PDTD series

User Manual

PDTD68

High Voltage diagnostics system

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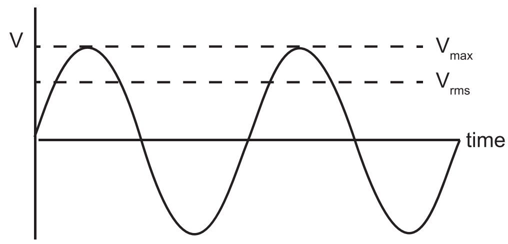
Abbreviations and Glossary

List of terms used in the PDTD series User Manual, sorted alphabetically:

Term	Meaning
Auto frequency	Mode that automatically selects a frequency as close as possible to 0.1 Hz depending on the connected load.
Com unit	Short for "Communication Unit." A modular component responsible for managing data exchange between system elements. For a detailed explanation, see Chapter 4.4.
DUT	Short for "Device under test"
FOC	Short for "Fiber optic cable"
Guard	Leakage current correction
HV	Short for "High voltage"
MWT	Short for "Monitored withstand test"
PD	Short for "Partial discharge"
PDC	Short for "Partial discharge calibrator"
Propagation velocity	Speed at which an electrical signal can propagate through the cable given in [m/µs]. The propagation speed depends mainly on the used insulation material of the cable.
RMS value	Root mean square voltage of sine wave voltages. Vrms = Vmax / √2 
Sample	Applies to Tan Delta measurements only and defines the test duration. Each valid measurement value is one sample. In general, you get one sample per period (0.10 Hz → 10 s is one period).
Sequence	Test consisting of up to 15 test steps.
TD	Short for "Tangent Delta" / "Tan Delta"
VLF	Short for "Very low frequency" 0.1 to 0.01 Hz range
Withstand Test	Test in which a voltage of a predetermined magnitude is applied for a predetermined time duration.

1 Introduction

Purpose
This user manual provides information on the proper and safe use of the PDTD diagnostics system and of b2 Suite, a software program designed for the management of the PDTD diagnostics systems. b2 Suite communicates with the unit over the fiber optic cable.
The manual contains important safety rules for working with this product and gets you familiar with operating this product. Following the instructions in this document will help you to prevent danger, repair costs, and avoid possible down time due to incorrect operation.

1.1 Regarding this document

This user manual applies to the PDTD68 VLF partial discharge diagnostics system with integrated Tan Delta unit.

Safety first

NOTICE

While working with this PDTD diagnostics system, it is essential to always keep this document and corresponding Safety Instructions for the PD, TD & PDTD Series (b2 article Nr. DHV1441) at hand. Proceed with the measurement only if all safety precautions, applicable normative and relevant safety regulations are obeyed.

Documentation conventions
Safety colors and safety signs mentioned in this document are used in accordance with the International Organization for Standardization technical standard ISO 3864-2; symbol definitions in accordance with ISO 17724. All safety signs and their referents are used in accordance with ISO 7010.

Hazard Severity Panels
Hazard severity panels mentioned in this document are used in accordance with the International Organization for Standardization technical standard ISO 3864-2. They are rectangular in shape and contain the following elements: the general warning sign, the hazard severity panel color and the signal word (which is however optional). Signal words appear in upper case and bold fonts.

- **High level of risk**
  Red background with a white contrast color and a warning sign.
  Danger label: Indicates a hazardous situation that, if not avoided, will result in death or serious injury.

- **Medium level of risk**
  Orange background with a black contrast color and a warning sign.
  Warning label: Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

- **Low level of risk**
  Yellow background with a black contrast color and a warning sign.
  Caution label: Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

Signal Word Definitions

DANGER

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

Indicates information considered important but not hazard related.

Safety signs and their referents

Warning sign
Hazard: Electricity
Human behavior intended: Taking care to avoid coming into contact with electricity.

Prohibition sign
Hazard: Risk to people specified by the supplementary sign.
Human behavior intended: Not doing an action specified by the supplementary sign.

Mandatory action sign
Hazard: Risk to people not following the mandatory action specified by the supplementary sign.
Human behavior intended: Carrying out mandatory action specified by supplementary sign.

1.2 Designated use

Diagnostics of medium and high voltage cables provides the opportunity for early detection of potential issues, enabling preventive maintenance to be carried out before the cable fails in service. The PDTD system provides a portable solution for the diagnostics of all kinds of medium voltage cables. It enables simultaneous and sensitive partial discharge (PD) and Tan Delta (TD) diagnostics with sinusoidal operating voltage with constant frequency. The device is specially designed for the use with the HVA very low frequency (VLF) test sets and a PC to remotely control the devices.

Appropriate devices under test (DUTs)
- Extruded cables (e.g. XLPE)
- Laminated cables (e.g. PILC)
- Insulated cables
- Cable jackets / sheaths

Appropriate high voltage tests
- Simultaneous PD and TD diagnostics
- Partial Discharge diagnostics
- Tangent Delta diagnostics

NOTICE

If the PDTD diagnostics system does not appear to function properly, discontinue use immediately and contact b2 electronics Technical support (see Chapter *1.5 Technical support* for contact details).
Only qualified personnel at the b2 electronics Repair Center are authorized to open the device for inspection, maintenance, or repair.

1.3 Operator qualifications

Working on high voltage assets can be extremely dangerous. Only personnel qualified, skilled, and authorized in electrical engineering are allowed to operate this PDTD diagnostics system and its accessories! Proof of necessary qualifications for working in the high voltage domain as well as obeying relevant local safety regulations is mandatory.
Before approaching the work, clearly establish the responsibilities.
The supervising operator is responsible for the safety requirements during the whole measurement.

1.4 Legal considerations

Compliance statement
The device is referred to in the following statements as “PDTD diagnostics system”, "VLF diagnostics system", “PDTD system", "device”, “equipment” or "appliance". All relevant high voltage tests listed in chapter *1.2 Designated use* comply with the following standards and guidelines:
- Test setup and calibration: IEC 60270
- Tan Delta testing: IEEE 400.2

They both are implemented in the b2 Suite software.

Declaration of conformity (EU)
The equipment adheres to the guidelines of the council of the European Community for meeting the requirements of the member states regarding one or a combination of the following directives: Electromagnetic compatibility (EMC) directive; Low voltage directive (LVD); RoHS directive.

Declaration of conformity (UK)
The equipment adheres to the regulations of the UK government for meeting the requirements regarding one or a combination of the following regulations:
- Electromagnetic Compatibility (EMC) Regulation
- Electrical Equipment Regulation (Safety)
- Regulation for Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment

FCC compliance (USA)
This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense. Changes or modifications not expressly approved by the party responsible for compliance could void the user’s authority to operate the equipment. If this equipment does cause harmful interference to radio or television reception, contact b2 Technical support.

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1.5 Technical support

b2 electronics Technical support provides you with following services regarding the b2 products:
- Technical support
- Technical information on repairs
- Basic applications assistance
- Product trainings
- Support at measurement for training purposes

For technical inquiries or to access our support services, please contact our Technical support team at:
support@b2hv.com | T +43 59896 3232

2 Safety instructions

In this chapter, the most important safety instructions for the use of the PDTD diagnostics system are summarized. Respect all safety information contained in here! If you do not understand some of the safety instructions, contact b2 electronics Technical Support Team before proceeding (see previous page for contacts).

Before carrying out any high voltage test with a b2 VLF diagnostics system, read these Safety Instructions in their entirety. They are at your disposal also in a separate brochure Safety Instructions for the PD, TD & PDTD Series (b2 article Nr. DHV1441) where they are available in all EU languages.

NOTICE

Do not operate this b2 VLF diagnostics system without understanding the safety information!
This system is meant for specific applications only. Use it in a safe manner and sound condition only.

2.1 Safety rules for HV testing

CAUTION

It is mandatory to obey the five safety rules in the following order at all times!

1. Switch out Device Under Test
2. Secure against re-energising
3. Discharge and prove dead
4. Ground and short circuit
5. Cover or close off nearby live parts

You may proceed with the measurement using this diagnostics system only if all safety precautions, applicable normative and relevant local safety regulations are obeyed.

WARNING

Please study the equipment setup for this specific diagnostics system (see the inner flip outs of the Safety Instructions for the PD, TD & PDTD Series) in order to set up the equipment in a safe manner!
Establish secure earthing via connection 5. Follow the "Safe equipment setup" instructions in the chapter 2.2 below to do that in a safe and proper manner.

DANGER

Electric shock hazard
NEVER assume that equipment is safe to handle without using the necessary safety equipment and earthing procedures.

2.2 Safe equipment setup

Prior to starting the measurement, please refer to the equipment setup for the PDTD diagnostics system placed on the inner flip outs of the Safety Instructions for the PD, TD & PDTD Series and the five safety rules mentioned above under "Caution".

2.3 Short-circuiting the diagnostics set

To ensure safe operation and prevent accidental discharge, the diagnostics set must always be short-circuited when not in use. This includes periods between measurements, during storage, and throughout transport.
Use the designated 4 mm socket 50 which is available either on the top of the device or in the bottom module to establish the short-circuit connection. See page 10 for the exact location of socket 50.

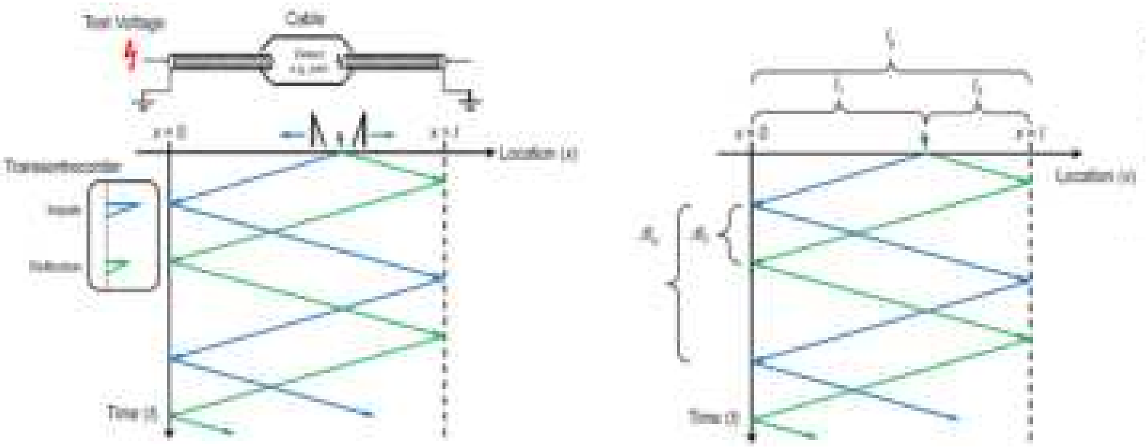
Why this is important: Short-circuiting the device safely discharges any residual high voltage that may remain after testing. This prevents unintentional electric shocks, equipment damage, or interference with other sensitive instruments. It also ensures that the device remains in a safe state during handling and transport.

3 About the diagnostics

3.1 PD basics

Long high voltage cable behaves as a wave guide. The cable has a conductor, a dielectric and a coaxial neutral (Screen copper tape or lead) which forms an ideal wave guide. The dielectric creates a large capacitor. The longer the cable, the more of these capacitors are in parallel. These PD waves travel down the wave guide – one PD wave to the one end of the cable and the other PD pulse to the opposite end. If we now place a capturing device – a coupling capacitor and a Digital Storage Oscilloscope at the one end, it is possible to view the "time of flight" of these PD pulses.

The following echo-gram is displayed by the transient recorder (b2 Suite). The 1st PD pulse (emanating from the PD source) arrives first at the coupling unit (see pulse marked 1st whilst the 2nd pulse travels to the far end), travels the full length of the cable and arrives at the coupling unit (see pulse marked 2nd). The 1st pulse reflects out of the coupling unit and travels to the far end and reflects back hence 3rd pulse. Δt2 is therefore the time difference between these two incoming pulses and the time to the PD source from the far end. If we now know the velocity of propagation of the PD pulse in the cable, we can calculate the distance to the PD source (dist = velocity x time).



Illustrations by Dr. Daniel Pepper

Unfortunately on very long cables the subsequent reflections may be attenuated to such an extent that they are not visible. Joint / splices also attenuate these pulses.
PILC cables have a greater attenuation on these traveling PD waves than that of a similar XLPE cable. If the returning pulse (2nd) is not visible, it is not possible to do a localization. The 1st pulse merely indicates that there is a discharge on the cable. By examining the rise times of the calibration pulse and this PD pulse it is possible to determine if it is from the near end termination or not.

3.2 Partial Discharge diagnostics made easy

Measuring PD on medium voltage cables is essential for fault-free power distribution. Conducting diagnostics of medium- and high voltage cables enables early detection of vulnerabilities and preventive maintenance work to ensure the long-term performance of the distribution system. PD allows a precise analysis of cables and their joints and terminations; TD allows a clear statement about the overall dielectric condition of aged polymeric cables and especially any damage by so-called "water trees".

PDTD68 is the latest member of our PDTD diagnostics series with a maximum voltage level of 68 kVpeak. While other PDTD systems consist of two separate devices (filter and coupling capacitor including data acquisition), the PDTD68 combines these into one housing, which allows simultaneous PD and TD diagnostics with one single device. Due to the new filter design and the increased coupling capacitor value the systems offer a better sensitivity. Furthermore, the redesigned signal acquisition of the PD signals provide the users additional opportunities for the PD analysis. (E.g. amplifier, digital filter, ...).
The localization of the PD faults is precise and sensitive, in real time, with 1 % accuracy and resolution of 0.1 pC and 0.1 m. These functionalities have many benefits which provide an efficient, cost-effective, and reliable method for assessing the condition and performance of medium voltage cables in-field.

3.3 Complete system

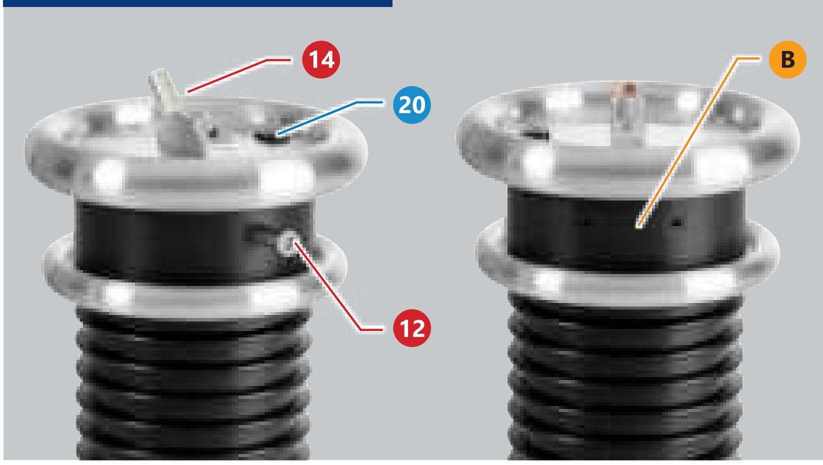
In combination with an HVA test set from our extensive product portfolio, you get a full-featured and full-value VLF cable test set and PDTD diagnostics system for up to 68 kV. For more information, please go to https://b2hv.com/products/hva-series.
You can apply the system to all kinds of medium voltage cables with length up to 100 km.

4 Design & construction of the PDTD system

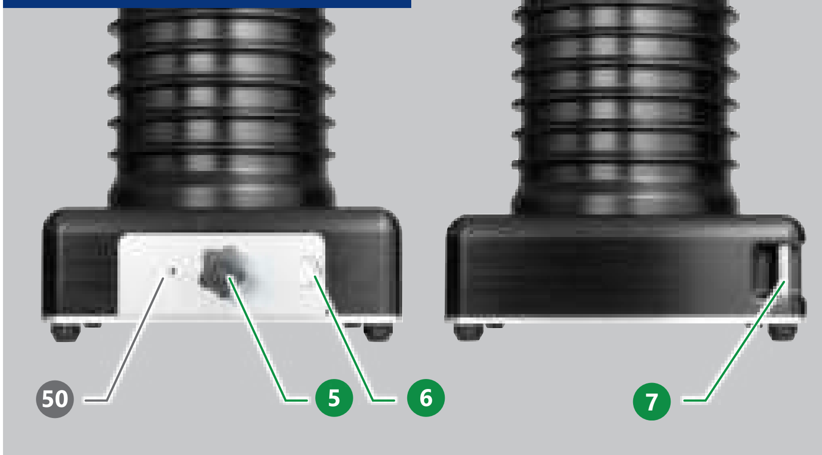
The images below outline the device's design, highlighting its key components and their physical arrangement. The table on the following page describes each of these components in further detail.

Corona sphere

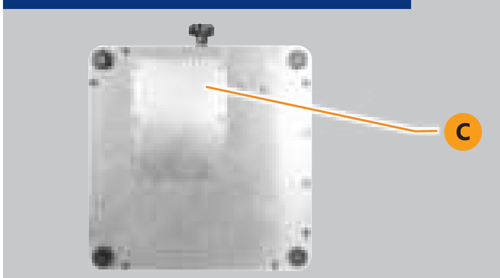
Top view:



Side views of the bottom module:



Bottom view:



Com unit 38

4.1 Components description

The following table presents the components of the PDTD diagnostics system, as illustrated on the preceding page.

Nr.	Name	Description
5	**Earthing connection**	Serves as the main connection point from the PDTD system to earth.
6	**MC14 contact**	Serves as optional earthing connection (for cables with MC14 contacts).
7	**Earthing rod**	Serves as optional earthing connection (for cables with G-clamp or 600 A clamp connections).
12	**MC14 contact - HV input**	Serves as connection point to the HV source.
14	**MC14 contact - DUT**	Serves as connection point to the DUT.
20	**Guard connection**	Serves as a socket for the guard cable. For more information see chapter *6.6 PDTD test setup with guard*.
33	**Fiber optic cable (FOC) socket**	Interface for establishing communication between the PDTD system and the PC. Connect the FOC to the communication unit (Com unit) and the Com unit to the PC. This setup enables data transfer and system interaction during measurement operations.
34	**USB-C® socket**	Serves as a power source, when connected to a power bank or a mains-connected adapter. It does not serve as a connection to the PC for the measurements.
38	**Com unit**	Communication unit serves as an interface between the fiber optic cable and the PC. For more information see chapter *4.4 Com unit*.
45	**Battery switch [I/O]**	The battery switch controls the power source for the device and manages the charging behavior of the internal [main] battery C: Switch ON ("I"): The system operates using the internal [main] battery C. This mode is used when external power is not available or when portable operation is required. Switch OFF ("O"): • The system operates using an external power supply. • The internal [satellite] battery B is charged if the device is connected to a power source.
50	**4 mm socket**	There are two sockets in the top part and one other one at the bottom module. Function: • Serves for applying the short-circuit connection. For more information see chapter *2.3 Short-circuiting the diagnostics set*. • Optionally serves as connection point for the PDC. However, we recommend using connection via 51 .
51	**4 mm socket on the corona sphere**	A 4 mm socket on the corona sphere which serves as a connection in corona spheres for connecting the PDC. For more information see chapter *6.6.1 PD calibrator test setup*.
A	**Batt. operation LED FOC LED USB-C LED**	See chapter *4.5 LED communication status* for details on how these three LEDs in the bottom module behave to indicate the status of PDTD system, user actions and power conditions.
B	**TD satellite battery**	The battery powers the TD satellite during TD measurements. Activation of the battery is managed exclusively through the b2 Suite software, which automatically powers on the TD satellite before each TD measurement. The battery status is displayed only within the b2 Suite interface; there is no physical battery status indicator on the PDTD device itself.
C	**Main battery**	The built-in battery powers the control unit. It is bottom-mounted. Flip the device to access it.

4.2 Earthing options

The device provides multiple earthing connection points to accommodate different cable types and connector configurations:

- 5 Earthing connection
- 6 MC14 contact
- 7 Earthing rod

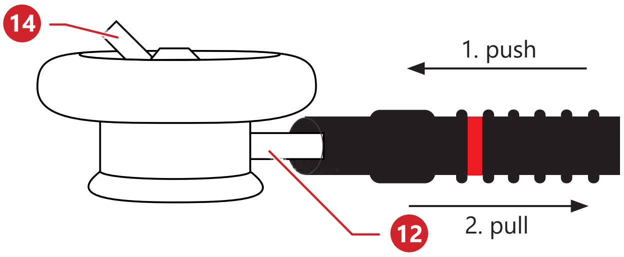
When multiple options are available, we recommend using earthing connection 5, as it offers the most suitable and reliable earthing solution.

Below is the PDTD68 device from two different viewing angles to identify all three earthing connection points in the bottom module, each marked with its corresponding number.

4.3 MC14 contacts

The PDTD diagnostics system utilizes MC14 contacts at three points:

- for high voltage connections 12
- for connections with the device under test 14
- for earthing the device 6 (depicted in the image above)



These contacts are designed for versatility and reliability, ensuring secure electrical connections under varying operational conditions. Interchangeable adapters are included to accommodate different configurations and use cases. For details, please refer to the corresponding PDTD datasheet.

The MC-locking system operates on the „push-pull" principle. It is self-locking when connected.
Disconnection is performed by an axially sliding coupling ring: first push the socket further in, then pull to disconnect.

4.4 Com unit

The Communication Unit (Com unit) 38 serves as the interface between the fiber optic cable and the PC, enabling seamless data transmission between the diagnostics hardware and the software environment. It converts optical signals from the fiber optic line into electrical signals that can be processed by the PC, and vice versa. Thanks to the Com unit, the PDTD device is galvanically isolated from the PC, which enhances system safety by preventing electrical interference or potential damage due to ground loops. This unit ensures reliable and high-speed communication, which is essential for accurate diagnostics and real-time monitoring.

NOTICE

Connection is only possible via a USB 3.0 port or higher.

Fiber optic data cable, on the left, (b2 article Nr. GH0941), PDTD communication unit 38 (b2 article Nr. GH5942) as well as USB-C cable, on the right, (b2 article Nr. KEK0219) are all included for the PDTD device in the scope of supply.

4.5 LED communication status

The three LEDs located in the bottom module A provide visual feedback on the status of the PDTD system, user interactions, and power conditions. Each LED corresponds to a specific function and is organized into its own column in the two status tables below. Different colors of the LEDs indicate a particular state or condition, allowing users to quickly assess system performance and identify potential issues.

Below is a detailed description of each LED and the meaning of its color indicators.

State		LEDs: Battery operation LED	Fiber optic cable LED	USB (5V) LED
Startup checking the functionality	step 1 (0.25s)	red	red	red
	step 2 (0.25s)	white	white	white
	updating FW, do not turn off or disconnect!	-	blinking blue	-
	... update finished, restart the device	-	blinking blue/green	-
	... update failed, restart the device	-	blinking blue/red	-
	ready to connect to PC	-	blinking yellow	-
Communication FOC connected	ready / connected		green	
	PD and/or TD measurement started		blinking green	
	Software disconnected		blinking yellow	
Communication FOC disconnected			blinking yellow	

State		LEDs: Battery operation LED	Fiber optic cable LED	USB (5V) LED
Battery operation ON & H disconnected	-	green ≥50% to yellow ≥20% to red <20% to fast red blinking <10%	-	-
Charging the battery ON & H connected		steady green for fully charged to green blinking for ≥50% to red blinking for <20%	-	green when charging the battery. blinking yellow, if the battery
Operation over USB	-	-	-	green when powered over USB. blinking yellow, if there is only 5V over USB. This is insufficient to power the device.

4.6 Power supply options for the PDTD diagnostics system

When operating the PDTD diagnostics system, selecting the appropriate power supply is crucial for ensuring safety, reliability, and measurement integrity. Depending on the application environment, whether in the field, or integrated into a larger system, different power supply methods offer distinct advantages and trade-offs. This section outlines three primary options for powering the device. Each method provides unique benefits in terms of portability, isolation, and convenience.

4.6.1 Battery operation

The unit is equipped with a built-in 6 V gel lead-acid "main" battery C located on the underside. Since it does not contain lithium-ion components, it can be safely transported by air without the need for special documentation or hazardous materials declarations. Using this integrated 6 V block battery to power the PDTD system offers a simple and portable solution, especially in scenarios where mains power is unavailable. The standardized form factor of 6 V batteries ensures wide availability across the globe, making them a reliable backup power source. Additionally, since these batteries are isolated from mains electricity, they inherently avoid issues such as electrical noise. This makes them ideal for field use, or emergency situations where clean and consistent power is essential.

To use the internal battery, the switch 45 has to be turned on.
The battery is located on the underside of the device. To replace it, see chapter *9.4 Battery replacement* for the procedure.

4.6.2 USB-C power via a power bank

Powering devices via USB-C offers significant advantages over traditional mains power supplies. One of the key benefits is the elimination of noise typically coupled in from AC mains, which can interfere with sensitive electronic circuits and degrade performance. Moreover, USB-C power delivery abstracts away the complexities of regional voltage and frequency differences. For instance, North America uses 110 V at 60 Hz, much of Europe and Asia use 230 V at 50 Hz, Japan operates on both 100 V at 50 Hz and 60 Hz depending on the region, and parts of South America and Africa vary between 127 V and 220 V at either 50 Hz or 60 Hz. These inconsistencies can pose challenges for global device compatibility. By standardizing power input through a universal interface, USB-C simplifies design, enhances portability, and ensures reliable operation across different regions without the need for bulky adapters or voltage converters.
For this option, the switch 45 has to stay off. The external power supply will automatically turn on the PDTD system.

4.6.3 USB-C power via a mains-connected adapter

Using a USB-C power supply connected directly to the mains offers a convenient and continuous power source, particularly suitable for stationary or long-duration applications. However, this method requires careful consideration of electrical safety and signal integrity due to the direct connection to the building's electrical system. It is best suited for controlled environments where stable power and proper earthing infrastructure are available.
For this option, the switch 45 has to stay off. The external power supply will automatically turn on the PDTD system.

4.7 Communication interface – fiber optic requirement

Regardless of the chosen power supply method from above, all configurations require a fiber optic connection for communication with the b2 Suite software on the PC. This interface is essential for maintaining signal integrity and safety in HV environments.

Fiber optic communication offers complete immunity to electromagnetic interference, ensuring that sensitive measurement data remains accurate and undistorted, even in electrically noisy conditions. More importantly, it provides galvanic isolation between the PDTD device and the control electronics, significantly enhancing user safety and system reliability.
This isolation is especially vital in PD diagnostics, where precise, high-speed data transmission is necessary for accurate PD detection and localization. In contrast to copper-based connections, fiber optics enable reliable, interference-free communication, making them indispensable in HV testing scenarios.

5 PC software

The PDTD diagnostics system is delivered with a set of Windows-based software tools in an integrated software package. The corresponding b2 Suite v2 software with the version v2.2.0.50 or above connects, records, analyses and reports the test results from the PDTD system.

When the PDTD system is connected to the b2 Suite, reports and sequences can be downloaded from the PDTD using the corresponding functions. See software manual for further information.

Software-Controlled Battery Operation

The TD satellite is powered by an integrated battery B (b2 article Nr. M0026) during TD measurements. It is housed within the PDTD device and can only be activated via the b2 Suite software. Prior to each TD measurement, the software automatically powers on the TD satellite, ensuring seamless operation. Battery status is monitored exclusively through the b2 Suite software, there are no physical indicators on the PDTD device itself. All control and monitoring of the battery are centralized within the software environment.

Operation Modes

The following outlines the scope and purpose of each PD operation mode:

- Test Modes

  Used for diagnostic and verification purposes. They allow operators to simulate conditions, verify system responses, and ensure the equipment is functioning correctly before live operation.
  The PDTD units can be operated in “Manual” or “Automatic” mode (remote controlled with the b2 Suite Software).
  For detailed procedure, see b2 Suite v2 User Manual (b2 article Nr. DHV0089).

- Output Modes (Waveform)

  Here, the system generates specific waveform outputs. These are used to drive connected components or simulate operational scenarios. The waveform characteristics can typically be configured to match various testing or operational requirements.
  - AC (VLF) Symmetrical and load independent across full range
  - DC (positive or negative polarity)

- Data Transfer Modes

  Manage the communication between the PD system and external devices or software. They enable the transfer of measurement data, configuration settings, and system logs for analysis, storage, or remote monitoring.

6 Application

Short Cables and High-Accuracy Measurements
For measurement setups involving short cables and/or requiring high-accuracy Tan Delta measurements, special attention must be given to signal integrity and earthing. In these cases, please refer to chapter *6.6 PDTD test setup with guard* procedure. Proper guard connection is essential to minimize leakage currents and ensure precise TD results.

For accurate TD measurements, the condition of the cable, especially at the end terminations, is crucial. Contaminants such as dirt, moisture, or condensing fog can significantly affect measurement accuracy and lead to misleading results. Therefore, before performing any TD measurements, ensure that the end terminations on both sides of the cable are thoroughly cleaned using appropriate cleaning agents recommended for high voltage equipment. This step helps to eliminate surface leakage currents and ensures the reliability of the diagnostic results.

The measurement setups presented in chapters 6.3 through 6.6 are valid for TD, PD, and various other diagnostic methods.

Setup and installation:
Connect the device in accordance with the technical specifications. Specification of the electrical connection values is mentioned on the rating plate.

WARNING

If the device is connected to a voltage other than the rated voltage, it may be destroyed:
Fire hazard.

We strongly advise you to use only spare parts specified by the manufacturer.
Avoid using defective mains, high voltage test leads or earthing cables for the installation and operation of the appliance, this can lead to life-threatening situations.

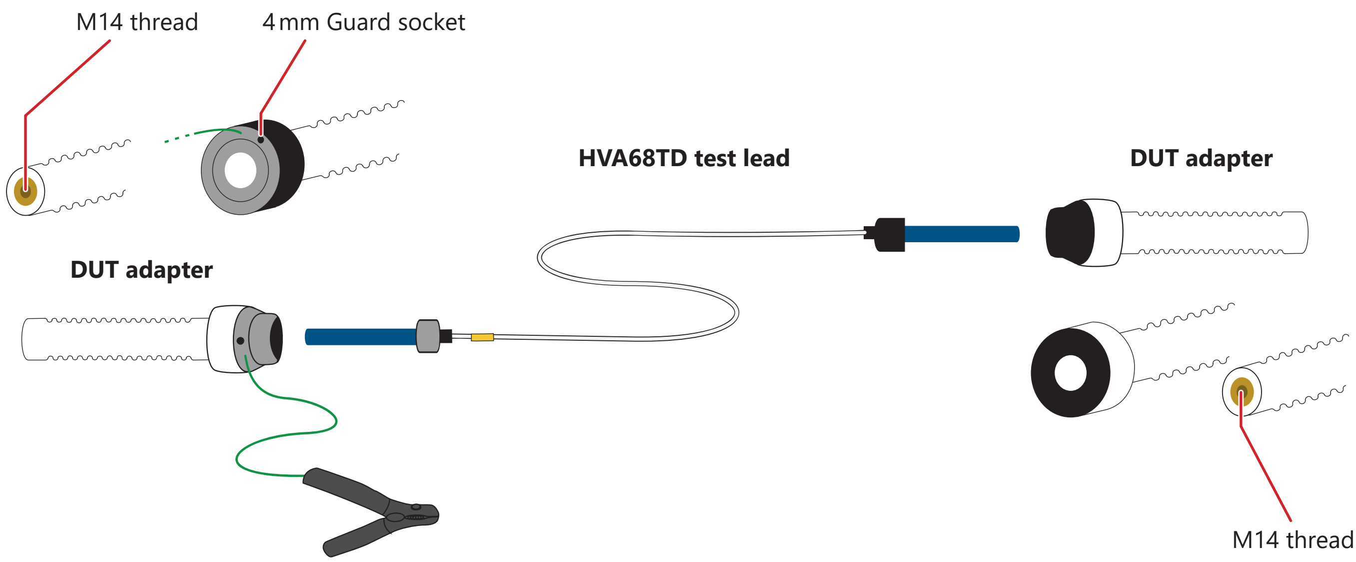
Connect the appliance as specified in the operating instructions. Use the cable types and cable colors as depicted on the connection schemes. Check the HV test lead, earthing lead, as well as all other cables for mechanical damage before each use! Should there be any defective cables on the measurement site, replace them immediately with new, undamaged ones.

Switching on the device:
When switching on the device, observe the sequence in which the LED lights A light up.
See chapter *4.5 LED communication status* for details on how these three LEDs in the bottom module behave to indicate the status of PDTD system, user actions and power conditions.

While measuring:
If any unusual situation is suspected, the appliance must be
- switched off immediately
- disconnected from the mains.

6.1 HVA68TD test lead

Here is an additional instruction on how to connect the HVA68TD test set to the PDTD68 diagnostics system. The HVA68TD HV test lead consists of an HV test lead and two different DUT adapters. **For transport** the DUT adapters are used as protective caps. Depending on your test purpose, one or the other DUT adapter needs to be unscrewed to screw that cable end into the PDTD system. The other adapter stays on the HV test lead and will be connected to DUT.

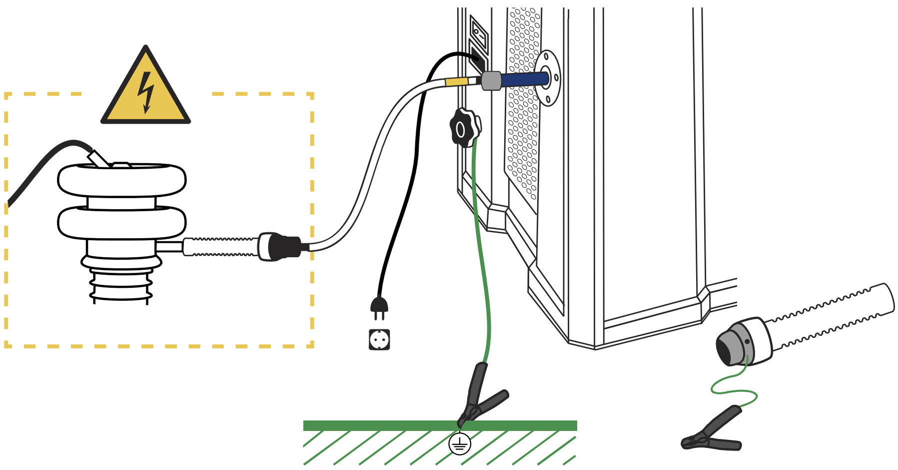


The different DUT adapters can be easily identified by the different materials and colors of the thread. The standard DUT adapter's thread is silver and made of metal and has a earthing clamp, the PD DUT adapter's thread is made of black plastics. Always consider that the HV test lead's knurled rotating rings match the DUT adapter's material (metal – metal, plastics – plastics).

PD standard configuration

For PD operation the HV socket with the metal thread needs to be tightened into the HVA.

The socket with the black plastic thread needs to be connected to the DUT adapter with the black plastic thread.



6.2 Securing a safe and verified earth connection

Proper earthing is vital for both operational safety and system reliability. It must always be treated as a top priority during setup and maintenance. Before initiating any measurements or connecting equipment, carefully inspect and verify all existing earth connections.

The configuration of the earth connection and the overall measurement setup depends significantly on the installed components and the physical accessibility of key elements—such as the end termination, the cable shield emerging from the termination, and any existing earth busbars. Always ensure that these components are securely and correctly connected to the earthing system to avoid potential hazards or measurement inaccuracies.
Also ensure that you follow the *Connection guidelines* for optimal performance listed here as well as with each type of the application mentioned in following chapters.

Connection guidelines for optimal performance:
- Minimize cable lengths:
  The connection to the DUT (Device Under Test) and the earth cables should always be kept as short as possible to reduce the impedance change and ensure signal integrity.
- Earth connection requirements:
  The earth connection from the PDTD system must always be connected to the cable shield (copper stranded shield) at the end termination point.

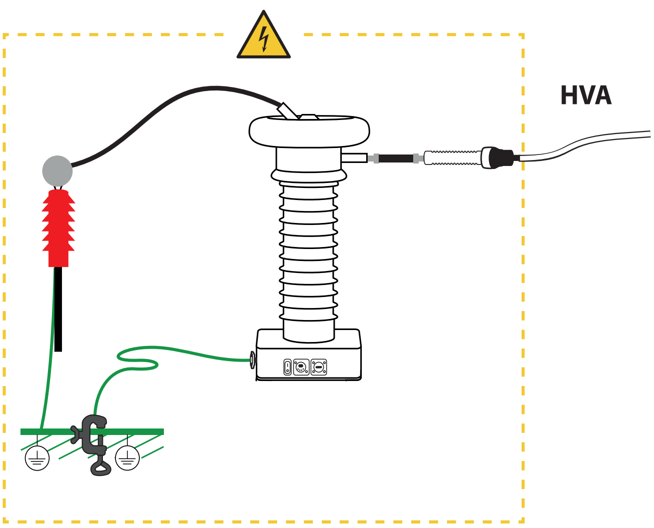
If the end termination is not accessible, connect the earth lead at the point where the cable shield is bonded to the earth busbar.

The second priority is to establish a short and reliable connection between the earth and the cable shield. This is essential for achieving optimal PD measurement results.
Depending on how the connection is made, it will have a direct influence on the signal clarity and the attenuation of PD pulses. Poor earthing can introduce environmental noise into the system, compromising measurement accuracy.

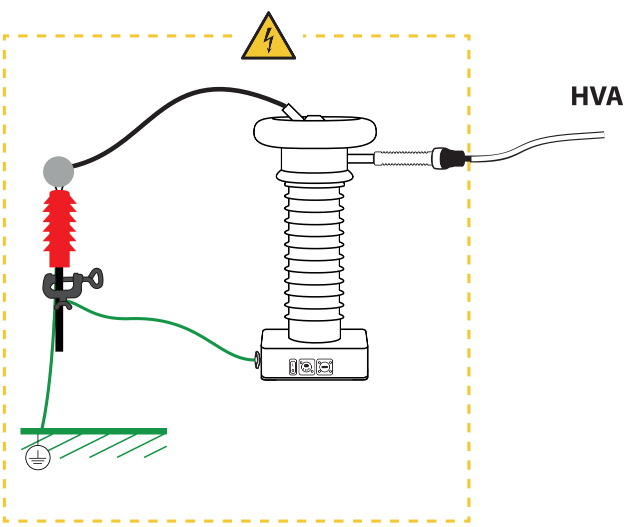
Earthing the PDTD system
The PDTD system can be earthed in two recommended ways:
- Via the station earth busbar.
  This is a standard and reliable method, especially when direct access to the cable shield is limited.
  Example: Figure (1) below on the left side.

- Directly to the cable shield at the end termination using a G-clamp.
  This method is preferred for best measurement performance. The connection should be as short as possible to minimize signal loss and interference. Direct earthing at the cable shield provides the most accurate and stable conditions for PD measurements.
  Example: Figure (2) below on the right side.

Earthing the PDTD system
(1) via the station earth busbar:



(2) directly to the cable shield at the end termination using a G-clamp:



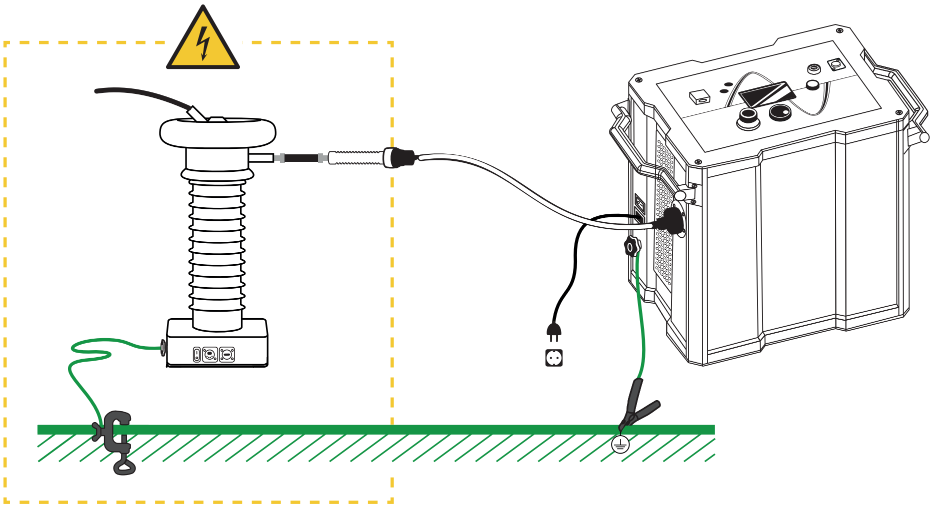
These earthing connections are relevant to all test setups presented in the subsequent chapters 6.3 to 6.6.

Earthing the HVA test set
(For a full-featured and full-value VLF cable test set and PDTD diagnostics system.)
Since the HVA test set generates high output voltage, a reliable earth connection is essential for ensuring operator safety and system protection.
The HVA test set can be earthed in two recommended ways:

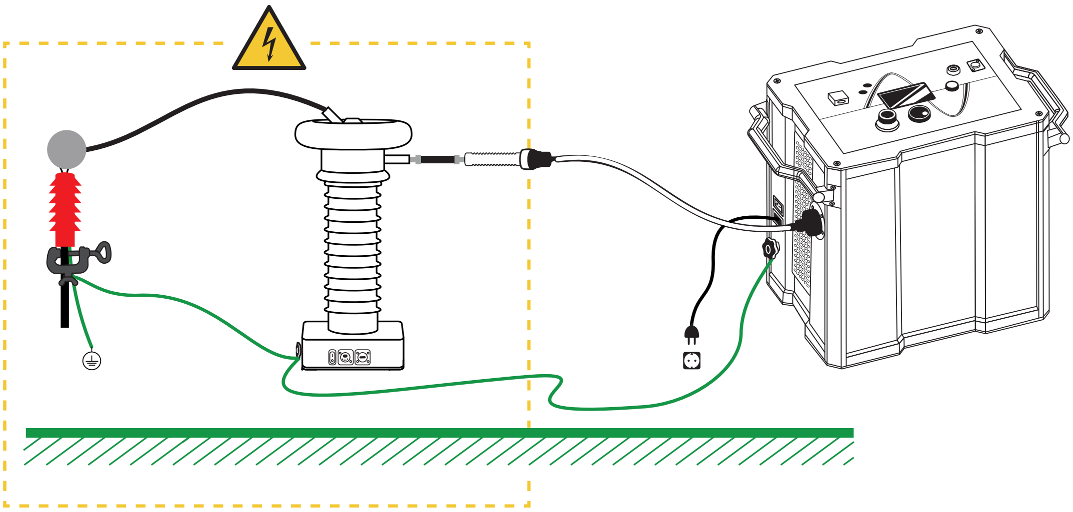
- Direct connection to the station earth busbar
  The HVA earth cable can be connected directly to any suitable earth busbar within the station. This is a standard and effective earthing method.
  Example: Figure (3) below.

- Connection via the PDTD system
  From there, the earthing is routed through the PDTD's main earth connection point, as depicted in the connection diagrams. This method integrates the HVA earthing into the overall diagnostics setup, ensuring a common reference point for all connected equipment.
  Example: Figure (4) at the bottom of this page.

Earthing the HVA test set
(3) direct connection to the station earth busbar:



(4) via the PDTD system:



These earthing connections are relevant to all test setups presented in the subsequent chapters 6.3 to 6.6.

6.3 PDTD test setup with PD impedance

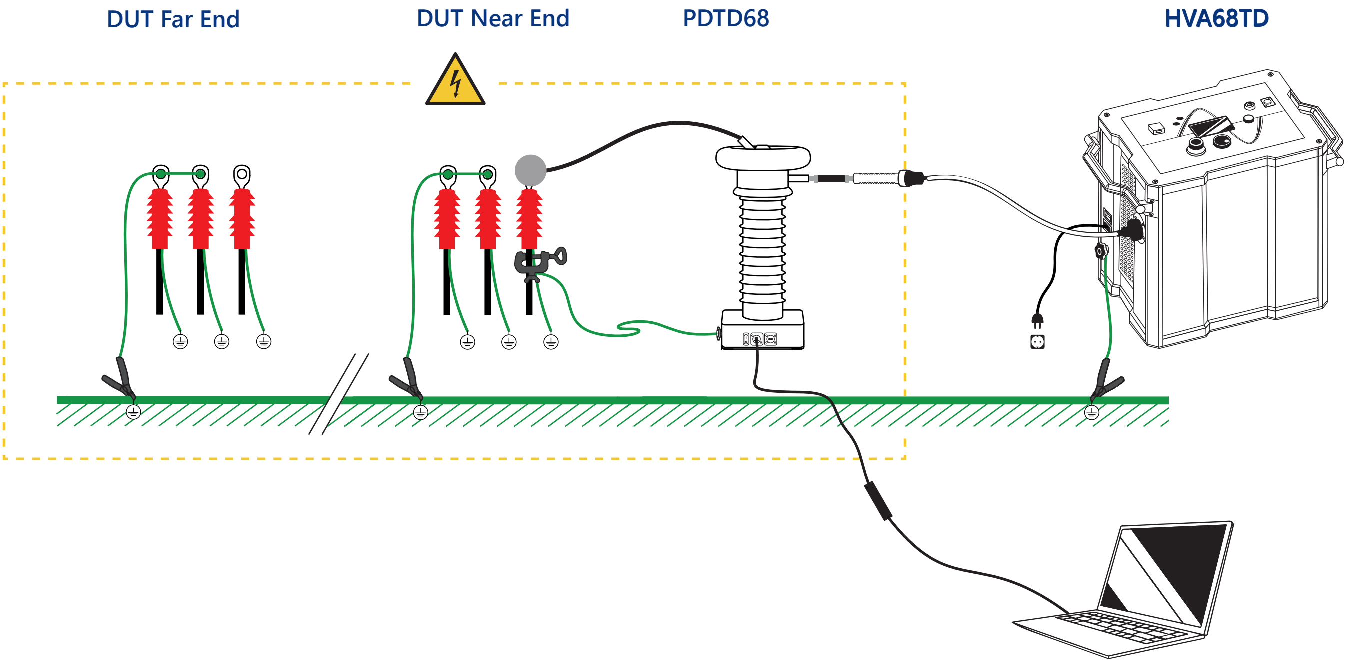
DANGER

Electric shock hazard
All procedures must comply with local safety regulations. Make sure you obey the five safety rules in the order listed in chapter 2.1 on page 8!
- Before operating the PDTD diagnostics system, equipment set up procedure must be completed!
- Cables must be connected according to the sequence below!
- Before turning on the power supply and before activating the PDTD system, verify that all system elements are properly earthed!

It is generally recommended to use the PD impedance (b2 article Nr. GH0581) when connecting the HVA test set. This impedance enhances the filter capacity of the PDTD system, further reducing possible noise influences over the HV connection. Together, they help ensure cleaner signal conditions and could improve the accuracy of partial discharge measurements.

The PD impedance is included in the scope of supply of the diagnostics system. When connecting, make sure to securely tighten the impedance to the test lead.
While the HVA68TD is shown illustratively, any suitable device from the HVA series may be used depending on the measurement requirements

Connection diagram:



Connection guidelines for optimal performance:

- Minimize Cable Lengths:
  The connection to the DUT (Device Under Test) and the earth cables should always be kept as short as possible to reduce the impedance change and ensure signal integrity.
- Earth Connection Requirements:
  The earth connection from the PDTD system must always be connected to the cable shield (copper stranded shield) at the end termination point.
- Inspect and Clean:
  Carefully inspect all cables for visible damage. Clean any dirt or debris from connectors and surfaces as needed.

If the end termination is not accessible, connect the earth lead at the point where the cable shield is bonded to the earth busbar.

Steps for the connection procedure:

S1	**Connect all earthing cables.** Discharge and earth the DUT complying with local safety regulations. Secure the correct earthing of the PDTD system. It is possible over 5, 6 or 7 (see chapter 4.2 for info). Apply the short-circuit connection 50. Prepare earthing for measurement on both Near and Far End.
S2	**Connect all HV cable connections.** Check the instructions in chapter 6.2 on more possibilities how to correctly earth both the PDTD and HVA devices. Connect the HV output from the HVA test set according to the instructions in the b2 HVA smartVLF manual.
S3	**Connect power supply 33 or use the integrated battery C.**
S4	**Verify connections.** Check that all cables are attached securely on both Near End and Far End. **Remove the short circuit connection 50 .**
S5	**Power up the PDTD and HVA devices.** For the PDTD device there are more options how to do this, please see chapter 4.6 for these options.
S6	**Start the measurement** using the b2 Suite software on your laptop.

NOTICE

For voltages above 15 kV we recommend the use of corona spheres for PD and TD diagnostics.

6.4 PDTD test setup with HVA68TD test lead

DANGER

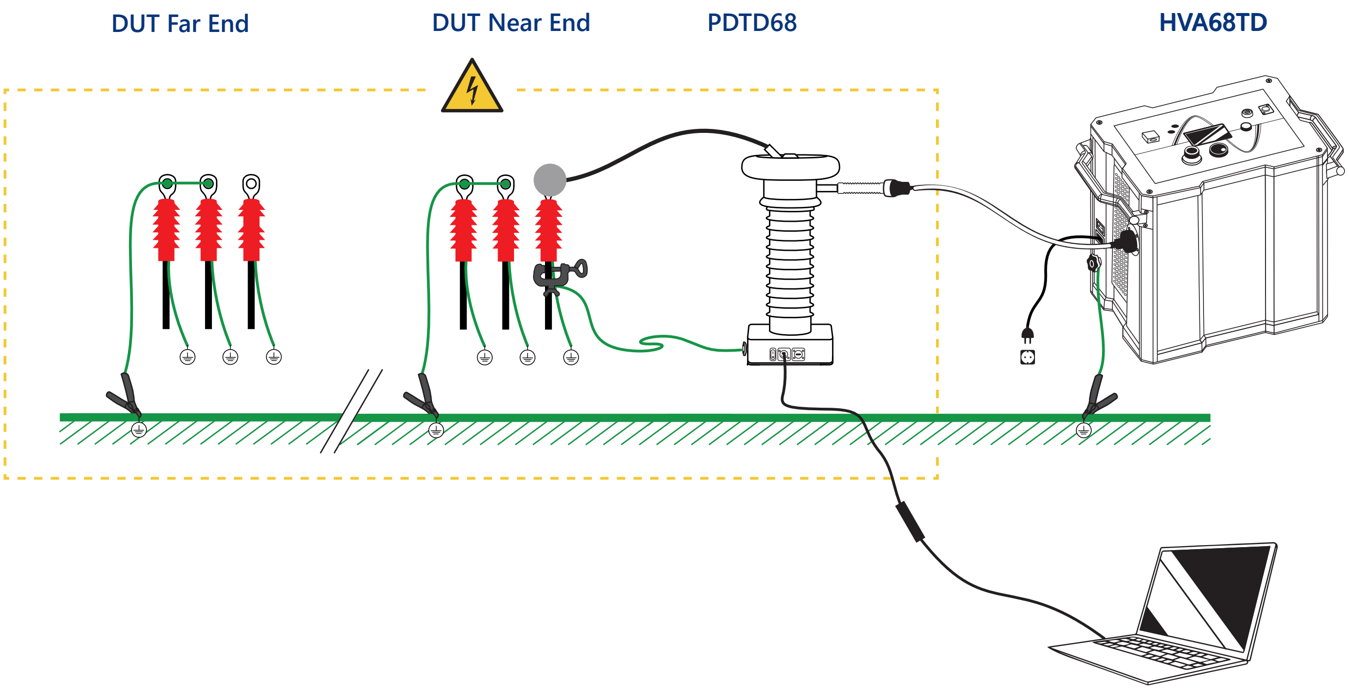
Electric shock hazard
All procedures must comply with local safety regulations. Make sure you obey the five safety rules in the order listed in chapter 2.1 on page 8!
- Before operating the PDTD diagnostics system, equipment set up procedure must be completed!
- Cables must be connected according to the sequence below!
- Before turning on the power supply and before activating the PDTD system, verify that all system elements are properly earthed!

When using the HVA68TD test set, the use of the PD impedance (b2 article Nr. GH0581) is not mandatory.
For most measurement scenarios, the resistor can be omitted without negatively affecting performance. However, depending on the surrounding noise environment, the specific measurement setup, and the quality of the earth connection, it may be advisable to include the PD impedance to improve signal clarity and reduce interference.

For setups where the PD impedance is not used, the test lead is connected directly to the diagnostics system, as depicted here below. The instruction on how to connect the HVA68TD test set to the PDTD68 diagnostics system is described in chapter 6.1, including a detailed illustration. For PD operation, the HV socket with the metal thread must be tightened into the HVA device, while the socket with the black plastic thread is connected to the DUT adapter with the matching black plastic thread.

While the HVA68TD is shown illustratively, any suitable device from the HVA series may be used depending on the measurement requirements.

Connection diagram:



Connection guidelines for optimal performance:

- Minimize Cable Lengths:
  The connection to the DUT (Device Under Test) and the earth cables should always be kept as short as possible to reduce the impedance change and ensure signal integrity.
- Earth Connection Requirements:
  The earth connection from the PDTD system must always be connected to the cable shield (copper stranded shield) at the end termination point.
- Inspect and Clean:
  Carefully inspect all cables for visible damage. Clean any dirt or debris from connectors and surfaces as needed.

If the end termination is not accessible, connect the earth lead at the point where the cable shield is bonded to the earth busbar.

Steps for the connection procedure:

S1	**Connect all earthing cables.** Discharge and earth the DUT complying with local safety regulations. Secure the correct earthing of the PDTD system. It is possible over 5, 6 or 7 (see chapter 4.2 for info). Apply the short-circuit connection 50. Prepare earthing for measurement on both Near and Far End.
S2	**Connect all HV cable connections.** Check the instructions in chapter 6.2 on more possibilities how to correctly earth both the PDTD and HVA devices. Connect the HV output from the HVA test set according to the instructions in the b2 HVA smartVLF manual.
S3	**Connect power supply 33 or use the integrated battery C.**
S4	**Verify connections.** Check that all cables are attached securely on both Near End and Far End. **Remove the short circuit connection 50 .**
S5	**Power up the PDTD and HVA devices.** For the PDTD device there are more options how to do this, please see chapter 4.6 for these options.
S6	**Start the measurement** using the b2 Suite software on your laptop.

NOTICE

For voltages above 15 kV we recommend the use of corona spheres for PD and TD diagnostics.

6.5 PDTD test setup with cable reel

DANGER

Electric shock hazard
All procedures must comply with local safety regulations. Make sure you obey the five safety rules in the order listed in chapter 2.1 on page 8!

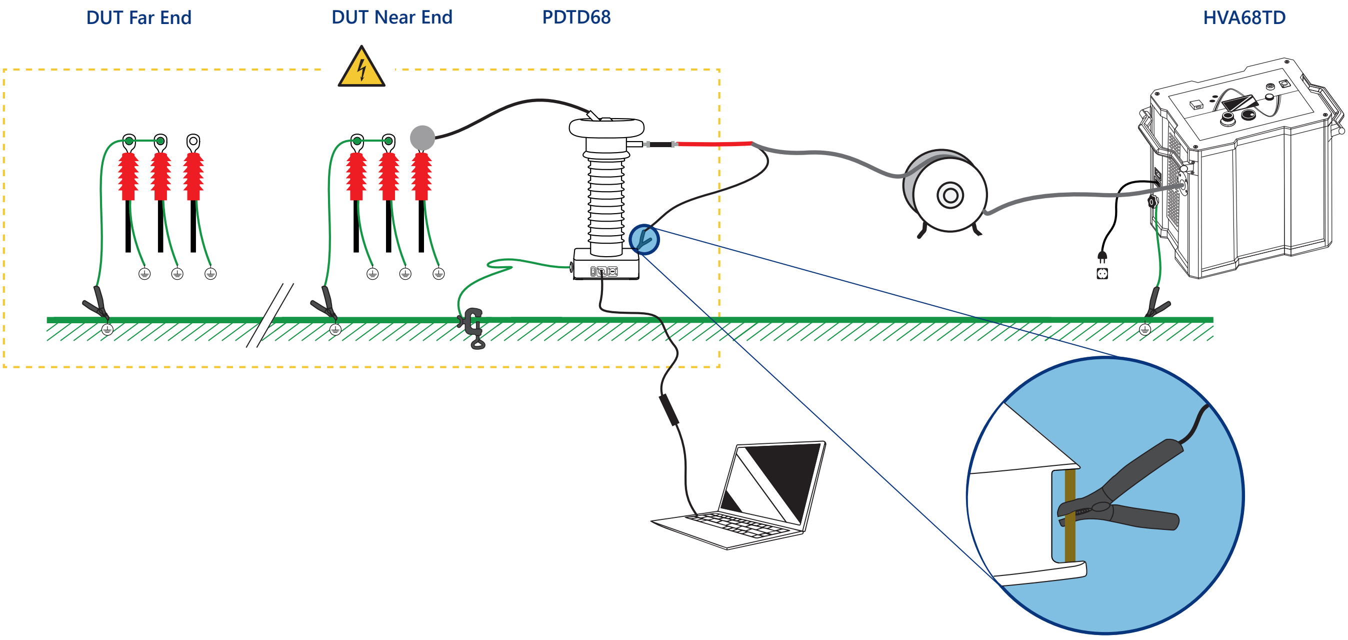
- Before operating the PDTD diagnostics system, equipment set up procedure must be completed!
- Cables must be connected according to the sequence below!
- Before turning on the power supply and before activating the PDTD system, verify that all system elements are properly earthed!

When the PDTD system is mounted on a pole or positioned at a distance from the HVA test set, a cable reel can be used to extend the connection between the devices.
When using a cable reel, connect the cable shield clamp to 7 earthing rod. This setup allows flexible positioning of the PDTD system while maintaining proper signal routing and safety compliance.

While the HVA68TD is shown illustratively, any suitable device from the HVA series may be used depending on the measurement requirements.

Note: This connection is not an HVA’s earth connection. The HVA test set must always be connected to a separate, dedicated earth point to ensure safe operation and proper earthing.

Connection diagram:



Connection guidelines for optimal performance:

- Minimize Cable Lengths:
  The connection to the DUT (Device Under Test) and the earth cables should always be kept as short as possible to reduce the impedance change and ensure signal integrity.
- Earth Connection Requirements:
  The earth connection from the PDTD system must always be connected to the cable shield (copper stranded shield) at the end termination point.
- Inspect and Clean:
  Carefully inspect all cables for visible damage. Clean any dirt or debris from connectors and surfaces as needed.

If the end termination is not accessible, connect the earth lead at the point where the cable shield is bonded to the earth busbar.

Steps for the connection procedure:

S1	**Connect all earthing cables.** Discharge and earth the DUT complying with local safety regulations. Secure the correct earthing of the PDTD system. It is possible over 5, 6 or 7 (see chapter 4.2 for info). Apply the short-circuit connection 50. Prepare earthing for measurement on both Near and Far End.
S2	**Connect all HV cable connections.** Check the instructions in chapter 6.2 on more possibilities how to correctly earth both the PDTD and HVA devices. Connect the HV output from the HVA test set according to the instructions in the b2 HVA smartVLF manual.
S3	**Connect power supply 33 or use the integrated battery C.**
S4	**Verify connections.** Check that all cables are attached securely on both Near End and Far End. **Remove the short circuit connection 50 .**
S5	**Power up the PDTD and HVA devices.** For the PDTD device there are more options how to do this, please see chapter 4.6 for these options.
S6	**Start the measurement** using the b2 Suite software on your laptop.

NOTICE

For voltages above 15 kV we recommend the use of corona spheres for PD and TD diagnostics.

6.6 PDTD test setup with guard

DANGER

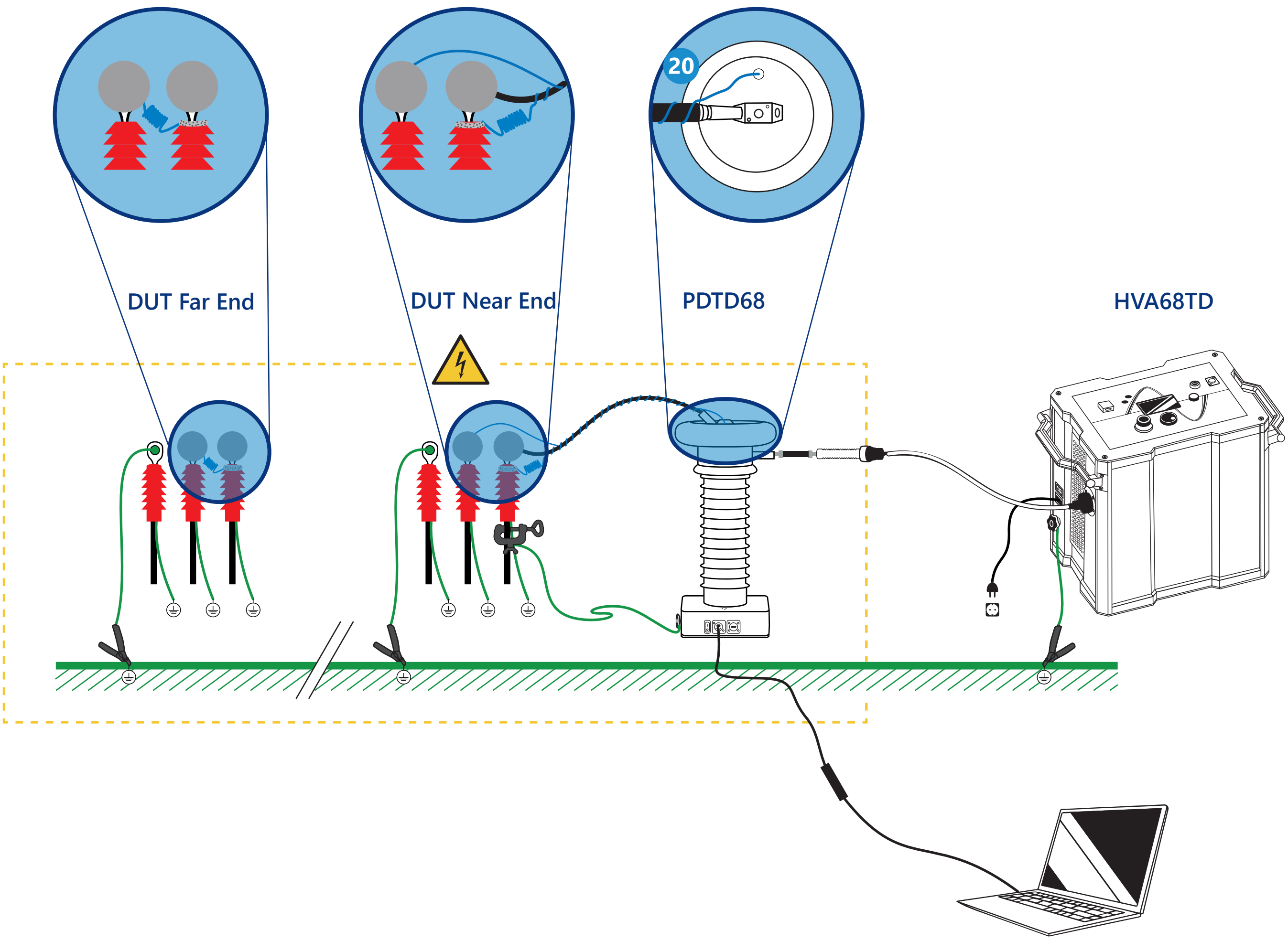
Electric shock hazard
All procedures must comply with local safety regulations. Make sure you obey the five safety rules in the order listed in chapter 2.1 on page 8!
- Before operating the PDTD diagnostics system, equipment set up procedure must be completed!
- Cables must be connected according to the sequence below!
- Before turning on the power supply and before activating the PDTD system, verify that all system elements are properly earthed!

The guard connection eliminates leakage currents from the end terminations to ensure it does not influence the TD measurement. While the HVA68TD is shown illustratively, any suitable device from the HVA series may be used depending on the measurement requirements.

Standard Guard setup (Near End):
- Mount the HVA Guard Connection DUT (b2 article Nr. KMSO0064) securely around the end termination as close as possible to the cable lug/conductor, but not touching it!
- Connect the HVA guard connection cable (b2 article Nr. KEK0126) to the guard socket 20 on the PDTD system
- Attach the other end of the guard cable to the HVA Guard Connection DUT

Optional: **Guard from Far End** (In cases where the guard connection is made from the far end of the cable):
- Mount the HVA Guard Connection DUT around the end termination at the far end close to the conductor
- Connect a guard cable from the HVA Guard Connection DUT to one of the phase conductors
- At the near end, connect that same phase conductor to the guard socket on the PDTD system

Connection diagram:



Connection guidelines for optimal performance:

- Minimize Cable Lengths:
  The connection to the DUT (Device Under Test) and the earth cables should always be kept as short as possible to reduce the impedance change and ensure signal integrity.
- Earth Connection Requirements:
  The earth connection from the PDTD system must always be connected to the cable shield (copper stranded shield) at the end termination point.
- Inspect and Clean:
  Carefully inspect all cables for visible damage. Clean any dirt or debris from connectors and surfaces as needed.

If the end termination is not accessible, connect the earth lead at the point where the cable shield is bonded to the earth busbar.

Steps for the connection procedure:

S1	**Connect all earthing cables.** Discharge and earth the DUT complying with local safety regulations. Secure the correct earthing of the PDTD system. It is possible over 5, 6 or 7 (see chapter 4.2 for info). Apply the short-circuit connection 50. Prepare earthing for measurement on both Near and Far End.
S2	**Connect all HV cable connections.** Check the instructions in chapter 6.2 on more possibilities how to correctly earth both the PDTD and HVA devices. Connect the HV output from the HVA test set according to the instructions in the b2 HVA smartVLF manual. Connect the Guard connections 20 according to one of the options on the previous page.
S3	**Connect power supply 33 or use the integrated battery C.**
S4	**Verify connections.** Check that all cables are attached securely on both Near End and Far End. **Remove the short circuit connection 50 .**
S5	**Power up the PDTD and HVA devices.** For the PDTD device there are more options how to do this, please see chapter 4.6 for these options.
S6	**Start the measurement** using the b2 Suite software on your laptop.

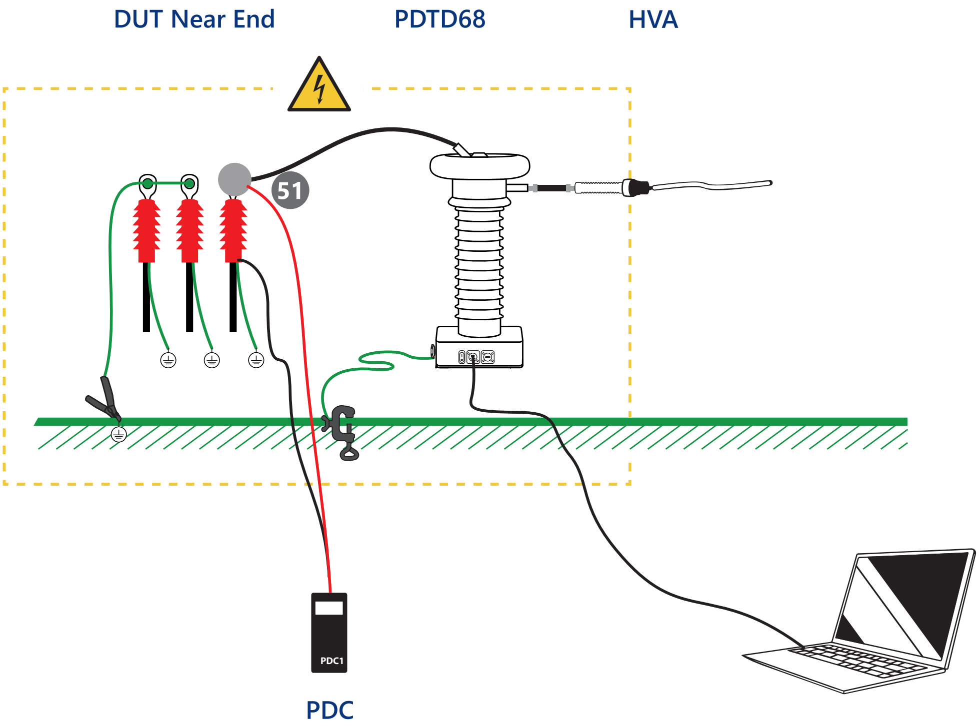
NOTICE

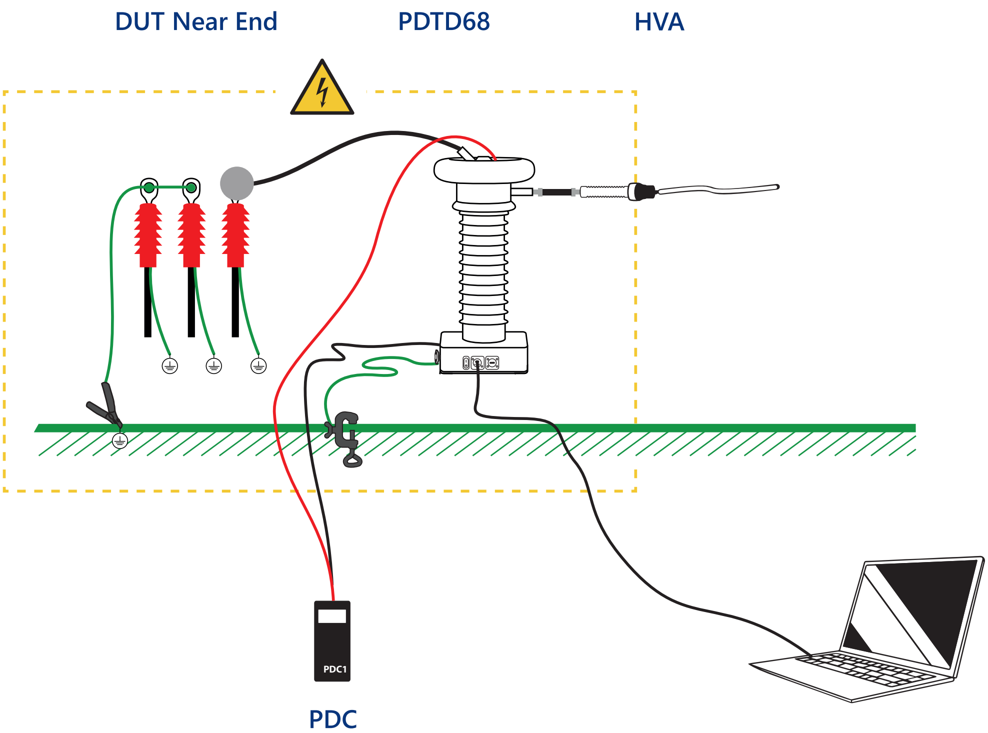
For voltages above 15 kV we recommend the use of corona spheres for PD and TD diagnostics.

6.6.1 PD calibrator test setup

We must proceed with the device calibration prior to each PD measurement.
We recommend the calibration prior to each phase over the 4 mm socket on the corona sphere 51 .

Make sure the high voltage remains off while initiating the PD calibration.
To connect the calibrator, use the 4 mm socket on the corona sphere.
For best results, we recommend connecting the calibrator directly to the DUT, as illustrated in the top Figure.
The second option is to connect the calibrator over the 4 mm socket on the top of the PDTD system (the bottom Figure).

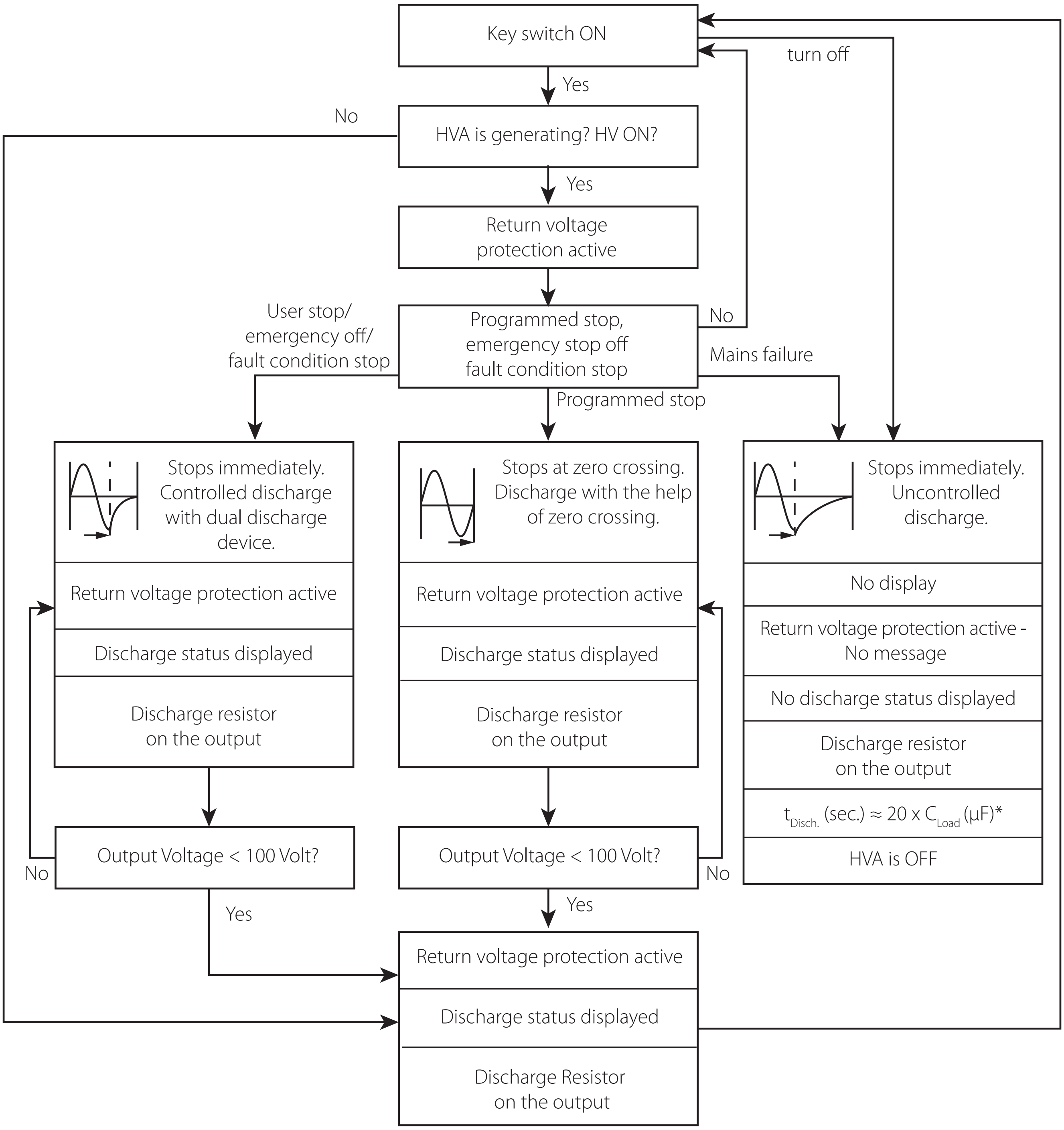




For more information on how to use the PD calibrator, please see the PDC1 PDC2 manual (b2 article Nr. DHV0096).

7 Discharge status

This section outlines the discharge status conditions of the HVA device. Although the HVA is not the primary focus of this manual, it plays a critical role in several measurement procedures involving the PDTD device. The following chart provides a comprehensive overview of its relevant states.
Follow these instructions carefully to ensure safe and correct handling of the HVA test set during all related procedures.



* Discharge time approximation: $t_{Discharge}$ (sec.) ≈ 20 $\frac{s}{\mu F}$ x C_L (µF)

Example: Load capacitance C_L = 1.2 µF.. $t_{Discharge}$ ≈ 20 x 1.2 = 24 sec.

This is an approximation only and does not replace the safety rules.

8 Disconnection procedure

DANGER

Electric shock hazard
All procedures must comply with local safety regulations. Make sure you obey the five safety rules in the order listed in chapter 2.1 on page 8!
- Before operating the PDTD diagnostics system, equipment set up procedure must be completed!
- Cables must be connected according to the sequence below!
- Before turning on the power supply and before activating the PDTD system, verify that all system elements are properly earthed!

Procedure steps for disconnection:
Please keep in mind, when working on medium voltage systems, always adhere to local safety regulations. Before performing any operation, follow standard electrical safety practices, including proper discharging and earthing of cables.

The disconnection process must be carried out in the reverse order of the connection procedure. Follow these steps carefully to ensure safety and protect the equipment:

1. Ensure Safe Discharge
Before disconnecting any components, confirm that both the system and the DUT are fully discharged and properly earthed. Use the discharge stick (see the Figure below) to safely discharge any residual voltage and to prevent the recharging of the coupling capacitor.

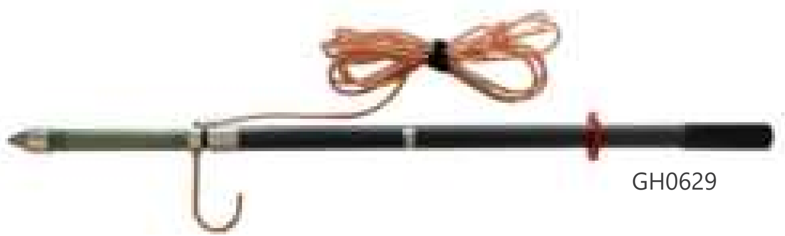
2. Establish Short-Circuit Protection
Establish a short-circuit connection on the PDTD system to ensure it remains in a safe state.

3. Power Down the System
Switch off all systems and disconnect them from the voltage supply. Unplug the mains power cables.

4. Disconnect Cables and Earth Wires
Remove all cables. Earth connections should be disconnected last to maintain safety during the process.

5. Inspect and Clean
Carefully inspect all cables for visible damage. Clean any dirt or debris from connectors and surfaces as needed.

Discharge stick:
The image below depicts a discharge stick with the parameters 60 kV / 12 kR / 8 kJ / 1100 mm (b2 article Nr. GH0629). This is the discharge stick we recommend to use for discharging both the system and the DUT before disconnecting any components.



GH0629

9 Additional information

9.1 Handling instructions

The PDTD unit must be handled with care to ensure operator safety and to prevent damage to the device. While the unit is designed to allow single-person handling, it must always be held centrally using both hands to maintain balance and control. For added safety and convenience, two-person handling is recommended, especially during lifting or transport over longer distances.
The PDTD device must not be opened or disassembled under any circumstances. Unauthorized disassembly can compromise safety, void warranties, and lead to equipment malfunction.

9.2 Appliance care

DANGER

Electric shock hazard
NEVER assume that equipment is safe to handle without using the necessary safety equipment and earthing procedures.

When cleaning the equipment, do not spray the control electronics directly with a high-pressure jet. Doing so may cause electrical faults or malfunctions due to water ingress into sensitive components.
If malfunctions are suspected due to moisture in the control electronics, immediately stop operation. Allow the equipment to dry thoroughly before restarting. Once dry, verify proper functionality by performing the switch-on/switch-off procedure multiple times.

Clean the **HV cable / DUT adapters / test lead** connection points after use before storing.

NOTICE

Authorized personnel only!
Repairs and maintenance should only be performed by authorized b2 personnel. It is strictly prohibited to open the device and do any changes within the interior of the device.

It is recommended that an annual inspection be carried out by authorized b2 personnel to ensure continued safe and reliable operation of the equipment.

9.3 Storage guidelines

Storage temperature: -20°C to +65°C
Humidity: 5 - 85% non-condensing

If the appliance is not to be used for a longer period of time, always store it in the packaging supplied.
If the appliance is stored open for shut-down and is heavily soiled, this can lead to malfunctions.

9.4 Battery replacement

The PDTD device contains two user-replaceable batteries: the main battery C and the TD satellite battery B. Both batteries have been described together with their functions in chapter *4 Design & construction of the PDTD system*. Follow the instructions below to safely replace them when battery performance degrades. Note: Only use the delivered screws here!

Main battery

The built-in 6 V gel lead-acid battery C is bottom-mounted. The device must be flipped to access it.

- Carefully flip the device to access the bottom panel to locate the battery.
- Unscrew the battery cover using a Torx T07 screwdriver, there are six Torx screws.
- Remove the depleted battery:
  - The battery is tilted in the battery compartment.
  - Keep both cables (red and black) attached
  - Carefully remove the battery and only then disconnect the red and black connection cables.
  - Dispose of the battery according to local regulations.
- Insert the new battery:
  - Reattach the red and black cables to the new battery, ensuring correct orientation.
  - Fix the battery into the guide rails within the device.
  - Slide it fully into place.
- Reattach the cover and tighten the six Torx screws securely.

The procedure is illustrated below:

1. Carefully flip the device to access the battery compartment

2. Unscrew the battery cover using a Torx T07 screwdriver

3. Accessing the battery within the device. It is tilted.

4. Remove carefully the battery, red and black cables remain connected

5. Disconnect the cables, insert new battery, reattach the cables on the new battery

6. Fix the battery into the guide rails within the device and slide it fully into place

TD satellite battery
The built 9 V block battery is side-mounted and easily accessible.

- Locate the battery **B** on the side of the device
- Unscrew the two slotted screws to access the battery
- Remove the old battery and dispose of the battery according to local regulations.
- Insert the new battery, ensuring correct polarity.
- Secure the latch and confirm the battery is properly seated.
- Reattach the cover and tighten the two slotted screws securely.

1. Locate the battery	2. Unscrew the two slotted screws	3. Ensure the correct polarity
		

9.5 Behavior at unexpected conditions

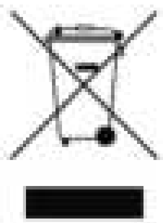
In case of fire
If the appliance switches to a faulty state due to sparking and starts to burn, there is a risk of toxic gases being released by the burnt materials. In this case, the device has a software check that monitors the output voltage and switches it off. Extinguish the resulting fire with extinguishing agents approved for high-voltage technology.

In case of wet environment
Position the device so that it does not get wet due to the environment. If the device is set up in a wet environment or if the device is subjected to strong temperature changes in high humidity and becomes damp, this can lead to voltage flashovers: Danger to life.

When reaching dew point
Position the device so that it is not in humid environment. If the device is set up in such an environment or if the device is subjected to strong temperature changes in high humidity and becomes damp, this can lead to voltage flashovers: Danger to life. In the event of significant temperature changes with dew point formation, you must first allow the appliance to acclimatize until the moisture has completely dried out before you start commissioning.

In case of power outage
A power failure causes the operating status of the appliance to be recognized. However, the device automatically switches to a safe state.
If you in case of possible power outage decide to work with the generator, working with over-voltage during generator operation will destroy the appliance. Ensure that a low-resistance earth connection is established.

9.6 Disposal



This test set, including all its accessories, is not intended for household use. At the end of its service life, do not dispose of the test set with household waste.
For customers in EU countries (incl. European Economic Area)
b2 electronics test sets are subject to the EU Waste Electrical and Electronic Equipment Directive (WEEE directive). As part of our legal obligations under this legislation, b2 electronics offers to take back the test set and to ensure that it is disposed of by authorized recycling agents.
For customers outside the European Economic Area
Contact the authorities in charge for the relevant environmental regulations in your country and dispose of the b2 electronics test set only in accordance with your local legal requirements.

Technical Support contact:
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