog.

- **Debug Mode:** Check this box to cause the system to send a SCPI *SYST:ERR?* command after each command to identify any errors in the system measurements. Use the **IO Monitor** utility in the IO Libraries Suite to monitor communication between the host PC and the DPT system test instruments and to view the error messages. Uncheck the box for best speed.
- **Output Directory:** Enter the complete file path for where you want to save the measured data. For example:
C:\Users\PD1550A\DPT_Tests\....

Characterization data is saved with the following folder structure:

Device > Model ID > Meas. Type > Voltages Tested > Currents Tested > Temperatures Tested > Date\Time > Test Data Files

For example:



Hardware Configuration for PD1550A Double-Pulse Test Control

Allows you to specify instrument connections, probe setup, shunt settings and more. This menu has three tabs:

- **DPT System PD1550A:** See “Hardware Configuration for Double-Pulse Test Control” on page 41.
- **Fixture:** See “Fixture Tab” on page 44.
- **Oscilloscope:** Use this tab to configure probe connections and other oscilloscope options. See “Oscilloscope Tab” on page 46.

Load Settings from File

Opens a Windows Explorer dialog to the folder specified in **Global Settings > Output Directory**. This allows you to reload saved DPT test settings into the software.

Save Settings to File

Opens a Windows Explorer dialog to the folder specified in **Global Settings > Output Directory**. Settings files are saved as .kts files.

Firmware Update

The Control (PD1550-020) and Safety (PD1550-030) Units have internal firmware that may need to be updated periodically. See “Update PD1550A Test Fixture Firmware” on page 93.

Calibration & Compensation

Runs the complete DPT system calibration procedure. Refer to “[Double-Pulse Test Calibration for Si/SiC Modules,](#)” starting on page 85 or the *PD1000A Control Software Help File* for additional information.

Show Oscilloscope Screen

This displays the oscilloscope screen from the last DPT test. For printing, click the **Change background to printer friendly colors** checkbox. Then click **Refresh** button.

Show Log

Show Log provides a Control Software logging feature useful in debugging Control Software issues.

About

Displays a screen showing the PD1000A Control Software version.

Hardware Configuration for Double-Pulse Test Control

DPT System PD1550A Tab

Select the **PD1550A** from the drop-down box to open the following dialog. It might show PD1500 at initial power-on:

1. Select the PD1550A from the drop-down menu.

2. Enter the oscilloscope's IP Address from "Obtain Oscilloscope IP Address" on page 38

3. Click the **Check** Button to verify communication with test instruments. See **NOTE** below

DPT System Selection	
Double Pulse System	PD1550A
IP Address	10.81.204.254

Instrument Connections	
Oscilloscope VISA Address	TCPIP0::10.81.204.254::inst0::INSTR
Isolated Probe Unit for High-Side Vgs Service Socket	10.81.204.254:5010
Control Unit VISA Address	TCPIP0::10.81.204.254::5001::SOCKET
Safety Unit VISA Address	TCPIP0::10.81.204.254::5000::SOCKET
Hotplate Socket Address	10.81.204.254:5005
Waveform Generator VISA Address	TCPIP0::10.81.204.254::5002::SOCKET
Power Supply VISA Address	TCPIP0::10.81.204.254::5003::SOCKET
Source/Measure Unit VISA Address	TCPIP0::10.81.204.254::5004::SOCKET

Figure 6 Double-Pulse Test Hardware Configuration Screen

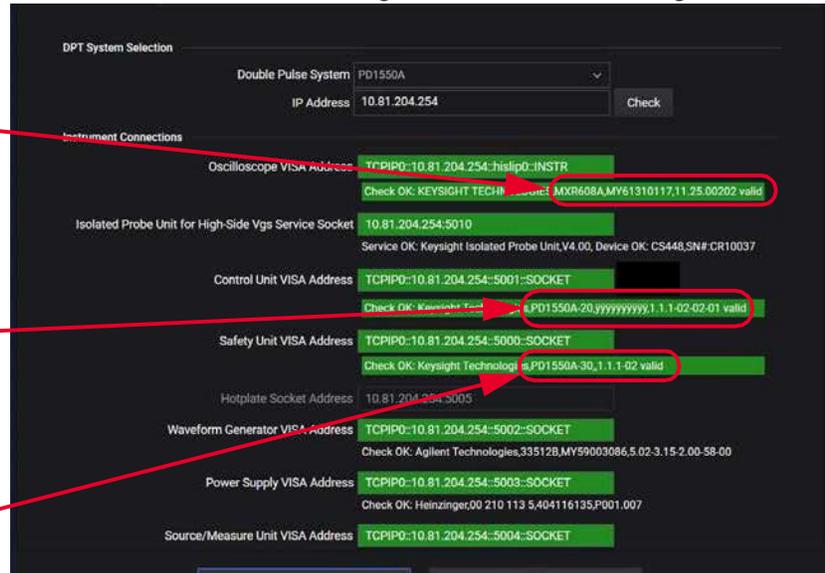
NOTE

Click the **Check** button to verify that the Control software can communicate with all of the DPT system instruments. It sends a SCPI **IDN?* command to each instrument and expects the correct identification string from each instrument. After a few moments, all of the address bars turn light blue and then turn green:

Oscilloscope Firmware Version.

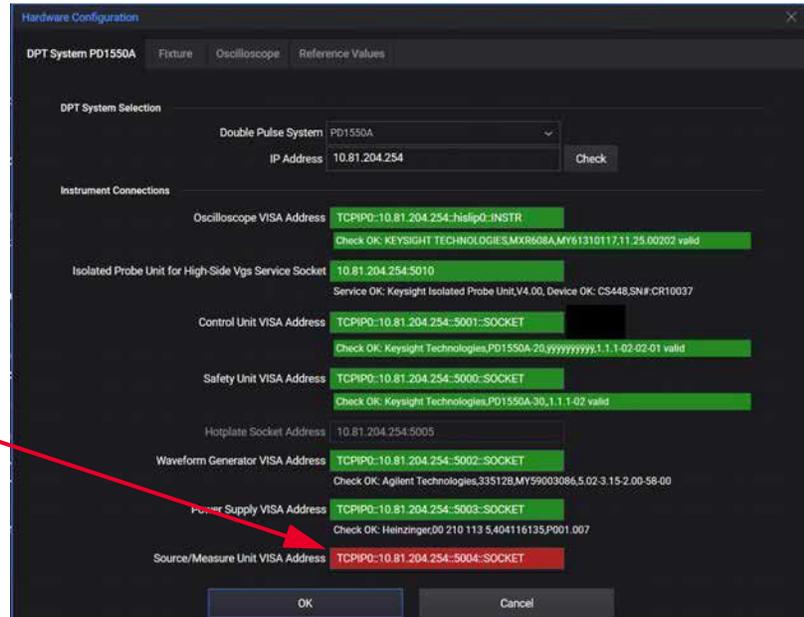
PD1550A Control Unit VISA Address shows the firmware version.

PD1550A Safety Unit VISA Address shows the firmware version.



If any or all of the address bars are red, it indicates a failure to communicate with that instrument or an invalid firmware version.

Cannot communicate with the B2902 SMU. It may be turned off.



Instrument Connections

Instrument VISA addresses should be automatically populated during the initial PD1550A Installation.

- **Oscilloscope VISA Address:** Shows the VISA address of the oscilloscope.

NOTE

Oscilloscope Software Version. If the **Check** returns a note such as the following:



You need to upgrade your oscilloscope software. Do not use version 06.60.00403. Versions later than 06.60.00403 have been tested and work without problems.

- **Isolated Probe Unit for High-Side VGS Service Socket VISA Address:** Shows the VISA address of the Keysight Isolated Probe Unit, PD1550A- 080.
- **Control Unit VISA Address:** Shows the VISA address of the PD1550A- 020 Control Unit. This address is fixed and cannot be changed. After clicking the **Check** button, the VISA address shows the firmware version of the PD1550A-020 Control Unit.
- **Safety Unit VISA Address:** Shows the VISA address of the PD1550A- 030 Control Unit. This address is fixed and cannot be changed. After clicking the **Check** button, the VISA address shows the firmware version of the PD1550A-030 Safety Unit.
- **Hot Plate Socket Address:** Shows the default address of the optional InTEST (Watlow) Control Unit. This address is grayed-out if the Watlow Control Unit is not installed.
- **Waveform Generator VISA Address:** Shows the VISA address of the Keysight 33512 Waveform Generator. This address is fixed and cannot be changed.
- **Power Supply VISA Address:** Shows the VISA address of the Henizinger EVO Power Supply. This address is fixed and cannot be changed.
- **Source/Measure Unit VISA Address:** Shows the VISA Address of the Keysight 2902B Source/Measure Unit. This address is fixed and cannot be changed. The is used for system calibration only. Double-Pulse tests will run without error if this address field is red.

Fixture Tab

Shunt Settings: Low-Side

- **Source Shunt Value:** Enter value, in Ohms, of the Low-Side Coaxial Shunt Resistor. This value is printed on the shunt label. The default/nominal value for the Keysight PD1550-61901 Shunt is 0.05 Ω . For the PD1550-61902 shunt, the default/nominal value is 0.005 Ω .
- **Use High-Z Input** (checkbox): Leave the box unchecked when using the Coaxial Current Shunt with the PD1000-60002 Oscilloscope Protection Probe. Check the box if you are not using the PD1000-60002 Oscilloscope Protection Probe and the top of the Coaxial Shunt connects directly to the oscilloscope (High Z input).
- **De-embedding File Name:** Enter the de-embedding file name. For example, *MY584xxxx.tf2* (where “xxxx” is the shunt’s serial number). The file should be installed in the oscilloscope in the folder: *C:\Users\Public\Public Documents\Infiniium\Filters*.

NOTE

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

Temperature Control Settings

See Appendix A for a detailed description about using the device heater with the Double-Pulse Test Control Software.

- **Heater Unit:** Select either **None** (default) or **Hotplate** from the drop-down menu. Note that the InTEST Hotplate is not a Keysight products and must be ordered from InTEST^a. See [Appendix B](#), “Using the InTEST Heater” on [page 93](#) for more information about using the InTEST (Watlow) EZ-ZONE controller and hotplate.
- **Temperature Reference Measure Device:** Select **None** (default). The temperature is not displayed in the 2023-324 version of PD1000A software.
- **Tolerance:** Specify a range (\pm) around the specified temperature for triggering the DPT measurement. For example, if you specify making a DPT measurement at 10 °C and a 2 °C Tolerance, then the measurement triggers somewhere between 98 °C and 102 °C.
- **Settling Time:** Specify a time period (in seconds) to wait after the DUT reaches the specified temperature (withing the specified range) 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 DPT test aborts.

For example, to go from ambient temperature (~25 °C) to 100 °C with a 2 °C Tolerance may take a few minutes due to the thermal mass of the DUT and heater plate.

^a See <https://www.intestthermal.com/home>.

Oscilloscope Tab

Probe Setup, Headroom, and Timescale

Use Automatic Headroom Factor: Applies a factor to the y-axis of the Oscilloscope Capture display. When checked, the software detects clipping in the waveforms and automatically adjusts the vertical scale.

Default Headroom Factor for all oscilloscope channels is 1.6. Alternately, you can specify the headroom factor for each channel separately. For many GaN devices, the Headroom factor should be set to 2 or as high as 3.6 for the Channel 2, Output Current I_D/I_C .

NOTE

Do NOT use Automatic Headroom Factor with current shunt de-embedding on. When de-embedding is applied, the software cannot detect the clipping in the I_{DS} waveform. This results in using an incorrect waveform.

Refer to “Connect Probes to Oscilloscope” on page 30 for an explanation of the various probe locations. Color bars correspond to oscilloscope channel colors.

Gate Voltage $V_{GS,L}/V_{GE,L}$: Specify oscilloscope channel (default: Oscilloscope Channel 1) for the Low-Side Control Signal measurement.

Output Voltage $V_{DS,L}/V_{CE,L}$: Specify oscilloscope channel (default: Oscilloscope Channel 3) for the Low-Side Output Voltage measurement.

Output Current $I_{D,L}/I_{C,L}$: Specify oscilloscope channel (default: Oscilloscope Channel 2) for Output Current measurement. This is the current measured across the Coaxial Shunt Resistor with the PD1000-60002 Oscilloscope Probe.

Gate Current $I_{G,L}$: Specify oscilloscope channel (default: Oscilloscope Channel 4) for Gate current measurement I_G . I_G is the current measured across the Gate Resistor.

Output Voltage $V_{DS,H}/V_{CE,H}$: Specify oscilloscope channel (default: Oscilloscope Channel 5) for the High-Side Output Voltage measurement.

Gate Voltage $V_{GS,H}/V_{GE,H}$: (default: Memory Channel 6). This is the Gate Voltage measured on the High-Side Gate Drive Module with an N2873A 10:1 Oscilloscope Probe.

- **Use Isolated Probe Unit for $V_{GS,H}/V_{GE,H}$:** Check this box only if you need to measure High-Side output voltage. Configure the Isolated Probe Unit:
 - **Measure Channel:** Default channel on the Isolated Probe Unit is Channel A. Other channels are reserved for future use.

- **Probe Attenuation Ratio:** Specify the attenuation ration of the oscilloscope probe. The standard Keysight N2873A Passive Probe is 10:1 (default).
- **Trigger Channel:** Select External Trigger. The other options are for the Isolated Probe Unit channel and are reserved for future use only.

Output Current $I_{D,H}/I_{C,H}$: (default: Oscilloscope Channel 7). Note that Keysight does not provide a High-Side shunt resistor for the PD1550-66560 or PD1550-66560 62 mm Interface Modules. However, for your custom Interface Modules you may design a place to install a shunt or a small Rogowski coil current probe.

Timescale Factor: Applies a factor to the x-axis of the Oscilloscope Capture display. Default is 1.0

Oscilloscope Options

Use High Resolution Acquisition: Turns on (box is checked) or off (box is unchecked, default) the Infiniium oscilloscope's High Resolution Acquisition Mode. (Normal Acquisition is the default, box not checked).

High Resolution Acquire Mode: If the Use high resolution acquisition is turned on, sets the mode for the oscilloscope's high resolution data acquisition – **BITS10** (default), **BITS11**, **BITS12**, **BITF13**, and **BITF14**. This determines the minimum number of vertical resolution bits which affects the sampling rate. Do not use **BITF13** or **BITF14**; they are not applicable to the bandwidth of the oscilloscope.

Bandwidth Limit Mode: Sets the bandwidth limit mode – **Hw200MHz** (default), **Hw20MHz**, **Custom**, or **Off** – for oscilloscope's input channel's low-pass filter.

Custom Bandwidth Limit (MHz): Minimum value is 3 MHz; maximum value is (sample rate)/2. Field is editable only when **Bandwidth limit mode** is set to **Custom**.

NOTE

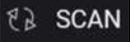
Configure Resolution and Bandwidth with caution. Verify that the acquisition bandwidth is appropriate for your test setup.

NOTE

If **Use High Resolution Acquisition** is enabled and **Bandwidth Limit Mode** is set to anything other than **Off**, a warning message about selecting the Bandwidth Limit Mode appears. For a detailed explanation, refer to the two Application Notes available in the PD1000A help file:

- Evaluating Oscilloscope Bandwidths for your Application
- Understanding Oscilloscope Frequency Response and its Effect on Rise-Time Accuracy.

Scan Button

Selecting the  button in the lower left-hand corner of the user interface initiates a scan of the UDI connections in the PD1550A system and read calibration constants. The Information field () shows the results of the scan, for example:

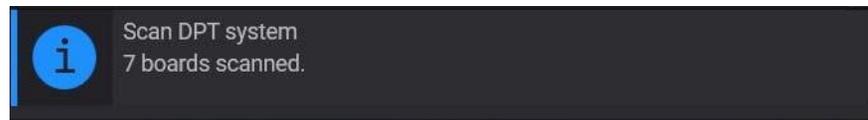


Figure 7 Scanned PD1550A System showing 7 UDI boards or instruments

In this example, the seven boards or instruments are:

- UDI1 - Low-Side Gate Drive Module
- UDI2 - High-Side Gate Drive Module
- UDI3 - Interface Module
- UDI3 - Low-Side Gate Resistor Board
- UDI3 - High-Side Gate Resistor Board
- UDI11 - High Current Test Fixture (PD1550A-010, see note below)
- UDI12 - Inductor Unit (PD1550A-090, see note below)

NOTE

UDI connectors 1 through 6 are on the front panel of the PD1550A-020 Control Unit. UDI connectors 7 through 12 are on the rear panel of the Control Unit and are accessible only through unlocking and opening the rear doors of the system rack.

Information Field

The Information field, generally marked with a large blue circle with a capital “I” displays information about the status of the current or most recent DPT test, plus any warnings and error messages. For example:

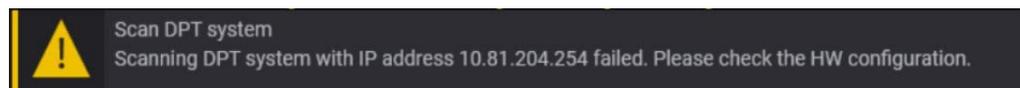


Figure 8 Information Field showing a scan error

Measurement Preparation – Calibration & Compensation

Oscilloscope probe compensation, calibration (AutoCal), and the shunt de-embedding file are steps that the Double-Pulse Test (DPT) system operator should perform periodically to achieve the most accurate measurements. System Calibration is a formal calibration procedure. For accurate DPT measurements, it is very important to calibrate the DPT system to insure that all delays are equivalent.

NOTE

It is not necessary to set the oscilloscope probe compensation before each DPT test. However, a complete calibration should be performed when the ambient temperature changes more than ± 5 °C or when any change is made to the DPT system.

Oscilloscope Probe Compensation

Prior to running system calibration or DPT tests, the oscilloscope probes must be adjusted for low frequency compensation. The passive probes have built-in compensation RC divider networks. The differential probes also require offset compensation.

PD1550A System Calibration

System calibration (also known as AutoCalibration or AutoCal) procedures are a formal calibration of the DPT system. For detailed calibration instructions, refer to “PD1550A System Calibration” on page 69 or the PD1000A help file.

Standard Double-Pulse Characterization Test

A Standard Double-Pulse Test is a common method for characterizing WBG power transistors. In general, it characterizes the turn-on and turn-off behavior for different supply voltages and different current levels. Two power transistors are configured in a totem-pole configuration (also called a half-bridge configuration). The Low-Side transistor is referred to as the Device Under Test (DUT). For proper operation, the body diode of the High-Side transistor is mandatory and is also used for the Reverse Recovery test.

1. Select the Standard Tab

2. Select device type (FET, IGBT, or GaN)

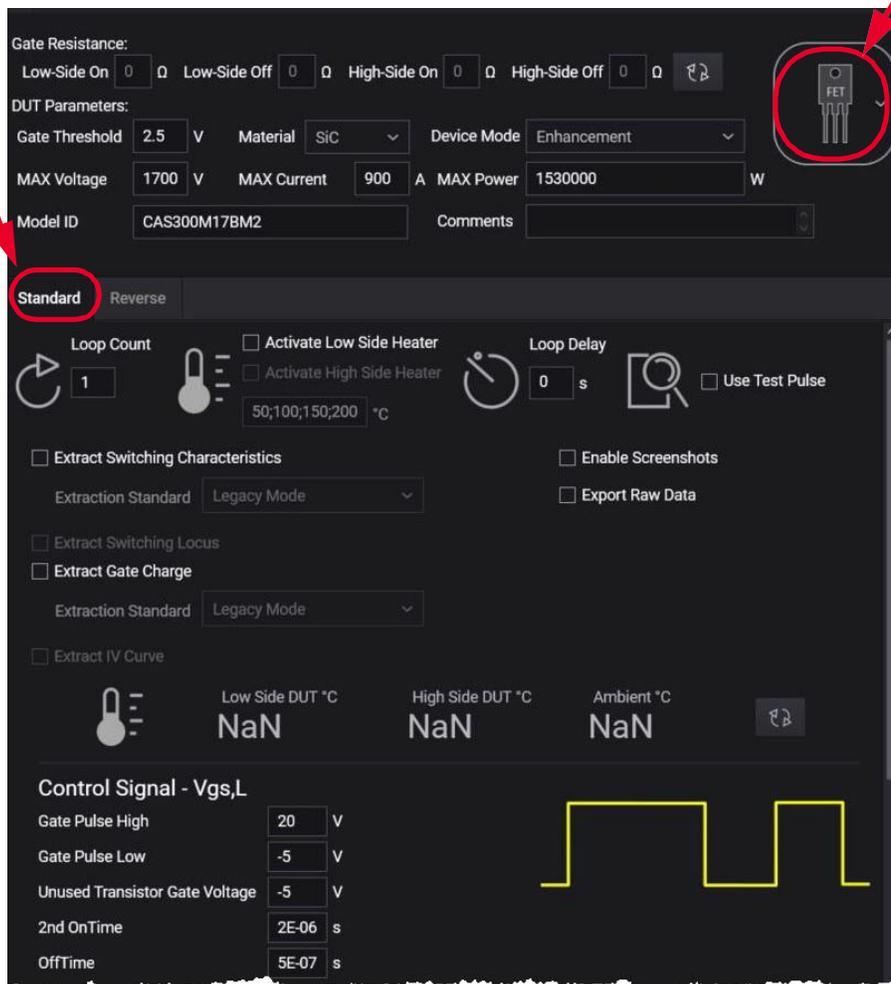


Figure 9 PD1000A Control Software Screen for Standard Double-Pulse Test

Reverse Recovery Test

Reverse Recovery tests characterize the body diode in the DUT device. If a diode is conducting in a forward direction and immediately switched to a reverse bias condition, the diode continues to conduct in the reverse bias state for a very short time as the forward voltage bleeds off. The current through the diode is fairly large in the reverse direction during this small recovery time.

After the carriers are flushed and the diode is acting as a normal blocking device in the reverse bias condition, the current flow drops to normal leakage levels.

There are multiple standards for reverse recovery measurements. Refer to the PD1000A help file for details.

1. Select the Reverse Tab

2. Select device type
(FET, IGBT, or GaN)

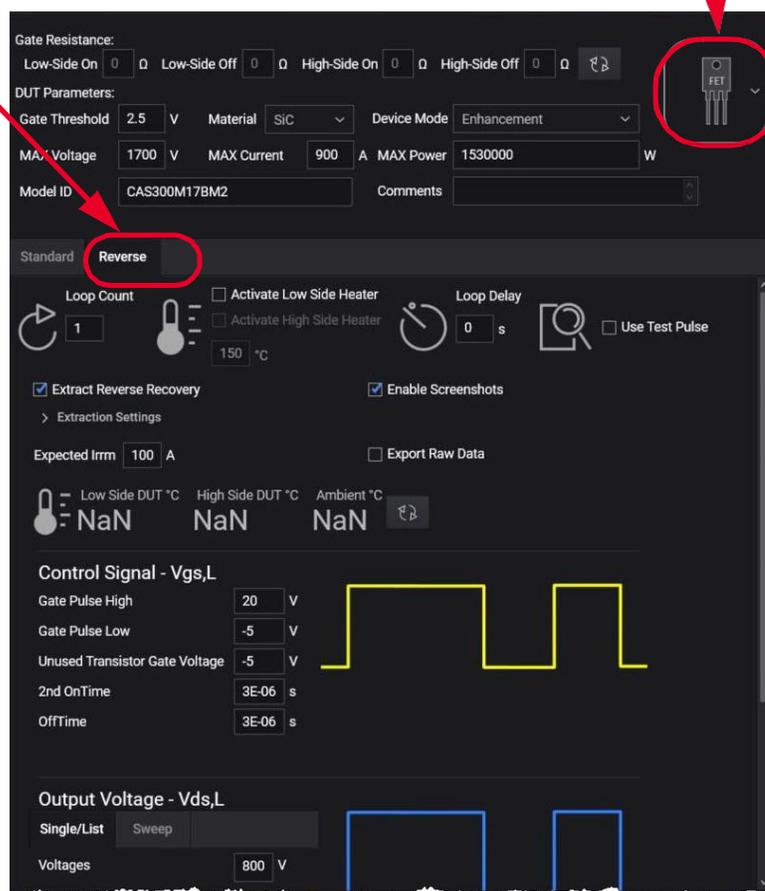


Figure 10 PD1000A Control Software Screen for Reverse Recovery Test

Set Double-Pulse Test Parameters

Many DUT test parameters can be obtained from the DUT data sheet.

The screenshot displays the DPT Test Parameters configuration interface, organized into several sections:

- Gate Resistance:** Includes fields for Low-Side On, Low-Side Off, High-Side On, and High-Side Off, all currently set to 0 Ω.
- DUT Parameters:**
 - Gate Threshold: 2.5 V
 - Material: SiC
 - Device Mode: Enhancement
 - MAX Voltage: 1700 V
 - MAX Current: 900 A
 - MAX Power: 1530000 W
 - Model ID: CAS300M17BM2
 - Comments: (empty)
- Standard / Reverse:**
 - Loop Count: 1
 - Loop Delay: 0 s
 - Temperature: 50, 100, 150, 200 °C
 - Options: Activate Low Side Heater, Activate High Side Heater, Use Test Pulse, Extract Switching Characteristics, Extract Switching Locus, Extract Gate Charge, Extract IV Curve, Enable Screenshots, Export Raw Data
 - Extraction Standard: Legacy Mode
 - Temperature Readings: Low Side DUT °C (NaN), High Side DUT °C (NaN), Ambient °C (NaN)
- Control Signal - Vgs,L:**
 - Gate Pulse High: 20 V
 - Gate Pulse Low: -5 V
 - Unused Transistor Gate Voltage: -5 V
 - 2nd OnTime: 2E-06 s
 - OffTime: 5E-07 s
- Output Voltage - Vds,L:**
 - Single/List: Sweep
 - Voltages: 600 V
- Output Current - Id,L:**
 - Single/List: Sweep
 - Currents: 200 A
 - Current Tolerance: 10 %
 - Inductor Selection: manual, Value: 100 μH

Figure 11 DPT Test Parameters

Gate Resistance

Keysight Interface Test Modules have High- and Low-Side Gate Resistor (R_G) Modules. The Control Software reads the value of the Gate resistors from the modules and displays the value. Both the Low-Side and High-Side $R_{G,ON}$ and $R_{G,OFF}$ resistances are shown.

Remember, both the High-Side and Low-Side Gate Resistor modules should have gate resistors of the same resistance value.

NOTE

Click the refresh button () next to the Gate Resistance to force the software to read the current gate resistor value. Do this when you first start the Control Software and anytime you change the Gate Resistor Modules.

DUT Parameters

- **Device Type** (Drop-down menu item): Select either **FET**, **IGBT**, or **GaN** for the Device Under Tested (DUT).

NOTE

IMPORTANT: Testing GaN devices require a special DUT Test Interface Board and a license for the control software. Contact your local Keysight Application Engineer for availability and information.

- **Gate Threshold:** Enter the Gate Threshold voltage from the device data sheet. If it is not available, enter “NaN” (not a Number).
- **Material** (Drop-down menu item): Select either **Si** for Silicon or **SiC** for Silicon Carbide. This is generally available from the device data sheet. If unknown, select **Not Specified**.
- **Device Mode:** (not available for IGBT device type) Select either **Enhancement Mode** (normally off device) or **Depletion Mode** (normally on device) for GaN or regular FETs. Refer to device data sheet. Default is **Enhancement Mode**.
- **MAX Voltage:** Specify the maximum voltage (V_{DSS} or V_{CES}) that may be applied across the device (Drain to Source or Collector to Emitter). Obtain value from the device data sheet.
- **MAX Current:** Specify the maximum current (I_D or I_C) that may be used to test the DUT (Drain to Source or Collector to Emitter). Obtain value from the device data sheet.
- **MAX Power:** Specify the maximum power in Watts) that may be applied to the DUT. This value is sometimes not specified on the device data sheet.

NOTE

As a general guideline, the typical operating voltage for a FET or IGBT is much lower than the Maximum Rated voltage (V_{DSS} or V_{CES}). The following examples are typical and not hard rules:

V_{DSS} Rating:	Typical Operating Voltage:
600 V	400 V
1200 V	600 V
1700 V	900 V

- **Model ID:** A text field to enter the model or device type of the DUT, or any other text information you want to record. Characters not legal for file paths (e.g., \, /, ?, <, >, ...) are replaced by the character “_”. If nothing is entered, the word “*Unknown*” is used.
- **Comments:** Allows you to enter comments such as test details or DUT details. Comments are saved as part of the Measurement History and in the Parameters Results page.

NOTE

GaN devices have different system limits than FET or IGBT devices. GaN devices are limited to:

Maximum System Voltage ; 500 V
 Minimum System Current: ; 1 A
 Maximum System Current ; 100 A

Standard or Reverse Tabs

- **Loop Count:** Specify number of times to repeat the DPT test with the current parameter settings. See Note, “**Looping or Sweeping Multiple DPT Tests**” below.
- **Activate Low-Side Heater:** Turns the heater circuit on or off. Remember to set the Temperature Control Settings in the **Hardware Configuration > Fixture** menu (see “Temperature Control Settings” on page 45).
 - **Temperatures:** Enter a single value or a semicolon (;) delimited list of temperatures to heat the device to when running the DPT tests. 175 °C Maximum. This box is grayed-out unless **Activate Low Side Heater** is checked. See Note, “**Looping or Sweeping Multiple DPT Tests**”.
- **Activate High-Side Heater:** Turns the heater circuit on or off.

NOTE

The Low-Side and High-Side heaters are not used in the PD1550A. These settings have no effect on DPT measurements.

- **Loop delay:** Specify the delay time (in seconds) for the DPT test to idle before running each DPT test in a loop. This time allows the device to cool if you use the heater. See Note, “**Looping or Sweeping Multiple DPT Tests**” below.

NOTE

Looping or Sweeping Multiple DPT Tests. When running multiple tests on a device, loops are nested:

```

Loop Count {
  Temperature {
    Multiple List or Sweep Voltage Values ( $V_{DS}$ ) {
      Multiple List or Sweep Current Values ( $I_{DS}$ )
    }
  }
}

```

That is, all “Current Values” are tested before incrementing the “Voltage Value”. All “Voltage Values” are tested before incrementing “Temperature”. All “Temperatures” are tested before incrementing “Loop Count”. When looping DPT tests, all measurement data is saved in the directory specified in the **Settings > Global Settings** menu.

- **Use Test Pulse** (checkbox): When checked, click **Start** to run a low voltage/low current Double-Pulse Test ($50 V_{DS}$) before the actual measurement begins. This verifies that the DUT is functional and has not been destroyed. Note, because of the low voltage/low current, the I_G and I_{DS} measurements will appear noisy on the oscilloscope. If the Test Pulse measurement succeeds, the complete test runs at full voltage and current. The Test Pulse is available only in Standard Test mode.
- **Extract Switching Characteristics:** (checkbox) If not checked, only the *Extract Gate Charge*, *Enable Screenshots*, and *Export Raw Data* check boxes are available. When it is checked, an **Extraction Standard** drop-down menu, the **Extract Switching Locus** and **Extract IV Curve** check-boxes become available.
 - **Extraction Standard:** Select Legacy Mode, IEC 60747-8 for FETs, or IEC 60747-9 for IGBTs.
 - In Legacy mode, 0 V is defined as 0% for both enhancement mode and depletion mode FETs; The measured V_{DS} is used as 100%.
 - In the IEC modes, 0 V is 0% for enhancement mode FETs but the negative V_{GS} start voltage is used for depletion mode FETs; the set V_{DS} value is used as 100%.
 - **Extraction Levels:** This allows you to specify exact voltage levels for data extraction.

- **Use Gate Pulse Low for 0% of V_{gs}:** For Enhancement Mode (normally off devices), use either 0 V or the specified negative Gate Pulse low voltage is used. For Depletion Mode devices, the specified negative Gate Pulse Low voltage is always used.
- **Extract Switching Locus:** This allows you to specify the percentage used for I_D/I_C Turn Off level. Switching locus represents the voltage and current combination (I_D / V_{DS}) along turn-on and turn-off. It is generally used to make sure the locus is within the Safe Operating Area (SOA) of a device. Switching locus does not follow a standard. It shows output current over output voltage during the switching periods. The switching locus can be generated for any power transistor and the algorithm is independent from semiconductor material or device topology.

For turn-off:

- Starts when the output voltage starts changing
- Stops when output current stops changing

For turn-on:

- Starts when the output current starts changing
- Stops when output voltage stops changing

The switching locus for turn-on and turn-off starts and stops at 0, unless there are no measured values close to 0. In this case, warnings are written to the log file.

For more information, see “*Parameter Extraction Techniques*” in the PD1000A help file.

- **Extract Gate Charge:** (available only in Standard DPT Test) Gate charge characteristics measure the input charge of gate-controlled power transistors. The algorithm is generally defined by JEDEC, there is also an IEC standard. Allows you to specify either the *Legacy* mode or the *JESD 24-2* definitions for Gate Charge. Accurate Gate Charge measurements require a high gate resistor (R_G) value; typically 100 **W** or greater. Refer to the PD1000A help file for details.
 - **Legacy Mode:** Refer to the PD1000A help file for details.
 - **JESD 24-2:** This characterization is used primarily for **Enhancement Mode** FETs but can also be used for IGBTs. Refer to the PD1000A help file for details.
- **Extract IV Curve** (checkbox, available only in Standard DPT Test): This checkbox is grayed-out (not available) unless the **Extract Characteristics** box is checked. If checked, the complete I/V derivation is extracted and saved. If a Gate Drive Module with a gate resistor (R_G) 10 **Ω** or greater was used in the DPT test, then the Gate Charge data is displayed. **Note:** 100 **Ω** Gate Resistor (R_G) or larger is recommended for IV derivation.

- **Control Voltage Resolution:** This field is grayed-out (not available) unless the **Extract IV Curve** box is checked. Enter a single voltage value to be used for the extraction of the IV curves.
- **Enable Auto Smoothing:** Enable Control Voltage auto smoothing during IV Derivation Extraction.
- **Voltage Smoothing Number:** Set the number of points used for Control Voltage smoothing signal during IV Derivation extraction.
- **Enable Screenshots:** Allows user to enable/disable the system automatically taking oscilloscope screen captures during a DPT test. Screen captures are saved in the test subfolder.
 - When disabled (default setting), the only screen captures taken are the *Summary.png* and the *PulseAdjustment.png*.
 - Disabling shortens the Standard DPT test time.
 - Enabling screen captures allows for easier test debugging.
- **Export Raw Data:** When checked, it enables the export of raw curve data from the oscilloscope. When unchecked, decreases the Double-Pulse Test time but the “Oscilloscope Capture” is not displayed or saved.
- **Extraction Settings:** When selected, allows extraction of Reverse Recovery information.
 - **Current Smoothing Number:** (available only in Reverse DPT Test). The output current signal is smoothed before extraction. I_{RRM} is extracted with this smoothed signal. For each other extraction (t_{RR} , charge, energy, di/dt , t_i) an additional user smoothing (default of 10 smoothing points) is applied.
 - **Integration End Time Threshold:** (available only in Reverse DPT Test) The software searches for first crossings of 0.0 A, and first crossing of 0.25 IRM after current peak, etc. Default is 0.25 (25%); range is 0% to 99%. If you select **Enable Screenshots** for the extraction, you can see the measured time of $I_{rrm} * 25\%$ in the *RevRec_trr.png* and *RevRec_trr_zoomed.png* images.
 - **Expected I_{rrm}:** (available only in Reverse DPT Test). Maximum Reverse Recovery Current of a fast or ultrafast diode; such as often used in switch-mode power supplies). Enter the maximum current the body diode is rated for.
- **Low-Side DUT °C:** Indicates the temperature of the DUT if the Heater/Thermocouple assembly is connected to the Test Fixture. If the Heater/Thermocouple assembly is not connected to the test fixture or if **Activate Heater** is not selected, **NaN** (Not a Number) is shown.
- **High-Side DUT °C:** Not used in this version of software. Reserved for future use.

- **Ambient °C:** Indicates the ambient temperature inside the Safety Hood enclosure. Sources for the temperature readings are three internal fixture sensors.

Click the **Refresh** button () to read the current temperatures.

NOTE

In PD1000A Control Software version 2023-324, the temperatures are not displayed.

Measurement Parameters for Standard and Reverse Tests

Control Signal (Gate Voltage ($V_{GS,L}$ or $V_{GE,L}$)):

- **Gate Pulse High:** A single voltage level for the turn-on Gate Pulse. For the *Standard* tests, this is for the Low-Side device (DUT). For the *Reverse Recovery* test, this is for the High-Side device. Minimum value for the Gate Pulse High = +13 V. Maximum value = +29 V. The difference between Gate Pulse High and Gate Pulse Low must be less than 30 V.
- **Gate Pulse Low:** The voltage level of the Gate Pulse; used to ensure the DUT is fully turned off. Minimum value = -10 V. Maximum value = 0 V.

NOTE

The maximum difference between Gate Pulse High and Gate Pulse Low must not exceed 30 V.

- **Unused Transistor Gate Voltage:** This sets the Gate Voltage for the device *not* being tested. For the *Standard* tests, this is the High-Side device (DUT).
- **2nd On Time:** Enter the time, in microseconds, when the DUT is turned on a second time (and V_{DS} is minimum). For example, 2 microseconds is expressed as “2E-6”. Minimum 200 nS, Maximum 10 μ S.
- **Off Time:** Enter the time, in microseconds, between when the DUT is turned off (and V_{DS} is maximum) and when the DUT is turned on a second time. For example, 2 microseconds is expressed as “2E-6”. Minimum 200 nS, Maximum 25 μ S.

NOTE

Keep **2nd On Time** and **Off Time** as short as possible. IGBT and some other slow devices may require longer times. The pulse width must be long enough that the transistor turns fully on (e.g., > 1 mS). However, the pulse width must not be too long, otherwise, the measurement will be influenced by self-heating of the transistor. 200 nS is the minimum time.

Output Voltage ($V_{DS,L}$ or $V_{CE,L}$):

The Double-Pulse Test can either test at a single $V_{DS,L}/V_{CE,L}$ Output Voltage, a list of semicolon-separated Output Voltages, Output Voltages or sweep a series with multiple $V_{DS,L}/V_{CE,L}$ Output Voltages.

NOTE

GaN devices have different system limits than FET or IGBT devices. GaN devices are limited to:

Maximum System Voltage ; 500 V
Minimum System Current: ; 1 A
Maximum System Current ; 100 A

- **Single/List or Sweep tabs:**

- If **Single/List** tab is selected, then run test with a single voltage or a semicolon (;) delimited list of voltages (e.g., 50; 100; 200; ...).
- If **Sweep** is selected, then enter the starting voltage, the ending voltage, and the number of points (voltages) to test. See note below: **Sweeping Voltage Example**.
 - **Output Voltage(s)**: Minimum Voltage = 300 V^b, Maximum Voltage = 13600 VDC.
 - **# of Points**: Sets the number of voltage steps between Start and Stop for sweeping.

NOTE

Sweeping Voltage Example: As a sweep example, suppose you want to run tests at the following $V_{DS,L}/V_{CE,L}$ voltages: 100, 150, 200, 250, 300, 350, 400 Volts.

- Check the **Sweep** tab.
- Set **Start** to: 100.
- Set **Stop** to: 400,
- Set the **# of Points** to: 7. This sets the Step Size to 50 V.
- Then click **Start** to run the test.

Also, see the **Looping or Sweeping Multiple DPT Tests** Note on [page 55](#).

^b This is the minimum voltage; at this voltage the system can reach 1000 A.

Output Current ($I_{D,L}$ or $I_{C,L}$):

The Double-Pulse Test can either test at a single $I_{DS,L}$ or $I_{CE,L}$ Output Current, a semi-colon-separated list of currents or sweep with multiple $I_{DS,L}$ or $I_{CE,L}$ Output Currents.

- **Single/List or Sweep tabs:**

- If **Single/List** tab is selected, then run test with a single current or a semicolon (;) delimited list of currents (e.g., 20; 35; 50; ...).
- If **Sweep** is selected, then enter the starting current, the ending current, and the number of points (currents) to test. See note below: **Sweeping Current Example**.

- **Output Current(s):** Minimum current = 50 A^c, Maximum current = 1000 A^d.
- **# of Points:** Sets the number of current steps between Start and Stop for sweeping.

NOTE

Sweeping Current Example: As a sweep example, suppose you want to run Double-Pulse Tests at the following I_{DS} or I_{CE} currents: 10, 15, 20, 25, 30, 35, 40 Amps.

- Check the **Sweep Current** box.
- Set **Single/Start** current at 10.
- Set the **Stop** current at 40,
- Set the **# of Points** at 7. This sets the Step Current to 5.00 A.
- Then click **Start** to run the test.

Also, see the **Looping or Sweeping Multiple DPT Tests** Note on [page 55](#).

- **Current Tolerance%:** Specify a Tolerance value used is setting the pulse width to obtain current values. For example, if you specify a current of 100 A and a tolerance of 5% then the actual current used in the test will be between 95 and 105 A. Value must be greater than zero (0).
- **Inductor Selection:** With software version 2023.324 (and later), inductance selection is moved under the **Output Current** heading. You have the option to have the PD1550A automatically select (**Auto**^e) the correct inductor for the voltage and current settings, manually select (**Manual**) the inductor from the three inductors in the PD1550A system (25 μ H, 100 μ H or 600 μ H), or use an external inductor (**External**) connected to the front panel terminals of the PD1550A-010 Test Fixture. If you are using an external inductor, enter the value of the inductor, in μ H, in the field next to the selection.

^c Lower current results in less accuracy.

^d First pulse only. Current after 2nd pulse must not exceed 1100 A.

^e If $I_{DS} > 1.2 \times V_{DS}$ then Inductor selected = 25 μ H. If $I_{DS} < 0.1267 \times V_{DS}$ then Inductor selected = 600 μ H. Otherwise, Inductor selected = 100 μ H.

Run the Characterization Test

After selecting the type of test (Standard or Reverse Recovery) and setting the test parameters:

- 1 Click the **Start** button () to start a measurement or a loop of measurements.
 - Stop an active measurement by clicking the **Stop** () button.
- 2 The DPT Control Software calculates the amount of energy that it needs to store in the inductor for the complete test and sets the width of the first pulse accordingly.
- 3 Watch the Progress details just above the  button.
- 4 After the test runs, and if **Enable Screenshots** is checked, the Oscilloscope Capture plot and other test data appear in the software display (right side of the display) on the host PC.

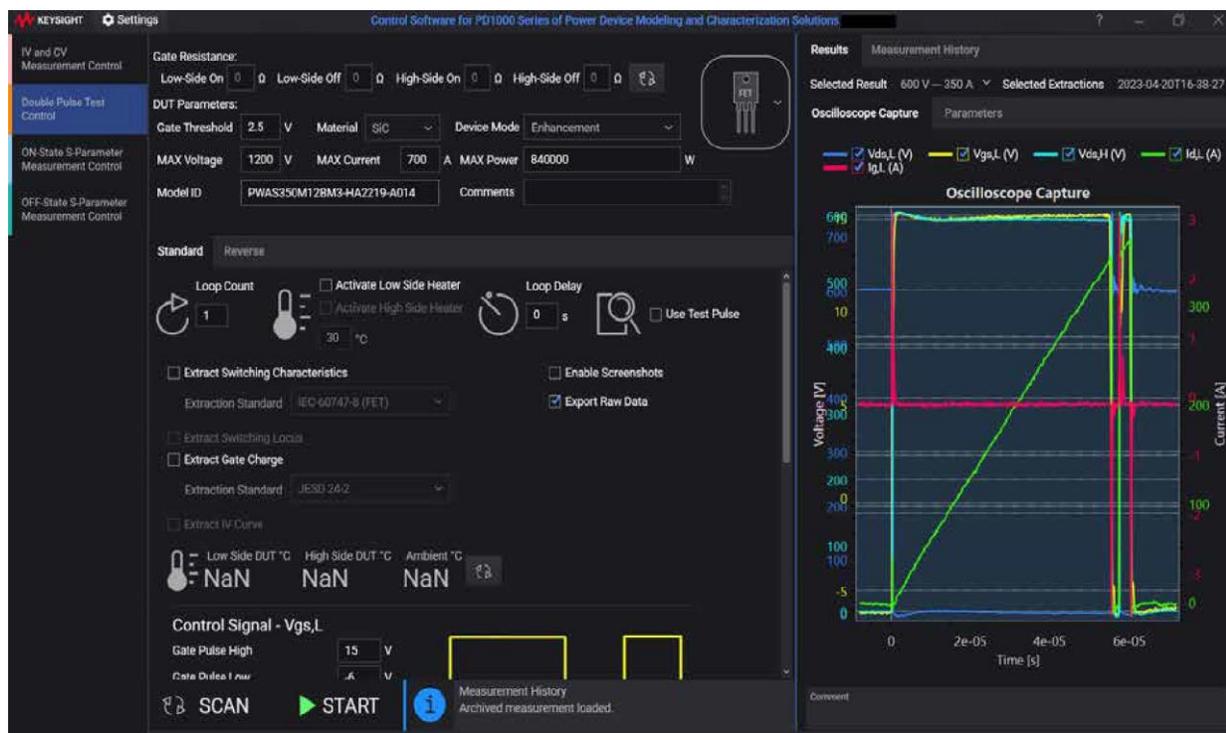


Figure 12 Sample Double-Pulse Test Plot for a FET Device

Test result data is automatically stored in the file specified in the **Global Settings > Output Directory** (see “Global Settings” on page 39).

NOTE

If a Gate Drive Module with a gate resistor (R_G) equal to or greater than 10Ω was used in the DPT test, then the Gate Charge data is calculated and available. If R_G is 0 Ohms, then the gate current cannot be measured.

NOTE

Waveforms from the PD1550A Double-Pulse Tests system are different from waveforms shown in various test standards. This is because of issues such as gate plateau, ringing due to parasitic inductances and capacitances, voltage drop due to stray inductances, overshoot, etc.

After a successfully completed test (or loop or sweep of tests). The right side of the screen displays the test results. The **Results Tab** shows the results of the most recent DPT test or the results of a test selected from the **Measurement History**.

Results Tab

Depending on the type of test (Standard or Reverse Recovery) and the extractions selected (Extract Switching Characteristics, Extract Switching Locus, Enable Screenshots, etc), the Results Tab shows the measured or calculated results of the DPT test. These results include an oscilloscope capture, Gate Charge, Test Parameters, etc.



Figure 13 Sample Oscilloscope Capture from the Results Tab

Selected Result

Shows the measured or calculated results of the DPT test. Note that you can select one or more tests from the **Measurement History** tab, right click, select **Load Measurement(s)...** to open the Results tab. Then click on the **Selected Result** down arrow to select one of the test results.

Selected Extractions

Provides a list of the **Run Extraction(s)** you have performed. You can do multiple extractions on one file; this list allows you to switch between the extractions.

Comment Field on each Results Page

Comments fields at the bottom of each Results page (Oscilloscope Capture, Gate Charge, Signal Levels and Time, etc.) are automatically saved.

Measurement History Tab

Starting with PD1000A Control Software version 2022.321, all tests are recorded and available in a Measurement History.

Measurement History Columns

System State Column

	Test completed without errors.
	Test completed but with a warning.
	Errors occurred during the test execution or data extraction. Error messages are recorded in the Measurement History.
	Test aborted by user, message recorded in Measurement History.
	No icons means that the selected test was done on a previous version of the PD1000A Control software. These are not available for Run Extraction(s)...

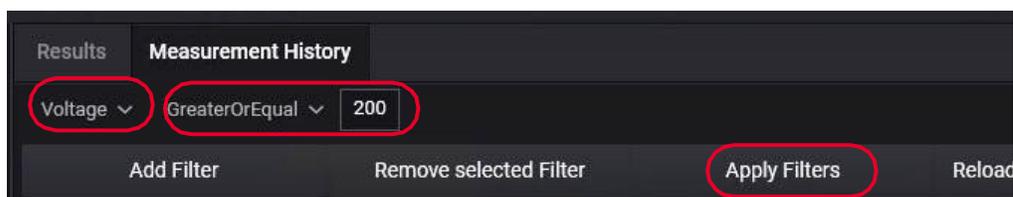
The other columns in the Measurement History table are taken directly from the main test parameter screen.

You can reorder the columns by holding the left mouse key down on a column head and sliding it to the position you want.

Using Filters

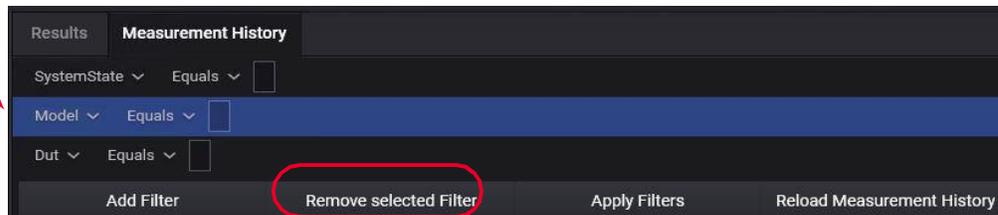
- 1 Click the **Add Filter** tab. This adds a filter menu to the screen. Click the down arrow to open the list of filter types; scroll down for the complete list.
- 2 Click the down arrow next to **Equals** to select the type of filter to use.
- 3 Enter the parameter in the blank field.
- 4 Click **Apply Filters**.

For example, if you want a list of all measurements made at 200 volts or greater:



To remove a filter from the list, select the filter to remove (click at the far left, the filter is highlighted when it is selected). Then click **Remove selected Filter**.

Click here to highlight a filter to remove



Reload Measurement History

This reloads the complete Measurement History. For example, after you delete one or more files or set and apply filters, then remove the filters, click **Reload Measurement History** to get the complete list of tests.

Additional Features of the Measurement History

Click on any test to highlight it; right click to open the Context menu. Use the *Shift* or *Ctrl* keys to select multiple tests.

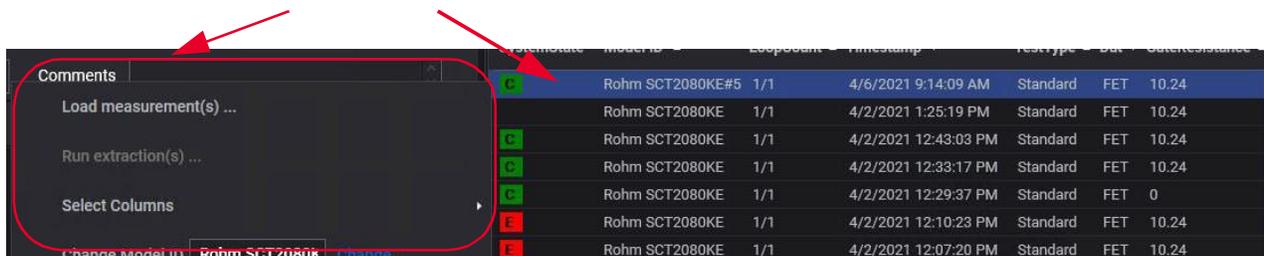


Figure 14 Measurement History Context Menu

Load Measurement(s)...

Select one or more tests from the Measurement History tab, right click to open the context menu, select **Load Measurement(s)...** to open the **Results** tab. Then click on the **Selected Result** down arrow to select one of the test results.

Run Extraction(s)...

Run Extraction(s)... allows you to open previous DPT measurement results in the Infiniium Offline PC-Based Oscilloscope Analysis Software. For example, you may want to expand the Turn-On / Turn-Off switching times on the oscilloscope display or change the IEC 10% / 90% measurement points^f. The Offline software allows you to view, analyze, share, and document previously captured DPT measurements.

To run extractions, the Infiniium Oscilloscope Offline software must be running first; **Run Extraction(s)...** does not open or start the Infiniium Oscilloscope software. Only one instance of the Infiniium can run at a time.

NOTE

Run Extraction(s)... requires the PD1000A Control Software PD1021A license **AND** the Keysight Infiniium Offline Software (*Infiniium D9010BSEO*) license has everything required) is to be installed and licensed on the host PC. If the PD1021A license is not installed, **Run Extraction(s)...** is disabled.

Run Extraction(s)... is available only for Double-Pulse Tests run with control software version 2022.321 (or later).

To use **Run Extraction(s)...**:

- 1 Start the Infiniium Oscilloscope Offline software on the same PC as the PD1000A Control software.
- 2 In **Measurement History** view, right click on the DPT test you want to analyze.
- 3 Click on **Run Extraction(s)...**
- 4 The PD1000A Control software reruns the analysis and transfers the measurement results to the Offline software.

A list of extractions you performed is available in the **Results** tab under **Selected Extractions**. You can do multiple extractions on one file; this list allows you to switch between the extractions.

It is beyond the scope of this manual to describe how to use the Infiniium Offline PC-Based Oscilloscope Analysis Software. Refer to the Offline Software help file.

^f For FET devices, measurements are defined according to IEC 60747-8. For IGBT devices, measurements are defined according to IEC 60747-9. Refer to the PD1000A help file for details.

Select Columns

This allows you to select and add/delete columns from the Measurement History view.

Change Model ID

The Model ID is part of the Output Directory path (see [“Global Settings” on page 39](#)) for saving test measurement data. Changing the **Model ID** moves the measurement on the hard disk to a new measurement path.

Right click the test that you want to change the Model ID. The context menu opens with the model ID of the test you selected. Type in the new Model ID and click **Change....** The control software creates a new folder with the new **Model ID** name.

Delete a Measurement from the Measurement History

To delete a test from the Measurement History, delete the measurement from the output folder. The next time the Measurement History is loaded (or click **Reload Measurement History**) the test does not appear in the Measurement History.

Frequently Asked Questions

Can I set the di/dt rate?

The di/dt rate is used for Reverse Recover tests. The rate can be controlled in two ways:

- a** You can increase V_{GS} to have a faster di/dt or decrease V_{GS} for a slower di/dt.
- b** You can increase the gate resistor value on the High-Side Gate Drive module to decrease the di/dt or decrease the gate drive resistor value on the High-Side Gate Drive module to increase the di/dt.

By controlling these two parameters, you can tune the di/dt for Reverse Recovery to match the data sheet. For more information on *di/dt* and *dv/dt*, see the PD1000A help file.

How do I change the Gate Drive Resistor (R_G)?

The PD1550A DPT system provides different Gate Resistor Modules. Unlike the PD1500, the same Gate Drive Modules are used for both high-Side and Low-Side, only the Gate Resistor modules change.

PD1000-66550 No installed Gate Resistor^g

PD1000-66551 0,0,0 Ω Gate Resistor^h

PD1000-66552 0,0,1.0 Ω Gate Resistor^g

PD1000-66553 0,0,2.2 Ω Gate Resistor^g

PD1000-66554 0,0,4.7 Ω Gate Resistor^g

PD1000-66555 0,0,10.0 Ω Gate Resistor^g

PD1000-66556 0,0,22.0 Ω Gate Resistor^g

PD1000-66557 0,0,100 Ω Gate Resistor^g

PD1000-66558 0,0,400 Ω Gate Resistor^g

Two modules are provided with each part number. Two modules of the same resistance value are required for PD1550A

^g See System Installation Manual for instructions on installing custom gate resistors on PD1000-66550 Gate resistor modules. After installation, module requires calibration.

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

How are general electrical characteristics measured: General FET characteristics, such as V_F , I_R , and C are measured with the PD1000A system using the Keysight B1505A or B1506A. Reverse Recovery parameters are measured with the PD1550A Double-Pulse Test Solution.

How is system discharge accomplished? Automatically, through a bleed resistor in the test fixture.

High Voltage Detection? In the Rack and Safety Enclosure, there is a voltage detection circuit that works with the interlock system. Additionally, the Heinzinger High Voltage Power Supply (HVPS) displays the output voltage.

3 PD1550A System Calibration

In this chapter:

Initiate Calibration & Compensation Procedures [page 70](#)
Required Equipment [page 71](#)

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

Initiate Calibration & Compensation Procedures [page 70](#)
Low Frequency Compensation for the N2873A Probe [page 71](#)
1 Oscilloscope Probe Offset Compensation [page 71](#)
2 Low-Side Gate Voltage Source Calibration -- $V_{GS,L}$ Output [page 77](#)
3 Low-Side Common Resistor Calibration -- $R_{COM,L}$ [page 78](#)
4 Low-Side Gate Resistance Calibration -- $R_{GON,L}$ [page 79](#)
5 Low-Side Gate Resistance Calibration -- $R_{GOFF,L}$ [page 80](#)
6 High-Side Gate Voltage Source Calibration -- $V_{GS,H}$ Output [page 81](#)
7 High-Side Common Resistor Calibration -- $R_{COM,H}$ [page 82](#)
8 High-Side Gate Resistance Calibration -- $R_{GON,H}$ [page 83](#)
9 High-Side Gate Resistance Calibration -- $R_{GOFF,H}$ [page 84](#)
10 Calibration Complete [page 85](#)
Coaxial Shunt Resistor Characterization [page 86](#)
Install the De-Embedding Transfer File on the Oscilloscope [page 86](#)

NOTE

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

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**

- **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 PD1000A software reads the EEPROMS on the Gate Drive and Gate Drive Resistor Modules.

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

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

- 1 Oscilloscope Probe Offset Compensation [page 71](#)
- 2 Low-Side Gate Voltage Source Calibration -- $V_{GS,L}$ Output [page 77](#)
- 3 Low-Side Common Resistor Calibration -- $R_{COM,L}$ [page 78](#)
- 4 Low-Side Gate Resistance Calibration -- $R_{GON,L}$ [page 79](#)
- 5 Low-Side Gate Resistance Calibration -- $R_{GOFF,L}$ [page 80](#)
- 6 High-Side Gate Voltage Source Calibration -- $V_{GS,H}$ Output [page 81](#)
- 7 High-Side Common Resistor Calibration -- $R_{COM,H}$ [page 82](#)
- 8 High-Side Gate Resistance Calibration -- $R_{GON,H}$ [page 83](#)
- 9 High-Side Gate Resistance Calibration -- $R_{GOFF,H}$ [page 84](#)
- 10 Calibration Complete [page 85](#)

1 Oscilloscope Probe Offset Compensation

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

NOTE

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

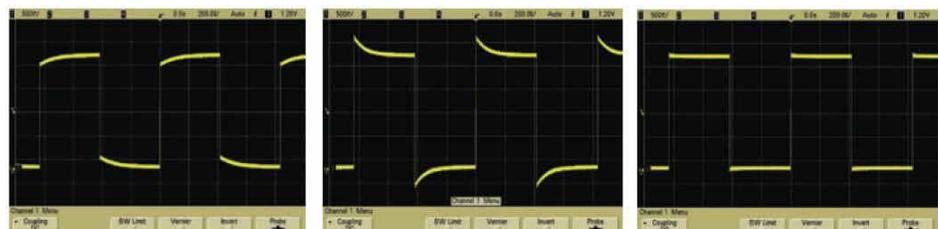
Required Equipment

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

Low Frequency Compensation for the N2873A Probe

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

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



Under Compensated

Over Compensated

Optimum

DP0001A Settings in the Oscilloscope User Interface

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

Setting the Attenuation Mode

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

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

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

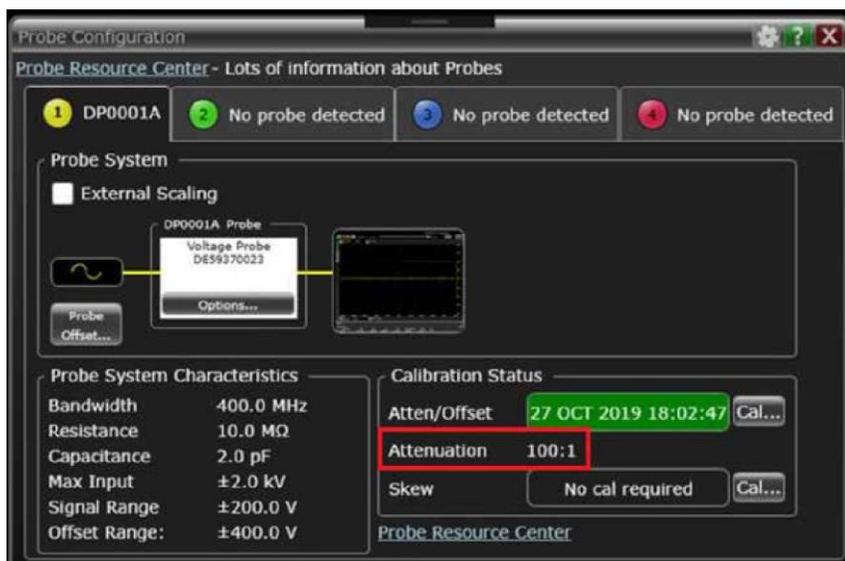
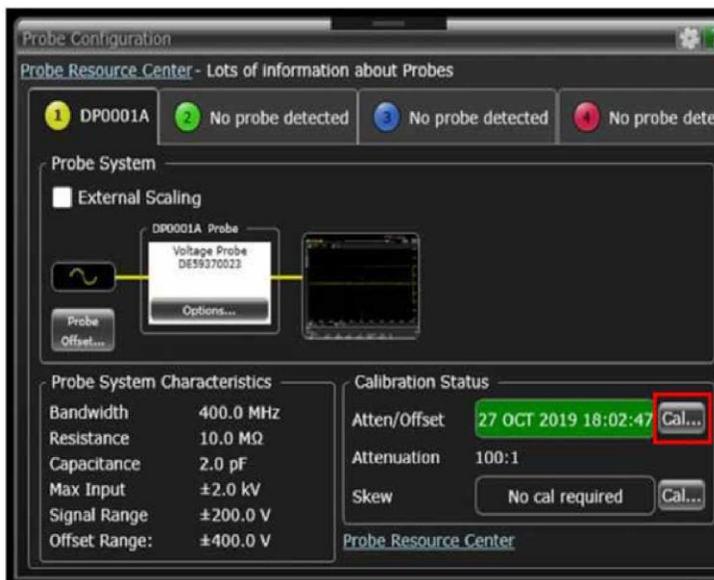


Figure 1 Setting PD0001A Probe Attenuation

Performing DC Offset and Gain Calibration

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

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



The **Probe Calibration** dialog box displays:



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

DP0031A Settings in the Oscilloscope User Interface

Not available, to be developed

PD1550A System Calibration (AutoCal)

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

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

Requirements

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

CAUTION

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

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

NOTE

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

NOTE

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

NOTE

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

CAUTION

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

Schematic for Gate Resistor Modules

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

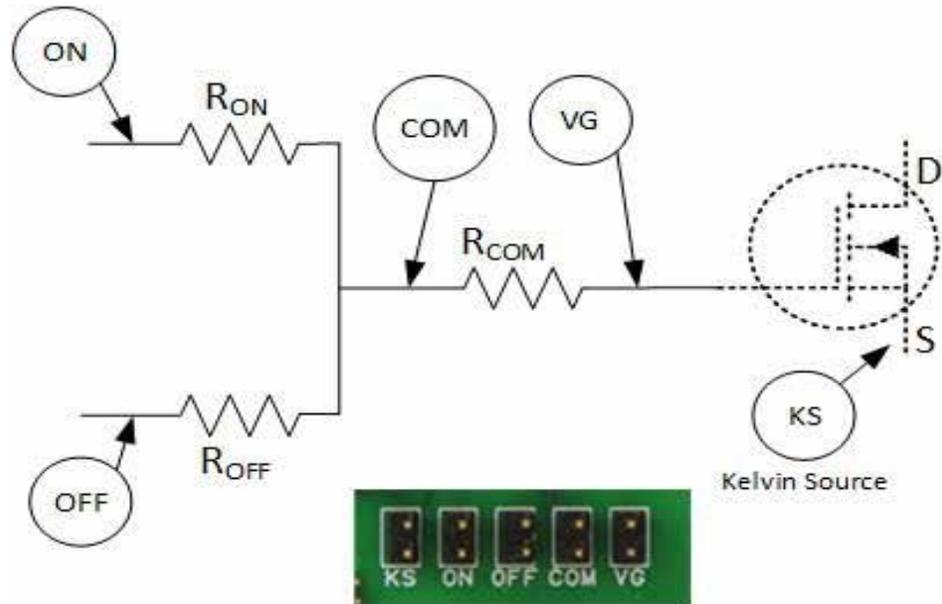


Figure 2

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

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

Hardware Setup:

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

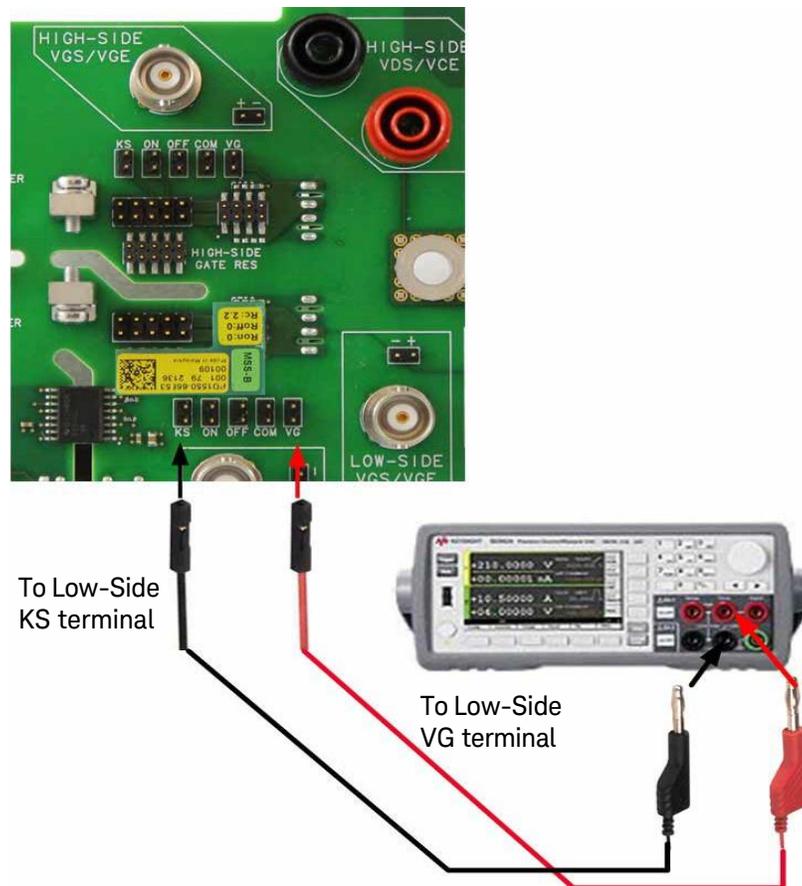


Figure 3 Low-Side Gate Voltage Source Calibration Connections

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

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

Hardware Setup:

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

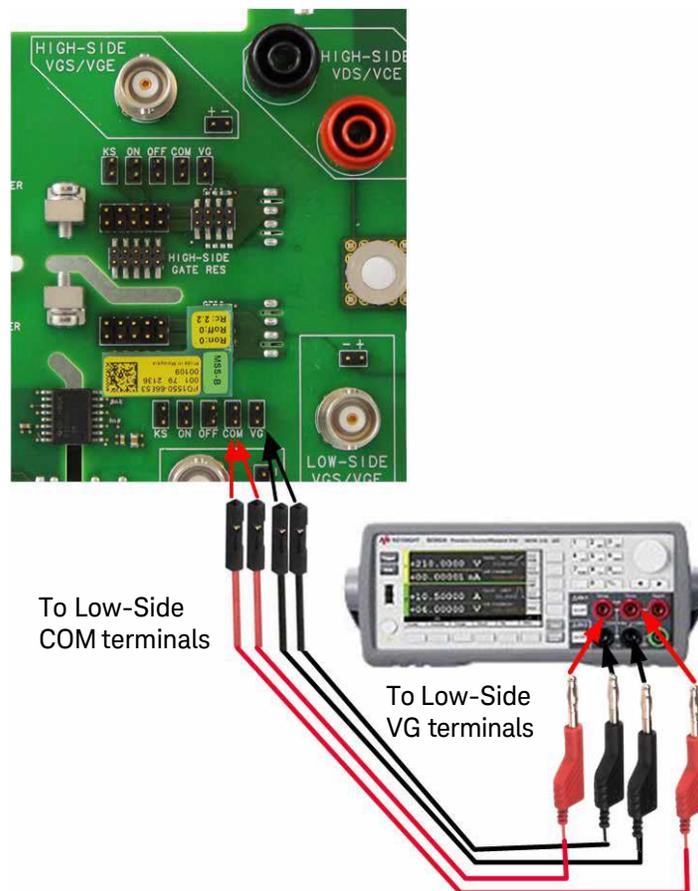


Figure 4 Low-Side R_{COM} Calibration Connections

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

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

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

Hardware Setup:

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

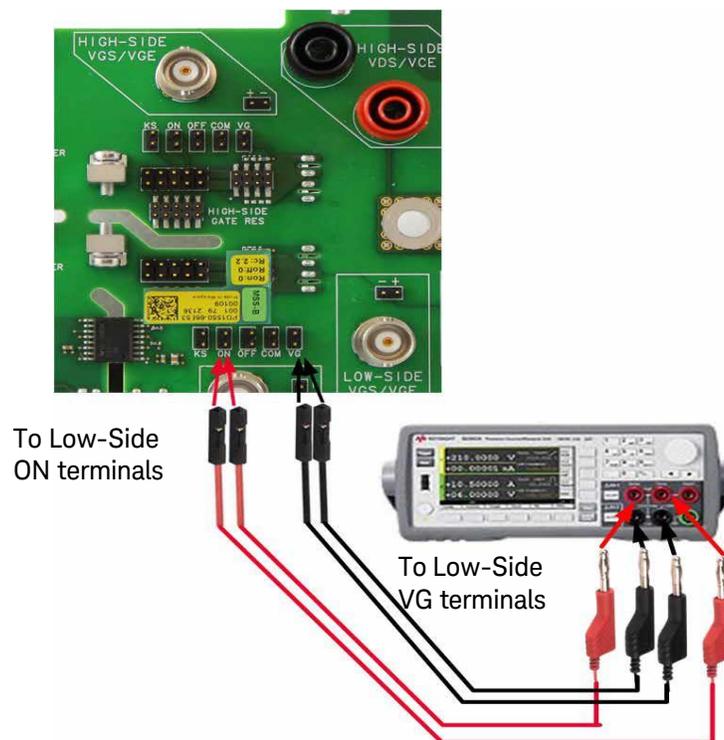


Figure 5 Low-Side $R_{G,ON}$ Calibration Connections

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

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

NOTE

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

Hardware Setup:

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

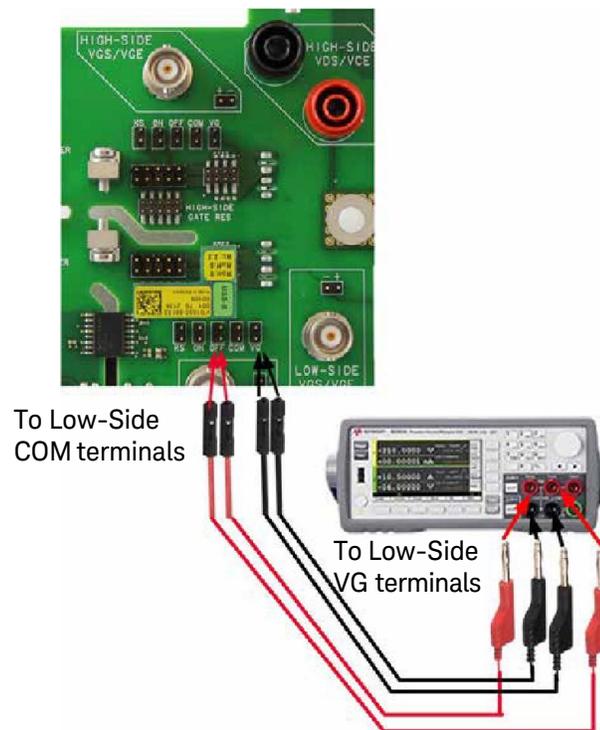


Figure 6 Low-Side $R_{G,OFF}$ Calibration Connections

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

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

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

Hardware Setup:

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

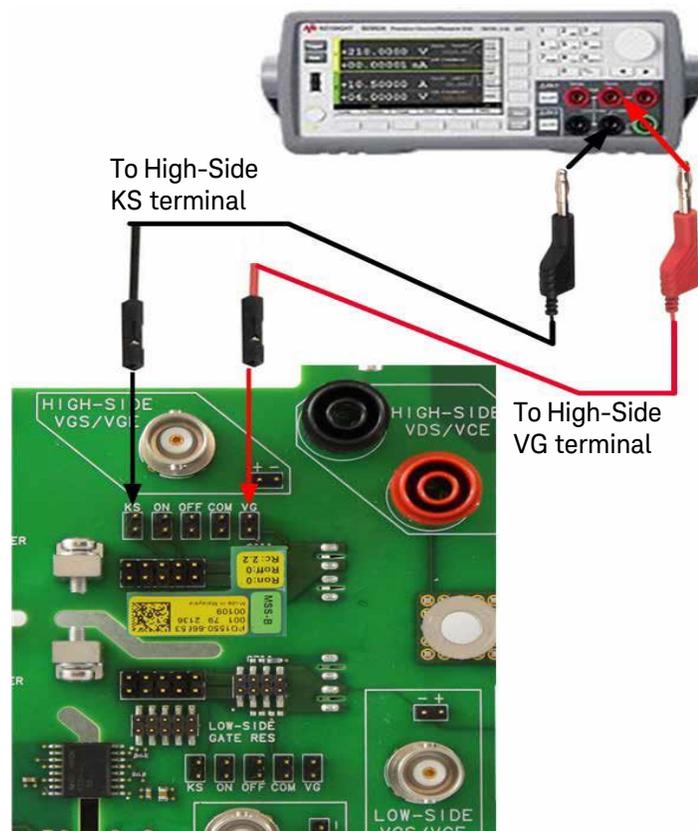


Figure 7 High-Side Gate Voltage Source Calibration Connections

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

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

Hardware Setup:

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

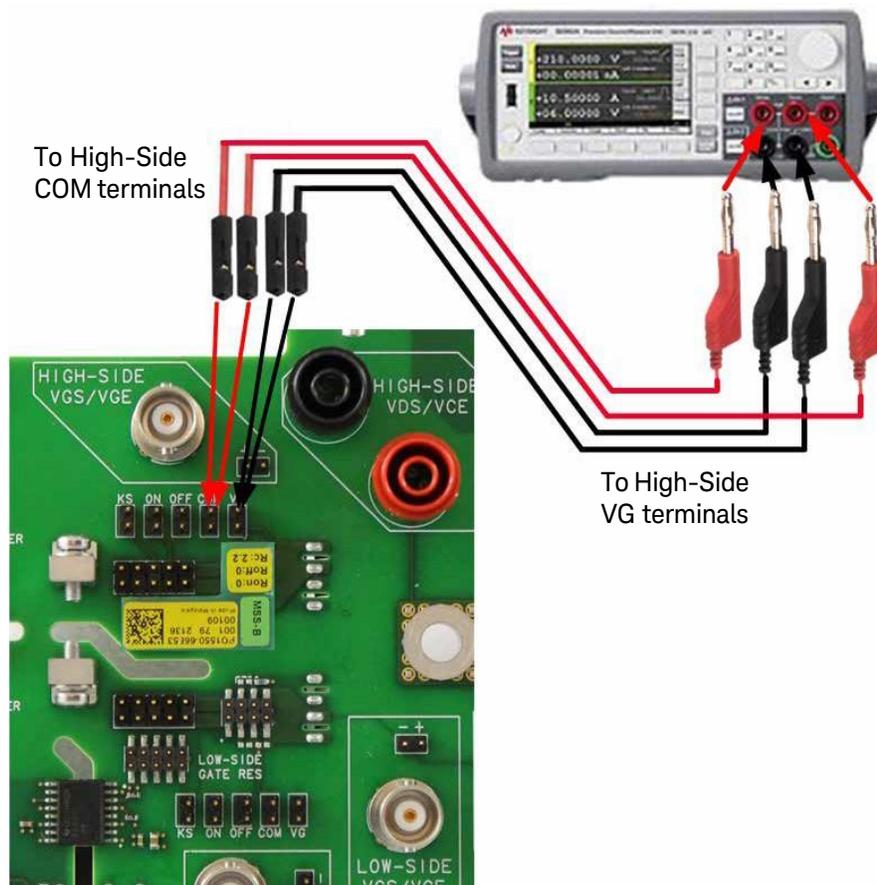


Figure 8 High-Side R_{COM} Calibration Connections

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

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

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

Hardware Setup:

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

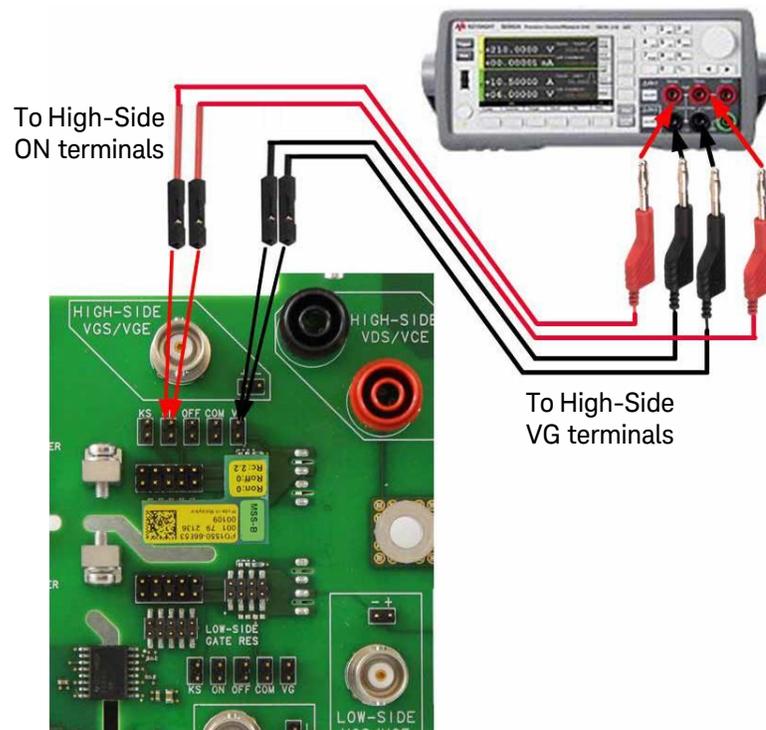


Figure 9 High-Side $R_{G,ON}$ Calibration Connections

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

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

NOTE

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

Hardware Setup:

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

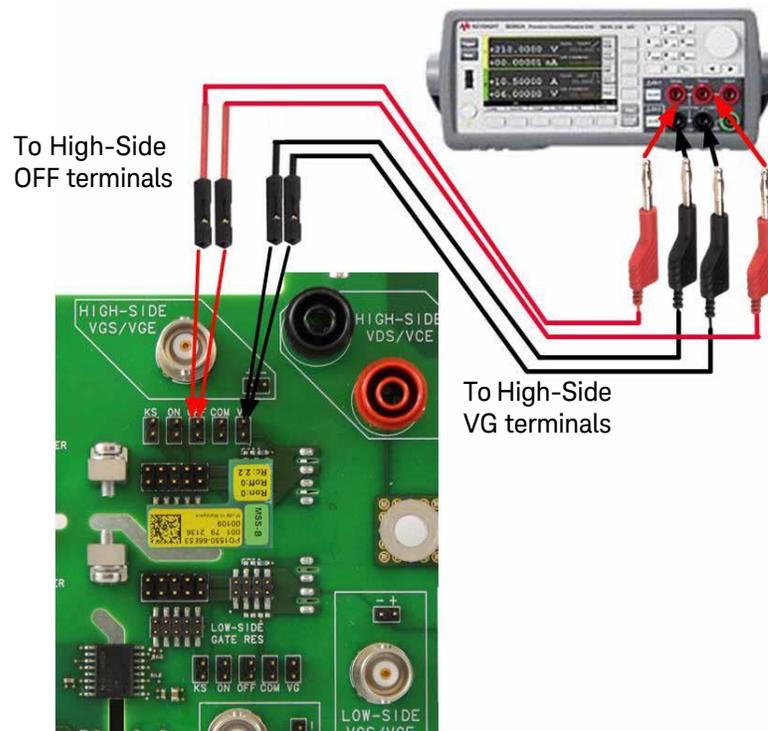


Figure 10 High-Side $R_{G,OFF}$ Calibration Connections

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

10 Calibration Complete

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

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

Coaxial Shunt Resistor Characterization

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

NOTE

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

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

Install the De-Embedding Transfer File on the Oscilloscope

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

NOTE

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

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

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

NOTE

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

A PD1550A System Specifications

Introduction to PD1550A Specification

All PD1500A documentation and individual instrument documentation are available on-line. Refer to the individual Keysight instrument data sheets, user guides and help files for the latest specifications, operation, and use instructions as well as specific warranty and support information.

www.keysight.com/find/PD1550A (for general product information including the PD1550 A data sheet, PD1000A Control Software, etc.)

www.keysight.com/find/MXR108A Infiniium MXR-Series Oscilloscope
For the full list of specifications and characteristics, see the Data Sheet,

www.keysight.com/find/33512B Waveform Generator.
For the full list of specifications and characteristics, see the Data Sheet, literature number 5992-2572, at:
(<http://literature.cdn.keysight.com/litweb/pdf/5992-2572EN.pdf>)

www.keysight.com/find/B2902B Precision Source/Measure Unit
For the full list of specifications and characteristics, see the Data Sheet, literature number 5990-7009, at:
(<http://literature.cdn.keysight.com/litweb/pdf/5990-7009EN.pdf>).

www.heinzinger.com EVO High Voltage Power Supply

Tested Parameters ^{a,b}			
Test	Parameter/Characteristics	Symbol	
Double-Pulse Test	Turn-on delay time	td(on)	
	Turn-off delay time	td(off)	
	Rise time	tr	
	Fall time	tf	
	Turn-on time	ton	
	Turn-off time	toff	
	Turn-on energy	e(on)	
	Turn-off energy	e(off)	
	di/dt	di/dt	
	dv/dt	dv/dt	
	On-resistance	Rds(on)	
	Switching Characteristics		Id vs. t
			Vds vs. t
			Vgs vs. t
		Ig vs. t	
		e vs. t	
Switching locus	Id vs. Vds ^c		
Reverse Recovery	Reverse recovery current rise time	ta	
	Reverse recovery current fall time	tb	
	Reverse recovery time	trr = ta + tb	
	Reverse recovery charge	Qrr	
	Reverse recovery energy	Err	
	Maximum reverse recovery current	Irr	
	Reverse recovery current characteristics	Id vs. t	
Gate Charge ^d	Total gate charge	Qg	
	Threshold Gate Charge	Qgs(th)	
	Plateau gate charge	Qgs(pl)	
	Gate drain charge	Qgd	
	Gate charge curve	Vgs vs. t	
Multiple Tests	Derived output characteristics	Id vs. Vd ^c	

a Based on standards such as IEC 60747 and JESD24 Standards. Other standards methods available in PD1000A software.

b Long off time leads to significant inductor current. This leads to limitations of parameter extraction.

c Quality of the characteristic depends on the cleanliness of measured switching characteristics.

d Gate Charge parameter extraction requires gate current monitoring. The quality of gate charge parameters depends on smoothness of measured curve. High Gate Resistance (e.g., ≥ 100 Ohms or larger) is recommended.

Specifications						
Category	Type		Item	Specification		
Electrical	General		Sample Rate	16 Gsa/s		
			Sampling Accuracy	8 ppb + 75 ppb/year		
			Deskew Accuracy	200 ps (typical)		
	Drain/ Collector Channel	DC	Source	Maximum Voltage	1360 V ^a	
				Minimum Voltage	300 V ^b	
				Maximum Current	1000 A ^c	
				Minimum Current	50 A ^d	
				Voltage Programming Resolution	23 mV	
			Measure	Voltage Accuracy	2% of range (typical)	
				Current Accuracy	4% of range (typical)	
			AC	Measure	Voltage Probe Bandwidth	400 MHz
					Current Shunt Bandwidth (compensated)	200 MHz (typical)
					Voltage transition time	<10 ns (depends on DUT response and Rg)
		Gate	DC	Source	High Level Max / Min Voltage	28V / 0 V
					Low Level Max / Min Voltage	0 V / -28 V
					Voltage Resolution	< 0.1 V (typical)
					Maximum Current	10 A (sink and source)
				Measure	Voltage Accuracy	2% of range (typical)
					Current Accuracy	4% of range (typical)
			AC	Source	Timing Resolution / Accuracy	100 ps / 200 ps
					Typical 1st pulse width	10 to 200 μ s
					Minimum Pulse width (1st Pulse)	1 μ s ^e
					Maximum Off-Time between 1st and 2nd Pulse	25 μ s ^f
	Minimum Off-Time between 1st and 2nd Pulse	1 μ s ^e				
	Maximum Pulse Width (2nd Pulse)	25 μ s				
	Minimum Pulse Width (2nd Pulse)	1 μ s ^g				
		Measure	Voltage Probe Bandwidth	200 MHz		
			Current Probe Bandwidth	200 MHz		

a Maximum supply voltage 1.36 kV; capable of characterizing 650 V, 1.2 kV, and 1.7 kV rated devices.

b This is the minimum voltage; at this voltage the system can reach 1000 A.

c First (1st) pulse - current after 2nd pulse must not exceed 1100 A.

d Lower current values result in less accuracy.

e Lower values may be possible, but are not recommended nor tested.

f Large values for Off-Time lead to significant loss of inductor current. This leads to limitations of parameter extraction.

g Second pulse width must be selected so that the maximum system current is not exceeded

Specifications (continued)			
Electrical	Modular Components	Load Inductors	25, 100, and 600 μ H
		DC-Link Capacitor	TBD
DUT	Discreet Devices	MOSFET, IGBT	
		Silicon and SiC	
		62 mm modules, custom ^a	
System	Safety Enclosure	Size - without signal lamp	125 cm (W) x 103 cm (D) x 174 cm (H)
		Size - with signal lamp	125 cm (W) x 103 cm (D) x 205 cm (H)
		Weight - complete system	~324 kg
	Environmental	Operating Temperature	20 °C to 30 °C
		Operating Humidity	50% to 70% RH, non-condensing
		Operating Altitude	UP TO 2000 M
		Warm-up Time	1 hour
		Storage Temperature	0 to 40 °C
	Line Power	Voltage	MAX 12A/200-240V/2800W/50/60Hz
		Power Consumption (typical)	TBD ^b
		Power Consumption (max)	2.7 kW
	Protection and Safety	Emergency Off Switch (EMO)	
		Maximum energy in system	TBD
		Lock	> 42 V ^c (typical)
		Open Hood Detection	High voltage disconnect DC-Link capacitor discharged
	Over-temperature Shutdown	> 50 °C (typical)	
Interface	LAN		10/100/1000 Base-T Ethernet

a For custom modules, please contact Keysight.

b Without heater / heater-cooler accessory.

c Safety doors cannot be opened when >42 V is present in the system.

How to use this Specification Appendix

This document contains technical specifications for all manufacturing versions of the PD1500A Dynamic Power Device Analyzer/Double-Pulse Tester. Specifications published in the data sheet apply only to the currently shipping version of the equipment.

If a specification only applies to a certain manufacturing version of the equipment, it is indicated in this document. Such changes are usually designated by a serial number break. For example, you might see a table indicating the specification for equipment with “**Serial Number TW51150212 and earlier**” accompanied with another column with “**Serial Number TW51160201 and later.**” indicating that the equipment with serial number TW51160201 and greater use the new specification.

Technical Specification and Characteristics

- **Specifications** describe the warranted performance and include guard bands to account for the expected statistical performance distribution, measurement uncertainties, and changes in performance due to environmental conditions. All specifications and characteristics apply over the operating environment outlined in the “Environmental and Regulatory” section. In addition, the following conditions must be met:
 - All instruments are within their calibration cycle.
 - All instruments have been stored for a minimum of 1 hour within the operating temperature range prior to turn-on and after a 60-minute warm-up period.
- **Characteristics** describe product performance that is useful in the application of the product, but that is not covered by the product warranty. Characteristics are often referred to as Typical or Nominal values.
- **Typical** describes expected performance of an average unit when operated over a 20 to 30 °C temperature range. Typical performance is not warranted. All instruments must be within their calibration cycle .
- **Nominal** describes representative performance that is useful in the application of the product when operated over a 20 °C to 30 °C temperature range. Nominal performance is not warranted.

Additional information

- Any graphs contain measured data from multiple units at room temperature and are representative of product performance within the controlled temperature range unless otherwise noted.
- The data contained in this document is subject to change.

B Using the InTEST Heater

IMPORTANT: InTEST (Sigma Solutions) Thermal Solutions^a heaters and controller are not available from Keysight and must be purchased directly from InTEST Thermal Solutions.

Two pieces of equipment are required: the Heater Control Unit (Watlow) and a temperature plate. Select from the list below and order directly from InTEST. The Controller and Heating plate is for heating the Device under Test (DUT) only, it does not provide cooling.

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



Figure 11 InTEST (Watlow) Controller Unit in Rack Panel and Heating Plate

NOTE

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

- 1 Connect the heating plate to the multi-pin connector on the front of the control unit rack mount panel.
- 2 Place the heating plate on top of the lift table but under the DUT module.

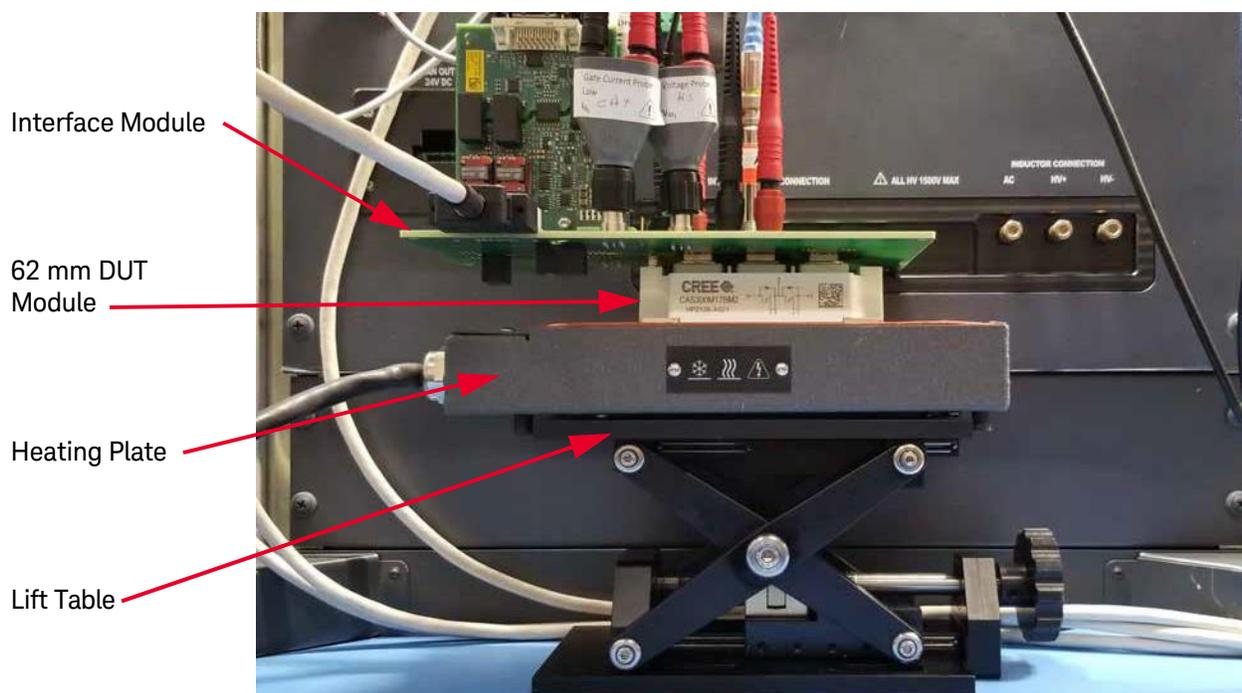


Figure 12 Heating Plate on the Lift Table Supporting the DUT Module.

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

Watlow Controller Turn-on Sequence

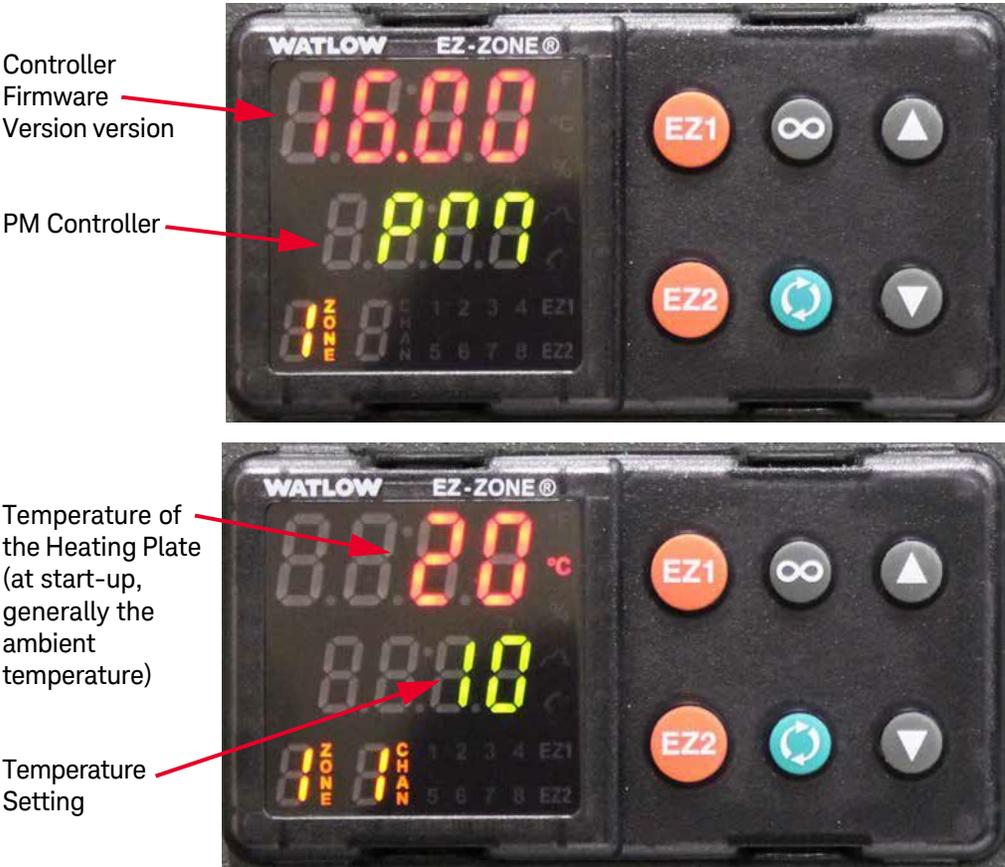


Figure 13 Watlow Controller Turn-on Sequence

NOTE

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



Figure 14 Watlow Controller set for 100 °C, currently reading 75 °C

HP61 Small Plate

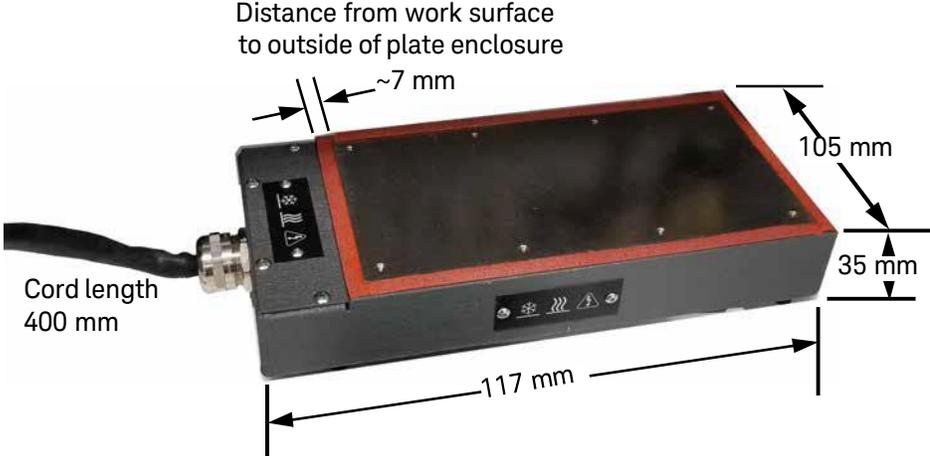


Figure 15 HP-61 Small Heating Plate (not to scale)

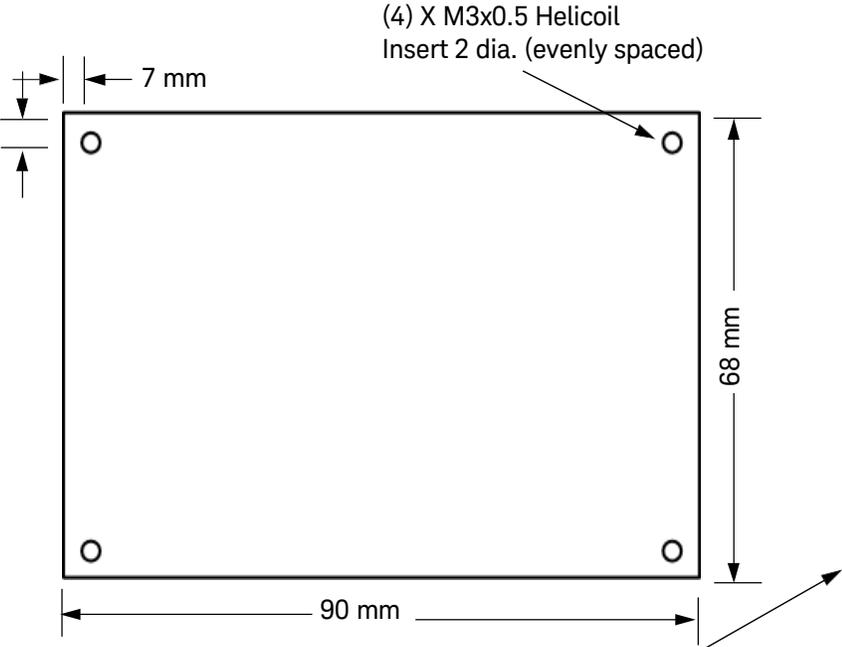


Figure 16 HP-61 Heating Surface Hole Pattern (not drawn to scale)

HP168 Medium Plate



Figure 17 HP-168 Medium Heating Plate (not to scale)

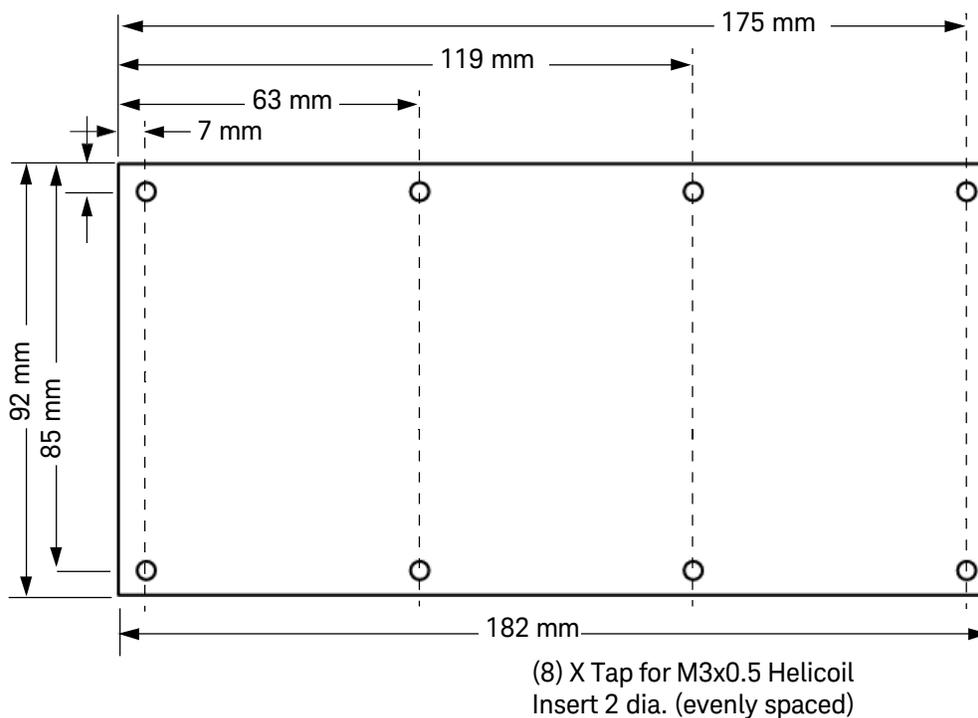


Figure 18 HP-168 Heating Surface Hole Pattern (not drawn to scale)

HP448 Large Plate

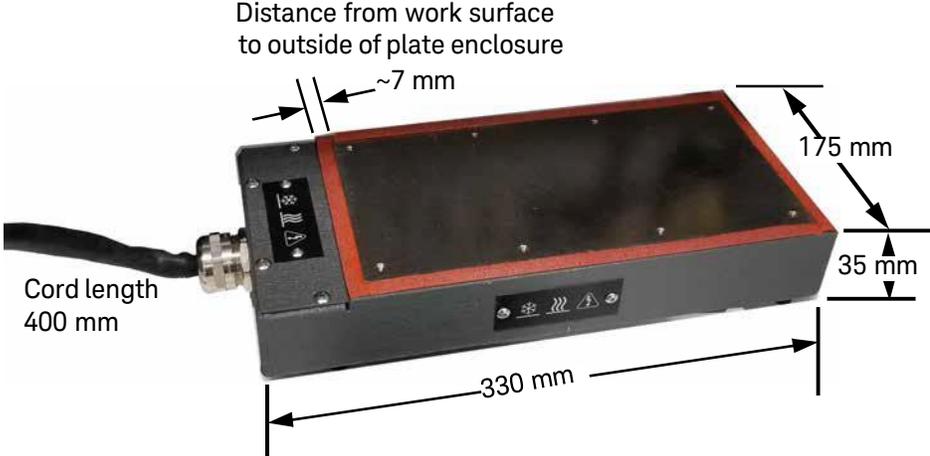


Figure 19 HP-448 Large Heating Plate (not to scale)

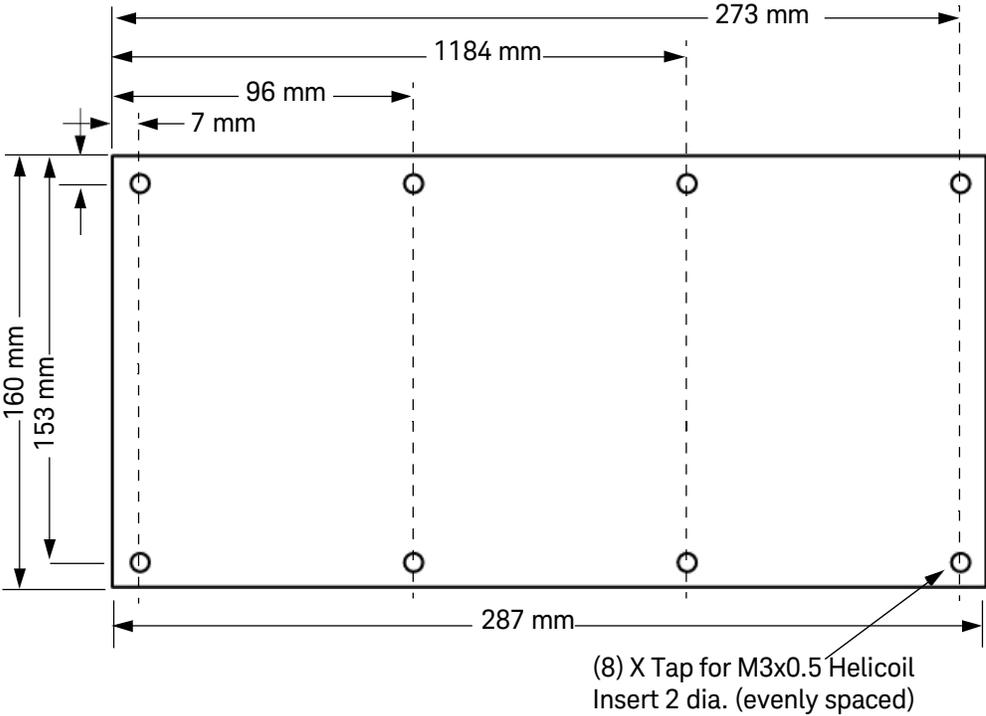


Figure 20 HP-448 Heating Surface Hole Pattern (not drawn to scale)

Using the InTEST Heater

C Update PD1550A Firmware

Use the following procedure to update the firmware in the PD1550A Control Unit and the Safety Unit. To prepare for this procedure, you must first download the firmware updates (*.bin files) to your local PC drive.

There should be two firmware update files, one for the Control unit and one for the Safety Unit. The file names will be in the form:

- PD1550A_CTRL_1.x.xx.bin for the PD1550A Control Unit
- PD1550A_SAFETY_1.x.xx.bin for the PD1550A Safety Unit

Only one can be updated at a time.

CAUTION

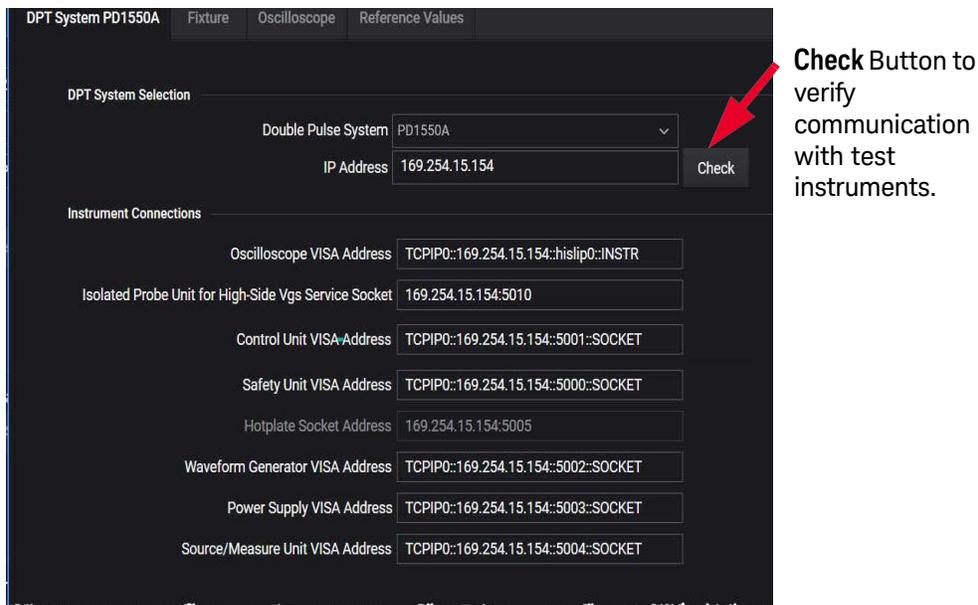
Be sure to execute the Firmware Update procedure only under conditions of reliable power and I/O connectivity to the PD1550A. For example, do not update the firmware with an intermittent LAN connection, a loose power cord, or during a thunderstorm that may interrupt power. Loss of power or connectivity may cause the firmware update to fail, possibly leading to instrument inoperability.

Identify Current Version of Firmware

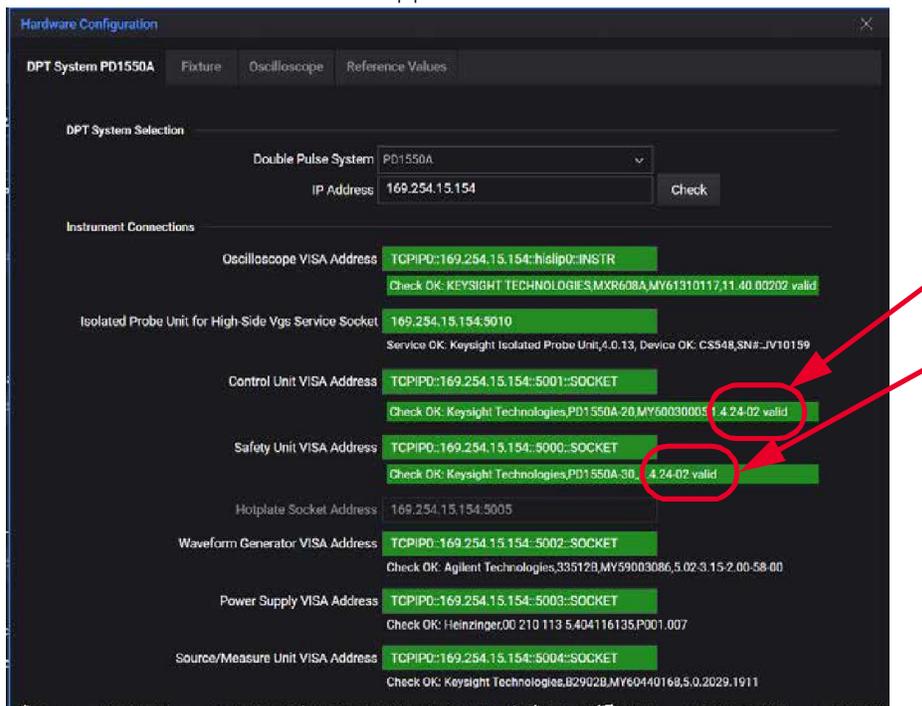
In the PD1000A Control Software:

- 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 Make certain the PD1000A is connected to the PD1550A system.

- 5 Select the **Hardware Configuration > DPT System PD1550A** tab to open the following dialog.



- 6 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 have a green bar and the Control Unit and Safety Unit serial number and firmware code appears:



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

When selecting the **Check** button, ***IDN?** is sent to all the test instruments in the system. If this is successful the instrument address turns green. Additionally, for the Test Fixture, Control Unit, and Safety Unit, the complete ***IDN?** response appears. This includes the serial number and firmware version.

The full identification string documentation for the ***IDN?** response format is:

Keysight Technologies,PD1000A,<serial number>,<firmware revision codes>

A typical return is:

Keysight Technologies,PD1550A-20,MY600R295,A.XX.YY-01-02

where the revision codes are in the form:

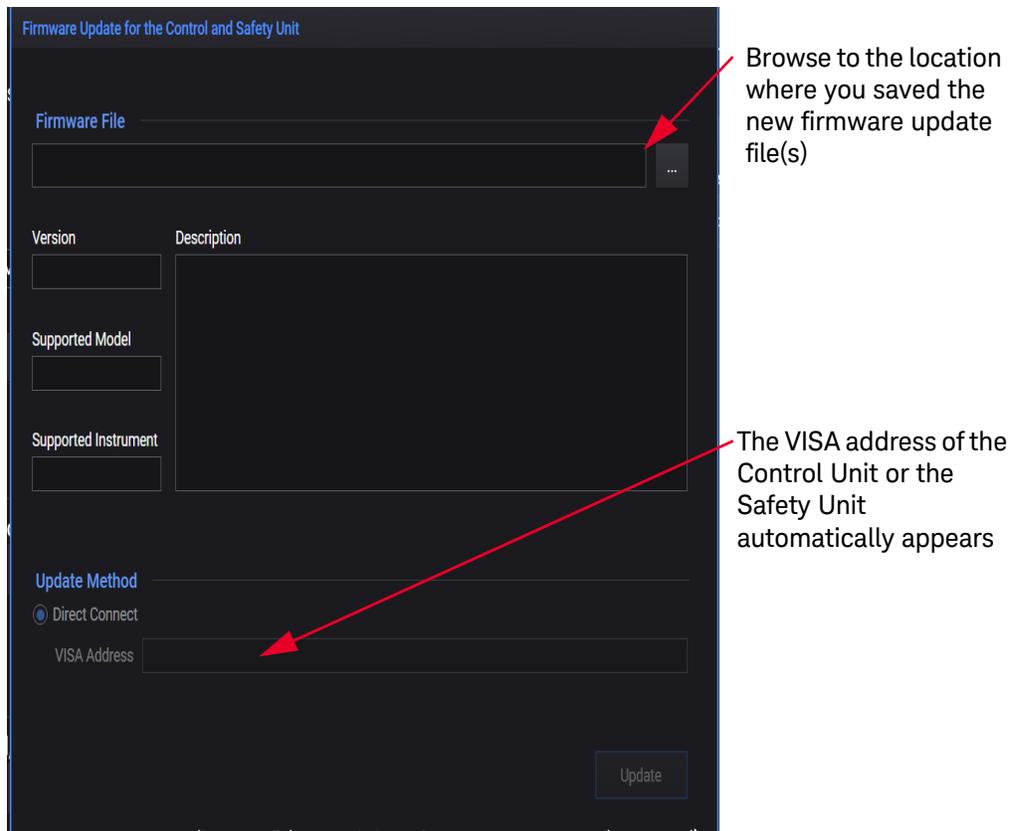
A.XX = major firmware revision

.YY = minor firmware revision

Firmware Update Process

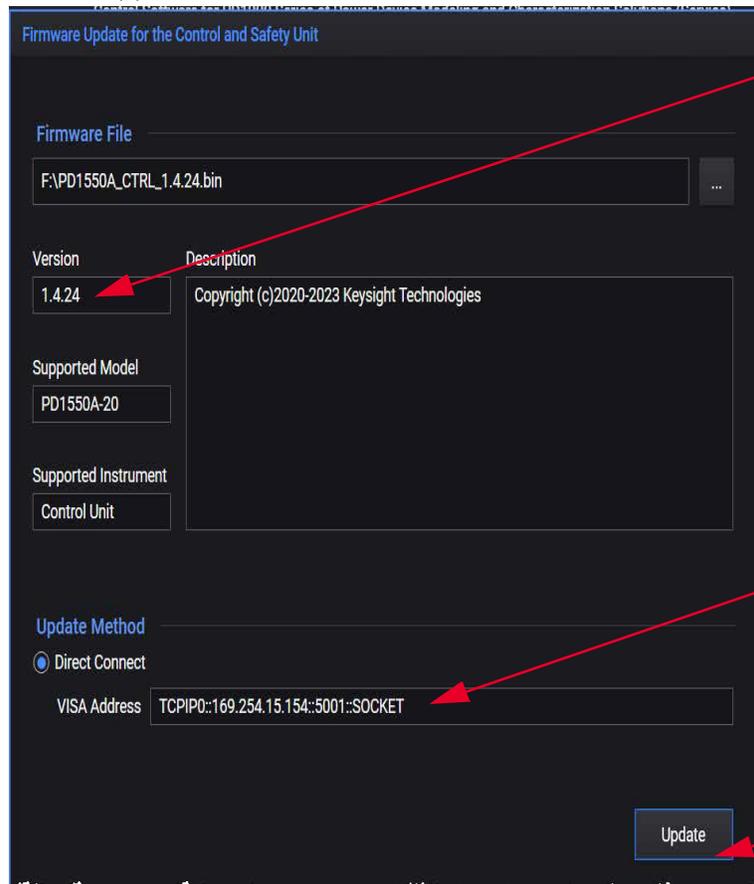
The firmware update utility is included as part of the PD1000A Control Software.

- 1 Click on the **Settings** icon at the top of the screen.
- 2 Select **Firmware Update** from the drop-down menu.
- 3 This opens the firmware update utility..



- 4 Use the **Browse** button in the utility to browse to the location where you saved the new firmware file. Select the file.

- 5 The new Firmware version and the address of the Control Unit or the Safety unit appear. .



- 6 Click the **Update** button in the Firmware utility.

When the utility finishes updating the firmware, the Test Fixture automatically reboots.

Update PD1550A Firmware

D SMA Connector Care & Connection

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

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

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

Final Connection Using a Torque Wrench

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

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



Figure 21 Keysight 8710-1582 SMA Torque Wrench

NOTE

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

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

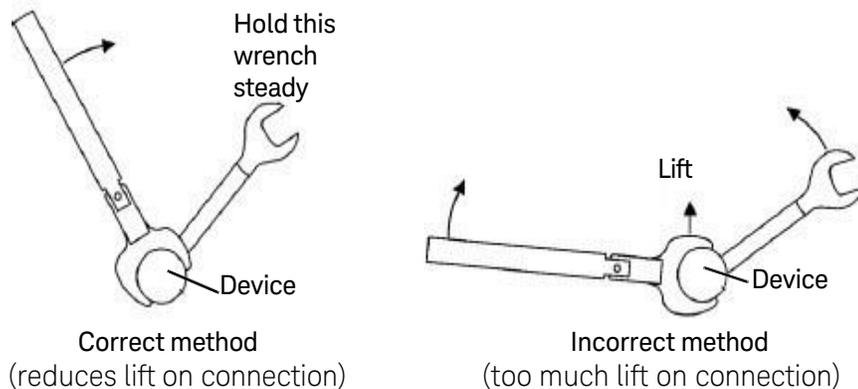


Figure 22 Wrench Positions

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

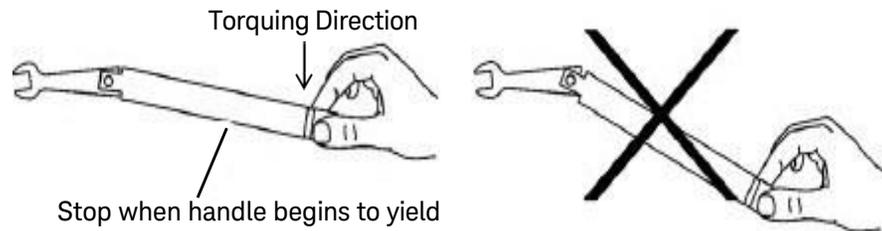


Figure 23 Using the Torque Wrench

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

CAUTION

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

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

Separating Connections

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

CAUTION

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

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

Inspect and Clean Connectors

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

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

Connector Cleaning

WARNING

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

WARNING

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

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

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

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

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



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