Megger

Remote Control of Test and Diagnosis systems via GPSP software

Valid for: VLF Sinus 34 / 45/ 62 and TDM 4540 Series

USER GUIDE

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Consultation with Megger

The present system manual has been designed as an operating guide and for reference. It is meant to answer your questions and solve your problems in as fast and easy a way as possible. Please start with referring to this manual should any trouble occur.

In doing so, make use of the table of contents and read the relevant paragraph with great attention. Furthermore, check all terminals and connections of the instruments involved.

Should any question remain unanswered or should you need the help of an authorized service station, please contact:

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Contents

1 Safety Instructions

Labelling of safety instructions

The following signal words and symbols are used in this manual and on the product itself:

Signal word / symbol	Description
DANGER	Indicates a potential hazard which **will result** in death or serious injury if not avoided.
WARNING	Indicates a potential hazard which **may result** in death or serious injury if not avoided.
CAUTION	Indicates a potential hazard which may result in moderate or minor injury if not avoided.
NOTICE	Indicates a potential hazard which may result in material damage if not avoided.
	Serves to highlight warnings and safety instructions. As a warning label on the product it is used to draw attention to potential hazards which have to be avoided by reading the manual.
	Serves to highlight warnings and safety instructions that explicitly indicate the risk of an electric shock.
	Serves to highlight important information and useful tips on the operation of the device/system. Failure to observe may lead to unusable measurement results.

Five safety rules

The five safety rules must always be followed when working with HV (High Voltage):

1. De-energise
2. Protect against re-energising
3. Confirm absence of voltage
4. Earth and short-circuit
5. Cover up or bar-off neighbouring energised parts

2 Introduction

The GPSP software (General-Purpose Software Platform) is used for remote control of Megger test and diagnosis systems via notebook. These systems can be stand-alone systems as well as test van installations without a dedicated operating unit. The only requirement is a network port, as can currently be found in the following systems:

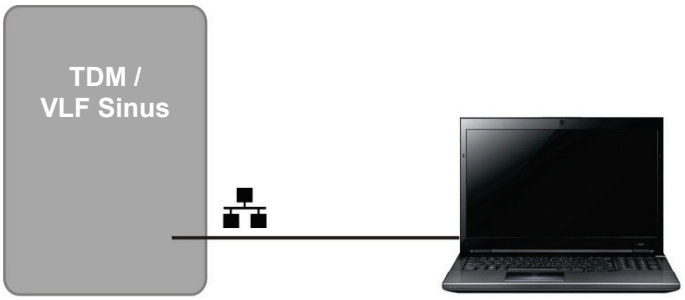
- VLF Sinus 34 / 45 / 62
- TDM 4540 Serie

Depending on the range of functions of the test system, cable tests and tan-delta measurements with different voltage forms can be carried out with the GPSP software.

In combination with a partial discharge coupler (e.g. PDS 60), partial discharge measurements can also be carried out using the notebook. Those are conducted using the "PD Detector" software, the description of which is not part of this manual.

3 Start-up

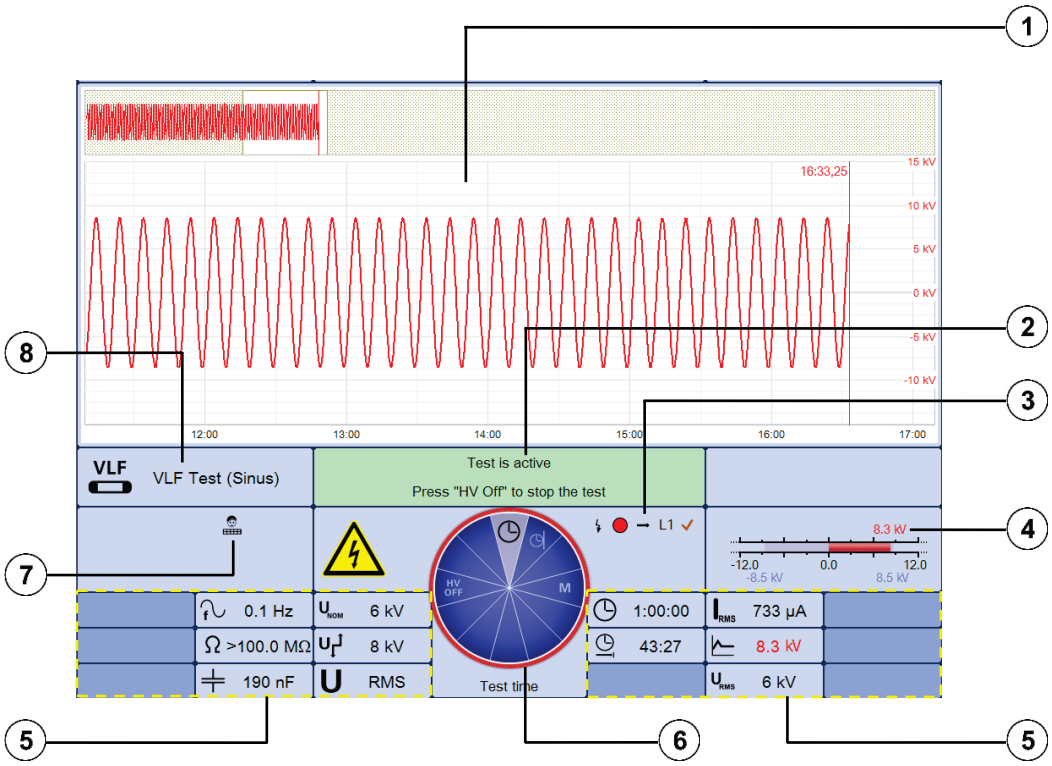
Proceed as follows in order to prepare the Test and Diagnosis Module for operation via the notebook:

Step	Action
1	Carry out the electrical connection of the Test and Diagnosis Module (or the test van). For detailed instructions on electrical connection please read the operating instructions for the Test and Diagnosis Module or the test van.
2	Connect the notebook with the remote control software to the test module's network socket using a network cable (not necessary, if installed in test van). 
3	Switch on the Test and Diagnosis Module or the test van respectively.
4	Select the desired operating mode at the control panel of the test van (not required for stand-alone systems).
5	Start up the notebook.
6	Double-click on the desktop icon to launch the remote control software. **Result:** The software launches and any potential communication problems are displayed as error messages.

4 Basics of operation

4.1 Screen layout

The following figure shows the typical screen layout:



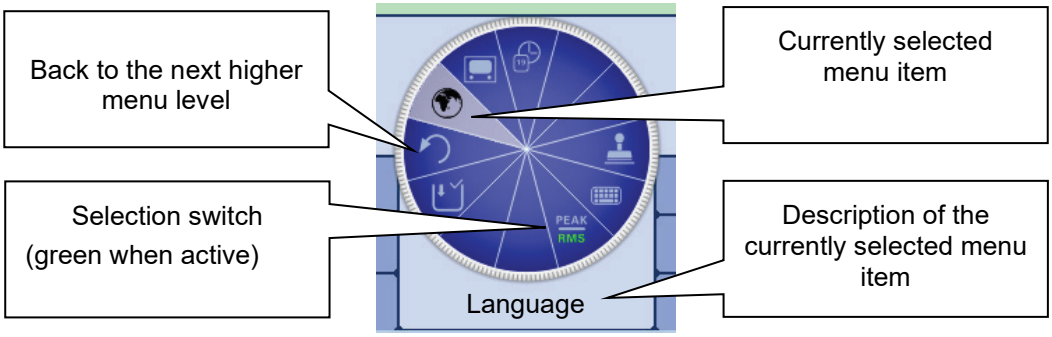
Segment	Description
1	Traces for current measurement or loaded measurements. The display is split up into a general overview (top) and in an enlarged section (bottom).
2	Current status messages and information on the next step required in the test sequence.
3	Information on current phase selection (see page 15). The symbol to the left of the phase description gives an indication of the status of the phase and it can adopt the following states: ● High voltage generation is switched off and the HV output is discharged. ● The resistor discharge is cancelled here. High voltage is active!
4	Voltage display bar graph Blue bar: Set value Red bar: Actual value

Segment	Description
(5)	The display elements arranged in the lower area of the screen may contain the following information: • Set measurement parameters • Current measurement values, which are continuously updated as the measurement progresses • Legend of traces currently shown in display (see page 17). Information (such as, e.g. measurement values) which apply for a particular trace only, is shown in the respective colour.
(6)	Selection menu (see page 12)
(7)	Current system state — The system is currently in standby.  The user operating the system has successfully logged into the administration menu (see page 24) and identified himself / herself as administrator.
(8)	Current operating mode

4.2 Basics of control system

Selection menu

Navigation within the menus is effected almost entirely from the circular selection menu:

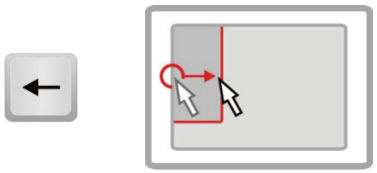


Operation with mouse and keyboard

The system can be operated using mouse and keyboard as follows:

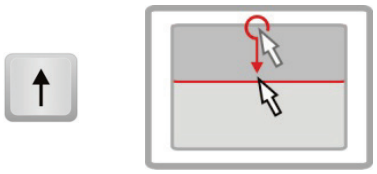
- Select the required menu item
- Increase or decrease the value of a variable parameter
- Select an option from a selection list

- Call up the selected menu item
- Confirm the setting or the selection made

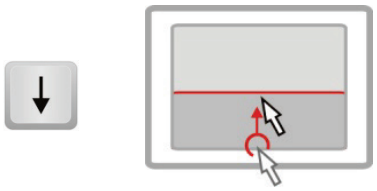


Quick selection of operating modes

Phase selection (see page 15)



Online help



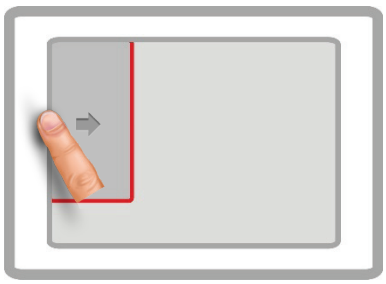
History database (see page 17)

Operation using the touchscreen

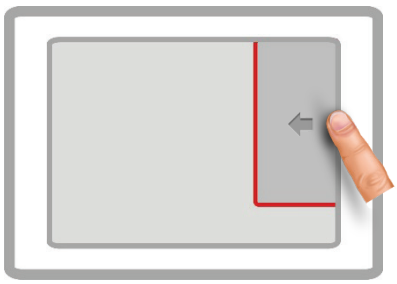
If the device/system is equipped with a touch-sensitive display, then the software can also be operated just by using your fingers.

Briefly tapping on the buttons in the various menus, and tapping and holding the buttons in isolated cases, allows the respective functions to be activated in the same way as the rotary encoder control.

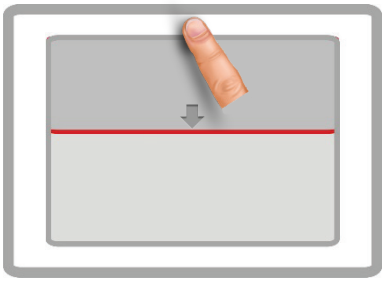
The four menus at the side can be opened by a swiping motion.



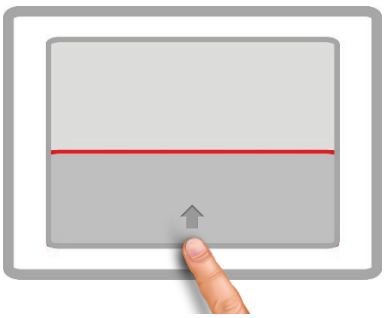
Quick selection of operating modes



Phase selection (see page 15)



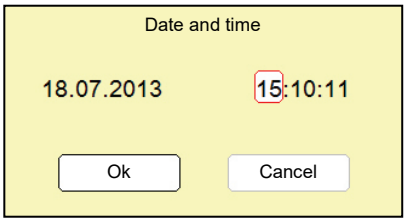
Online help



History database (see page 17)

Whenever character strings need to be entered or changed, an on-screen keyboard appears at the lower edge of the display:

Dialog boxes A few settings, which require values to be entered, are not made directly using the selection menu, but rather in a separate dialog box.



Using ← and → the user can switch back and forth between the individual buttons in a dialog box. Each active button is then highlighted in white or it is surrounded by a red frame. Whenever the selected button requires letters or digits to be entered the screen keyboard automatically appears (touchscreen required), and it can then be used to make the entries.

To close a dialog box, the corresponding button must be selected and then the left mouse button pressed.

4.3 Quick selection of operating modes –

Using ← the quick selection menu can be accessed (as well as closed) at any time. The menu provides direct access to all the available operating modes and the log function.

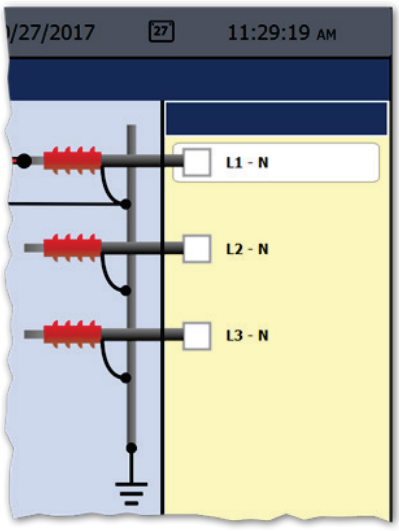
4.4 Online help –

Using ↑ a compact online help function with basic operating instructions can be called up at any time.

4.5 Phase selection -

Opening phase selection menu

The selection menu for the phase(s) involved in the measurement opens automatically as soon as an operating mode is entered. It can also be opened manually at any time via →.



Selecting the phases

The desired phase can be marked for selection by turning the mouse wheel and then selected or deselected by pressing it.

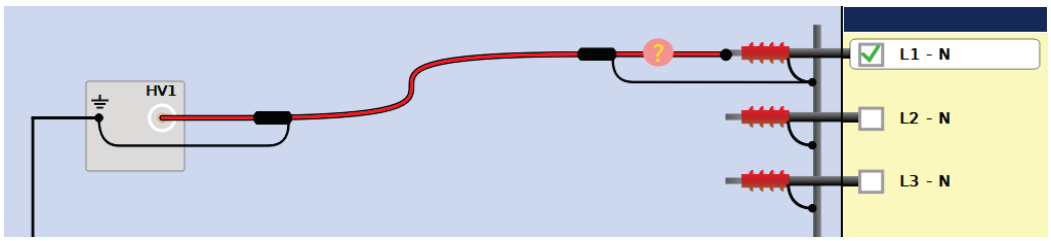
☑ Option is active

☐ Option is not active

The number of simultaneously selectable options depends both on the operating mode and the type of system (single-phase or three-phase).

Correcting the connection situation

Immediately after at least one option has been selected, the recommended connection situation for the current phase selection is shown on the left next to the selection window, as shown in the example below.



Depending on the operating mode and the available cable reels, changes can also be made to the connection schematic shown using the ? and ✎ buttons within the technical permitted scope. In this way, for example, test object phases can be individually connected / disconnected, the assignment between patch panel output and test object phase can be changed, or bridges installed at the test object (for simultaneous testing of multiple phases) can be added.

Confirming the phase selection

The phase selection menu can only be closed once a valid selection has been made. By closing the menu via → , the active selection is confirmed. Until the actual start of the measurement, the selection menu can be called up again and adjusted.

Make sure that the phase selection matches the actual connection situation! Otherwise, the measuring data will be stored with incorrect phase details whereupon the data will not be able to be correctly assigned afterwards.

4.6 History database -

Purpose

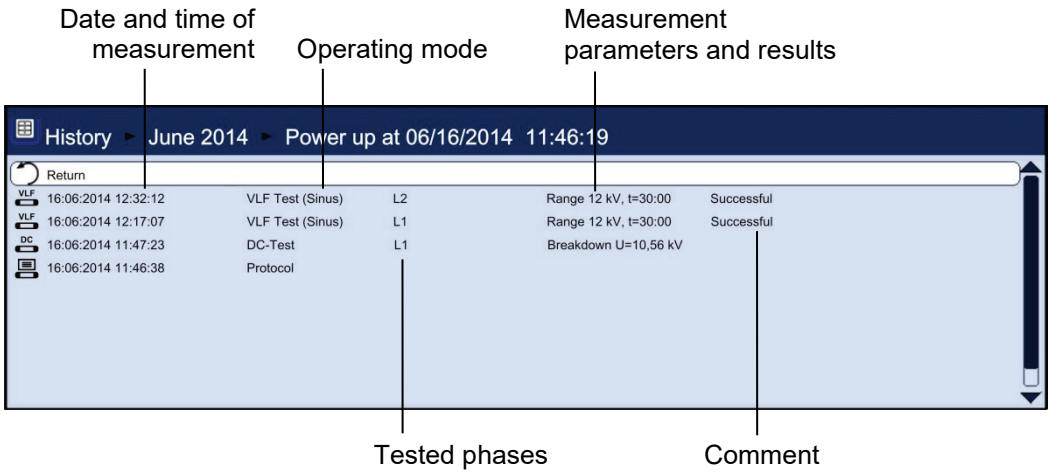
Each conducted measurement is temporarily stored in the History database and it can be retrieved from there again. This enables the user to access old traces and to compare them with the current traces. The parameters under which the measurement was conducted are also shown.

Browsing the history database

Via the history database can be called up at any time.

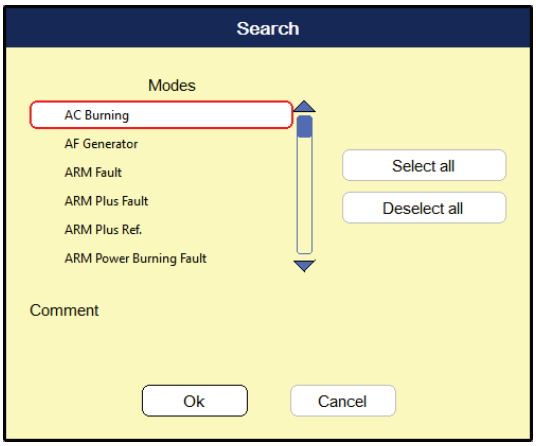
The measurement data records and the logs are organised by date in sub-directories.

After the desired month and then the desired day have been selected, the measurement data records registered on this days can be searched through and retrieved.



Via the list entry you can always return to the next directory level up.

Via the list entry you can reach the search mask using which you can search for particular operating modes and comment entries through the data records of the current directory and all sub-directories.



If you are searching for both an operating mode and comment entry at the same time, only those results which fulfil both criteria will be displayed.

Holding down the button will cause the search criteria to be discarded and all the data records to be displayed again.

Managing data records

If a data record or an entire folder is to be exported or deleted, it has to be selected first using the mouse wheel and then has to be marked appropriately using →.

Symbol	Description
	The data record or the folder (incl. all data records in it) is marked for deletion.
	The data record or the folder (incl. all data records in it) is marked for export.
	Several data records within the folder have been marked for deletion.
	Several data records within the folder have been marked for export.
	The folder contains both data records marked for deletion and data records marked for export.

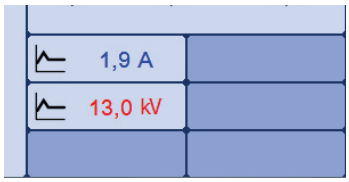
After selection of the measurements the data deletion or export process must be initiated in the data menu (see page 21). Otherwise the markings will expire the next time the software is started up.

Accessing measurement data from the history database

To access curves and data from old measurements, first access the history database and then use the mouse to select the respective measurement from the directory structure. **Briefly pressing** on the left mouse key enables all the curves and measured data for this measurement to be loaded.

If you want to repeat a test, you can use this function to first of all access the measured dataset from the previous test from the history and then launch a new test with the same test parameters. Because the curves from the previous test also remain on the display after the new test has begun, you can conveniently compare these with those of the current test.

The colour-coded legend on the bottom right edge of the screen provides information relating to the measured values of the curves currently displayed.



Current and loaded curves can be differentiated between using the symbols in front of them.

Symbol	Description
	Curves which were recorded during the measurement in progress.
	Curves which have been accessed from the history database.

If the current and loaded measurements differ in their operating mode, the current measurement is automatically suspended and only the loaded measurement is displayed.

By contrast, **holding down** on the left mouse key brings you to a context menu from which you can access the following special functions:

- Add / edit a comment for the measurement
- Add the result of the measurement to the current log (or remove it from the log). In this way, you can also fill a log with measured data from previous sessions (this is useful if you forgot to make a log for a past session).

4.7 System settings -

The System menu can be access directly through the menu item when in the main menu, and it contains the following menu items:

Menu item	Description
	Submenu for managing the measurement data (see page 21).
	Basic settings (see page 22)
	Default values can be adapted for nearly all the system settings. If user management (see page 26) is active then each user can define and store his / her own default values. These defaults are then loaded each time the system starts or a user logs in. The submenu contains the following items: This menu item enables the current settings to be stored as default values. Naturally, only the changes made during this session are taken into consideration. The following parameters may be affected: • all parameters that can be configured within the operating modes such as, e.g. voltage values, pulse width etc. (with exception of phase selection and propagation velocity) • the names for the **Tester** and **Owner** entered in the log function When saving the default values, note that all values that have been changed since the last system start are saved, which means that you might inadvertently save some changes that you do not want. To be on the safe side, you can first reload the current defaults (see below), make the required settings and then save them. This menu item can be used by the current user to reload his / her stored default values. This menu item restores the factory settings. EXP DEFS This menu item enables the default values for the current user to be exported as XML files to the Windows home directory (*DefaultValues* subdirectory). IMP DEFS This menu item can be used to import defaults values that are stored on any storage medium into the system. The imported values then become immediately applicable. When user management (see page 26) is active, the imported default values are only applicable for the user currently logged on.
	Service menu which can only be accessed by a service technician.
	The administration menu (see page 24) enables a user with the appropriate permissions to access extended system functions.

Menu item	Description
	Submenu for displaying and exporting important system information. Information on software version Information on system hardware and the current IP address This menu item shows you the system log (fault memory). This menu item allows you to export the system log (fault memory) to the Windows home directory (*SystemLog* subdirectory). Option for checking key assignment for a connected USB keyboard.

4.7.1 Data menu -

The Data menu enables stored measurement data to be imported, exported or deleted. It contains the following menu items:

Menu item	Description
DEL	Menu item to enable measurement data records / logs to be deleted from the History database. The measurements to be deleted must be marked beforehand (see page 18).
EXP DATA	Menu item that enables measurement data records / logs from the History database to be exported to the Windows home directory (*Winkis* subdirectory). The data records to be exported must be marked beforehand (see page 18). The exported measurement data are suitable for further processing in the MeggerBook reporting software, which can be ordered from your sales partner.
IMP DATA	Menu item to enable measurement data records / logs to be imported. To do so, a window is opened in which the user can navigate through the directories on the drive.
	This function can be used to compile a list of common cable types, whereby these can be accessed quickly through the log function and assigned to specific cable sections. Two filters (cable type and cable insulation) can be used to limit the number of cables displayed. Saved cable types can only be edited or deleted with administration rights (see page 24).
EXP	Menu item to enable the cable list (see above) to be exported to the Windows home directory (*Cables* subdirectory).

4.7.2 Basic settings -

The following menu items can be used to adapt the software's basic settings:

Menu item	Description
	Sets the language. Select the desired language by turning the rotary encoder and activate by pressing it. The language selection is immediately active.
	This submenu enables the following screen settings to be made: This menu item enables the user to select one of the available screen layouts. This menu item can be used to change the line thickness for the traces to meet one's own requirements.
	Date and time.

Menu item	Description
	This menu item enables the following functions that influence the measurement sequence to be activated or deactivated:  If this option is activated, the log function is called up upon entering the TAN operating mode.  If this option is activated, the phase selection will always be reset upon exiting the operating mode and must be conducted again upon each return.
	Menu item to select suitable printing template for paper format being used.
	This menu item can be used to change the logo in the header of the printed form (for printouts of measurement data). Corresponding image files in the *PNG* format can be imported by the administrator (see page 29).
	Layout of the connected keyboard.
	This menu item enables the currently logged-on system user to be changed. Once a new user has been selected, the new user's default settings are then loaded. The menu item is only available if at least one user exists in the database. The administrator can manage user accounts in the administration menu (see page 24).
PEAK RMS	Menu item for switching the voltage input / voltage display. Voltages are given as peak values or effective values depending on the setting.

4.7.3 Administration menu - (administration password required)

Purpose The administration menu is password-protected and provides access to advanced system settings such as the user administration, as well as update and backup functions.

The software's menu structure has concealed menu items added to it when administration rights are issued. These enabled functions, which are only rarely used during day-to-day operation of the device, are described in greater detail throughout the course of the manual.

Access To open the administration menu, you must first enter the password. Proceed as follows:

Step	Action
1	Select menu item , to access the Control Panel and then select menu item .
2	Select menu item , to enter the password.
	Result: The password entry dialogue appears in the display.
3	Enter the password and confirm your entry with **OK**.
	Result: If you entered the password correctly, the menu items of the administration menu appear (see below). If your entry is incorrect, you must repeat the procedure from **Step 2**.

Menu items The administration menu contains the following menu items:

Menu item	Description
UP DATE | BACK UP	These menu items can be used to back up or update (see page 25) the individual modules of the software.
	Menu item used to manage the users accounts (see page 26) of the system.
	Menu item used to disable administrator rights and to protect the administration menu with a password again.

4.7.3.1 Backing up and updating data - UP DATE | BACK UP

Data backup

Menu item BACK UP can be used to back up all the files required to recover the system.

During a backup the following files are exported to the Windows home directory (*Backup_<serial number>* subdirectory):

File	Explanation
application_<version>.tar	The application file itself
printforms.tar	All print templates, log templates and logos
Languages.tar*	Language file that contains all the available menu languages in the system.
SebaKMT.cfg.xml	Configuration file
backupDB.sql	A backup of the database, containing the saved measurement data, cable database, user database and the default values.
ProtocolDefinitions.xml	Names and sequence of log parameters (see page 29)
Printers.tar	Configuration data for all compatible printers

Because the *backupDB.sql* file contains the complete database and therefore can only be loaded again in its entirety, the following data can also be exported separately using the menus so that they can be transferred separately (e.g. to another system):

- Measurement data (see page 21)
- User account data (see page 26)
- Default values (see page 20)
- Cable data (see page 21)

Loading software modules

Menu item UP DATE can be used to install the individual software modules (see above) into the system. This way, you can restore or update modules, or transfer them to another system.

When you open the function, a file browser appears to help you navigate through the files on the storage medium. Only the files which the system identifies as software modules and which the user is authorised to load are displayed.

This means that the application itself, the database and the configuration file can only be loaded by users with enhanced administrator rights. If you do not yet have the appropriate rights, please contact your local Megger sales partner.

4.7.3.2 User administration -

User administration allows you to set up various user accounts on the system, so that each user can adjust the default values and the way the system behaves according to his own preferences.

Menu item	Description
NEW	A new user can only be created if a user name is entered. You can also limit the maximum voltage that the user can adjust and protect the account with a password. If you do not specify a password, the user does not need to enter a password when logging in, which makes the procedure quicker. The default values for the new user are the same as the factory settings. If necessary, you can import (see page 20) the default values from another user account (or even another system).
EDIT	This menu item can be used to edit the name, voltage range and password of a user.
DEL	This menu item can be used to delete individual users from the user database. If the last user has been deleted, the user management is deactivated and there is no longer a login procedure when the system is started. You can only delete the last user by interrupting the login. When deleting a user, his default values are lost. Therefore – particularly for the last user – you should export the default values beforehand (see page 20) beforehand.
EXP. USER	This menu item allows you to export a selection of user profiles from the system together with the respective standard values as an XML file to the Windows home directory (*User* subdirectory).
IMP. USER	This menu item can be used to import user profiles that are stored on any storage medium into the system. This does not affect existing users. If two user names are the same, the system asks whether you want to overwrite or keep the existing user in the system.

4.8 Log function -

Introduction

The log function can be used to automatically or manually summarise data from the current measuring operation (such as, e.g. local conditions, cable characteristics or measurement results) in a formatted log and, if necessary, to print out the data.

The log function can be activated using the menu item from the main menu.

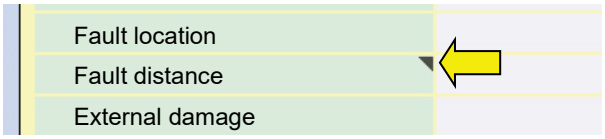
Menu items

The log function contains the following menu items:

Menu item	Description
	Clicking on this menu item calls up the general data on the measuring deployment (such as cable parameters, local conditions) on the left side. This data can then be selected and edited.
	Clicking on this menu item calls up the log data (such as measuring results, fault descriptions) on the left side. This data can then be selected and edited.
	This menu item is used to load alternative printing templates stored in the system.
	This menu item is used to print out the available log data in the format of the currently selected printing template.
	This menu item can be used to reset the current log and start a new log during an ongoing operation (for example, if the measurement is being continued on a different cable). By default, the log is only reset after the device has been restarted. In both cases, the previous log is stored in the History database.
	This menu item can be used to exit the log function. The data entered up to this point are retained and automatically filled in when the log functions is activated again (if the system has not been restarted in the meantime).

Automatic entries

Log parameters, which are indicated by a small triangle (see below), are filled in automatically with measurement data once a certain measuring procedure has been concluded. These parameters can also be edited manually. If the corresponding measuring procedure is conducted again, the existing data is automatically overwritten.



4.8.1 Logs from previous measuring operations

All logs are saved in the History database alongside the individual measurements. Consequently, they are subject to the same storage period that applies to the measurement data records. The History database also enables logs to be exported / imported (Excel format) and deleted.

Protocols called from the history are indicated with this DB symbol. The protocol of the current measuring operation remains active in the background and can be accessed again via the protocol function as soon as the protocol from the history is closed.

A log accessed through the History database can only be displayed but not edited anymore. The following functions are available for these logs:

Menu item	Description
	Using this menu item a new log can be started based on the log that has been called up from the History database. Only the general information (such as cable data) is taken over. The measured values of the archived log are not adopted. Adopting log data can save a lot of time, if, for example, a second measurement is taken on a known cable that has already been tested.
	This menu item is used to permanently save the loaded log in the history, meaning that it is no longer subject to the normal data life cycle.

4.8.2 Modifying log templates

Requirements

Modifying the print templates and parameters of the log function, requires the user to be logged on as administrator (see page 24). Only if the is the case, the menu item can be activated within the log function.

Modifying log parameters

The parameters of the currently active category are shown on the left side of the settings screen. Menu items and enable you to switch between the categories. You can adjust the currently selected parameter as follows:

Action	Description
Activating and deactivating parameters	Briefly pressing the left mouse button activates (✓) or deactivates (✗) the selected parameter.
Renaming parameters	Every parameter can be renamed using the menu item . However, make sure that - especially with parameters that are automatically filled or provided with certain options - the actual meaning is retained. To introduce new parameters the three parameters designated as **Free** at the end of the list can be renamed.
Adjusting the order of parameters	To change the position of the selected parameter in the list, press the left mouse button for roughly 2 seconds. You can then move the parameter up and down the list by turning the mouse wheel. Confirm the new position by briefly pressing the left mouse button.

The selection, order and names of the log parameters are the same for all user accounts.

Modifying log print templates

You can modify the layout of printed logs according to the company's requirements.

To create a print template, you must open the menu item in the settings screen. The print template editor opens, in which you can rearrange the log parameters (see previous page) on the print template as you like.

You can add (✓) the selected parameter to the print template by briefly pressing the left mouse button or remove it from the print template by pressing and holding it down. Parameters you have added to the print template are immediately displayed on the print template where you can position them as you like.

The menu item can be used to separately edit texts and logos in the header. The required logo has to be imported into the system first (see below).

Once you have modified the print template as required, you should save it using the menu item . In this way, you can save several print templates in the system and switch to them as necessary using the menu item .

Importing and exporting log templates and logos

The menu item can be used to export the modified log parameter set (see previous page) and the log print templates you have created yourself (see above) to the Windows home directory (*Protocol* subdirectory). In this way you can back up the changes you make and transfer them to another system if necessary.

To import a log parameter set *(ProtocolDefinitions.xml*) or print templates (*<Name_of_Print_Template>_Protocol.xml*) into the system, the file explorer has to be activated using the menu item .

In the same way, you can also import your own logos to the system as portable network graphics (**.png*) and use them later in log print templates (see above) or the normal print templates.

5 Performing measurements

5.1 Initialising a new log

Initialising a log

Before any measurements are commenced on a cable, a new log should be initialised. This happens automatically as soon as the log function (see page 27) is opened for the first time.

Filing details on connected cable

If you know the data for the connected cable, it is advisable to file the data in the log before starting the measurement.

To define a cable the number of cable sections must be specified first. After this, the type of the cable has to be selected from the cable database (see page 21) and the length has to be entered.

5.2 Standard functions

The following standard functions are generally available in every operating mode:

Menu item	Description
	This menu item can be used to move the cursor along the X axis. The current and voltage values of the point in time currently marked are displayed in the bottom part of the screen.
	This menu item can be used to increase or reduce the visual range on the X-axis. The section aligns itself with the current cursor position here.
	This menu item can be used to print out the currently displayed measuring data.
	This menu item can be used to access a list of all data records stored in the History database which match the currently active operating mode. Only the permanently stored data records are taken into account here. Using the rotary encoder (or mouse) enables a data record in the list to be selected and then accessed. This way, e.g. a reference curve previously recorded on the same cable can be quickly located and compared with the current curve.

5.3 Cable testing

Selecting the operating mode

The operating modes for cable testing are usually grouped not directly in the main menu but rather in the submenu TEST.

Menu item	Operating mode
VLF	Cable test with VLF sine wave voltage or trapezoidal AC voltage (rectangular voltage)
DC	Cable test with positive and negative DC voltage

If the test system is connected to the test object via the optional VLF CR Test Boost then only VLF cosine rectangular voltage tests can be carried out. This operating mode can be access through the VLF CR menu item. Due to the high testable cable capacitance, this operating mode is also suitable for norm-compliant testing of very long cables.

Setting the test parameters

The phases and the voltage range are automatically queried when entering the operating mode, however – like all other settings – they can be adjusted until the actual start of the test.

The following test parameters can be set:

Button / menu item	Description
→	The phase selection must be carried out in accordance with the actual connection situation. Thereafter, the phase selection menu must be closed using →.
	The test time is specified in minutes. After expiry of the test time, the high voltage will be automatically switched off.
U	Voltage range for the upcoming test. After starting the test, the actual test voltage can only be set within this range.
f	Only adjustable for tests with sine wave or rectangular voltage This menu item is used to change the frequency of the VLF test voltage (0.01 Hz to 0.1 Hz). The harmonisation documents HD 620 S1 and HD 621 S1 as well as the IEC standard 60502-2 recommend the 0.1 Hz frequency for VLF tests. As the maximum permitted test frequency depends on the determined cable capacitance and the test voltage being applied, it may be necessary to adjust the test frequency set, whereof the user is informed at the start of the test.
	Only adjustable for tests with sine wave or rectangular voltage Toggle between sine wave and rectangular mode.
DC +/−	Only adjustable for DC voltage tests This menu item is used to specify the polarity of the DC test voltage.

Notes on selecting the test voltage and test time

The requirements for a meaningful cable test are found in the harmonisation documents HD 620 S1 and HD 621 S1, the IEC standard 60502-2 and often in company-internal testing guidelines as well.

The following table provides a selection of proven test parameters for various applications:

Application	Test voltage	Test duration in minutes
VLF test (new cables)	3 Uo	15 to 60
VLF test (on aged cables)	1.7 to 3 Uo	60
DC test (on PILC cables)	4 to 8 Uo	15 to 30

Starting the test

Once all the relevant parameters for the test as well as the phase(s) have been set, the test can be started using the ⏻ menu item and, after this, the test voltage set. After which 10 seconds remain to enable high voltage with the “HV ON” button.

As soon as high voltage is enabled, the “HV OFF” button lights up red signalling “high voltage at the HV output”.

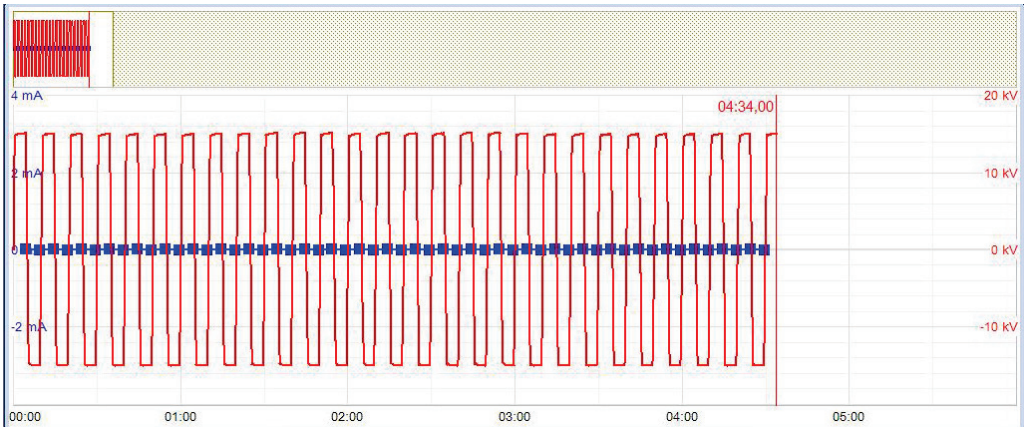
At the start of a test with sine wave or rectangular voltage, load detection is performed. If the load characteristics (capacitance and insulation resistance) do not permit a test with the set parameters, this is indicated on the screen by a system message.

For tests with sine wave or rectangular voltage, testing using a lower frequency is offered if possible. The user can then either cancel the test or start it using a different frequency.

Tests with DC voltage or cosine rectangular voltage must be stopped in any case and, if possible, restarted using a lower test voltage.

Performing the test

The voltage curve can be followed on the screen during the test. In DC, square and cosine square mode leakage current measurement is carried out too.



In the case of tests with DC, square or cosine square voltage you can switch to expert view and display the periodic onset of charge current using the STD/EXP menu item.

The test duration can be adjusted retrospectively even while the test is ongoing using the ◷ menu item or reset using the ◷| menu item.

Alongside the current and voltage values, some other relevant parameters and measurement values are shown at the bottom edge of the screen depending on the operating mode:

Symbol	Description
	Remaining test duration
	Set test duration
f	Actual test frequency
	The load capacitance determined at the start of the test
Ω	The insulation resistance determined at the start of the test

Finishing the test

If a test time was defined, the high voltage is automatically switched off at the end of this time. A manual switch-off can be initiated at any time using the “HV Off” button or the **HV Off** menu item.

If a voltage breakdown occurs in the test object during the test time, the test is also interrupted. In which event, the test does not qualify as having been passed.

Irrespective of whether the high voltage is switched off automatically or manually, the HV output is discharged. The test data logged up to the switch-off are recorded in the history database (see page 17).

5.4 Sheath test and sheath fault pinpointing (optional)

Introduction

Sheath tests can be conducted with a DC voltage of up to 20 kV (negative polarity), which also permits cables with a thicker outer sheath (such as cables rated 230 kV) to be tested.

If a voltage breakdown occurs during the course of a sheath test or the measured leakage current indicates that there is a sheath fault, fault pinpointing can be started directly after the test.

During sheath fault pinpointing, DC pulses with an adjustable pulse rate are coupled into the screen of the faulty cable.

With each coupled pulse, the current flowing into the earth forms a voltage gradient around the point of escape (the fault position in the sheath), the centre of which can be located precisely by means of an earth fault locator and earth spikes (step voltage method).

Selecting the operating mode

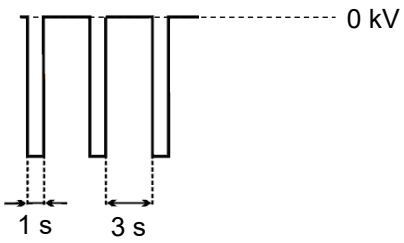
To start a sheath test, the submenu of the test operating modes must be opened using the menu item TEST and from this, the menu item must be called up.

Sheath fault pinpointing can be started either directly from the main menu or from the submenu using the menu item .

Setting the test parameters

The phases (sheath testing only) and the voltage range are automatically queried when entering the operating mode, however – like all other settings – they can be adjusted until the actual start of the test or pinpointing.

The following test parameters can be set:

Button / Menu item	Description
→	The phase selection must be carried out in accordance with the actual connection situation. Thereafter, the phase selection menu must be closed using →.
U	The set voltage range limits the maximum voltage that can be set during the test or pinpointing. In terms of the relevant standards (such as the VDE 0276), which may however differ from the local regulations or standards, the following guidelines are specified: • PVC cable ≤3 kV • PE medium voltage cable ≤5 kV • PE high voltage cable ≤10 kV
	Only adjustable for sheath fault pinpointing Menu item to select the rate of the DC pulses in seconds. **Example:** If a pulse rate of 1:3 produces is selected, every DC pulse with a duration of 1 second is followed by a 3 second voltage dropout. 
	Only adjustable for sheath testing The duration of the test can be specified within a range of 1 to 90 minutes. In the relevant standards (e.g. VDE 0276), the test duration of a sheath test is specified as being between 5 to 10 minutes depending on the cable type.

Starting the test / pinpointing

Once all the settings have been made, the test or pinpointing can be started with the ⏻ menu item and, right after this, the test voltage set. After which 10 seconds remain to enable high voltage with the “HV ON” button.

As soon as high voltage is enabled, the “HV OFF” button lights up red signalling “high voltage at the HV output”. The test system starts with voltage conditioning. During sheath testing or sheath fault pinpointing the applied voltage can be manually adjusted by means of the menu item U_{NOM} .

5.4.1 Sheath test

Performing the test

During the test the voltage curve and the measured leakage current are shown in the display area. The test duration can be adjusted retrospectively even while the test is ongoing using the menu item or reset using the menu item.

Alongside the current and voltage values, some other relevant parameters and measurement values are shown at the bottom edge of the screen:

Symbol	Description
	Remaining test duration
	Set test duration

Finishing the test

If a test time was defined, the high voltage is automatically switched off at the end of this time. A manual switch-off can be initiated at any time using the “HV Off” button or the **HV Off** menu item.

Irrespective of whether the high voltage is switched off automatically or manually, the HV output is discharged. The test data logged up to the switch-off are recorded in the history database (see page 17).

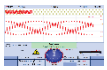
Evaluating the test results

If the leakage current values measured during the test are above the limits specified by the cable owner, the tested cable should be examined in more detail soon or at least a shorter testing cycle should be introduced.

5.4.2 Sheath fault pinpointing

Pinpointing sheath faults

After high voltage has been enabled and the desired voltage has been set, the fault position can be accurately pinpointed by means of an earth fault locator (e.g. ESG NT).



For more details about operating the earth fault locator, please read the accompanying instructions.

Do not leave the system in operation unattended and accessible to the third parties. Cordon off the location in a secure manner or instruct an authorised person to monitor the system.

Completing the measurement

After fault location has been completed, high voltage must be switched off manually using the “HV Off” button or the menu item **HV Off**. Afterwards, the test object is discharged by means of an internal discharge-resistor.

5.5 Dielectric diagnosis (optional)

Introduction

Underground medium and high voltage cables are continuously subject to thermal, electrical and mechanical stresses over the course of their use.

This fact inevitably leads - despite the use of durable materials - to increasing damage or ageing of the cable, which in turn leads to dielectric losses.

A measure of these dielectric losses is the so-called loss factor tanδ, which can be determined within the scope of a tan delta step test.

On the basis of the measurement results, integral ageing effects, such as the degree of humidity, can be diagnosed and cables with critical ageing identified.

Requirements

A tan delta test unit is essential for carrying out a dielectric state analysis. Both the optional internal measurement sensor and the external tan delta test attachment are best suited to this.

Both solutions can be ordered from your Megger distribution partner if need be.

Selecting the operating mode

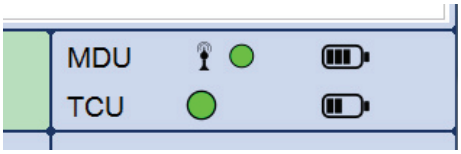
The operating modes for dielectric cable diagnosis can be accessed either directly from the main menu or grouped in the sub-menu DIAG.

Menu item	Operating mode
MWT	Dielectric test (sine wave voltage) with accompanying tan delta measurement (Monitored Withstand Test)
TAN	Tan delta step test with automatic standard-compliant evaluation of measured data

Selection and status of measuring sensor

If the measuring sensor to be used (internal or external) has not already been explicitly pre-configured in the software by the factory, this selection must be made before starting each measurement using the INT/EXT menu item.

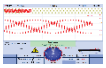
When using the external tan delta test attachment, the current status of the devices is displayed permanently at the right edge of the screen throughout the measurement.



The measurement can generally only be started when there is an adequate wireless connection to the MDU (green circle). If the TCU is also being used for the measuring and is connected to the MDU via a fibre optic cable, its status should also be displayed.

If the status display indicates problems connecting to the MDU (red circle) or to the TCU (not displayed despite being connected), the electrical connection of the respective individual device must be checked.

If an empty, red battery symbol is shown for one of the devices, it is recommended that you charge up the device before beginning the measurement.



For detailed instructions on connecting and charging the devices, please read the operating instructions for the tan delta test attachment.

5.5.1 Voltage withstand diagnosis

Setting the test parameters

The phases and the voltage range are automatically queried when entering the operating mode, however – like all other settings – they can be adjusted until the actual start of the test or pinpointing.

The following test parameters can be set:

Button / menu item	Description
→	The first phase to be tested must be selected. As soon as the testing of a phase has been completed, the phase selection opens again automatically and testing can be continued directly at the next phase with the same settings. Thereafter, the phase selection menu must be closed using →.
	The test time is specified in minutes. After expiry of the test time, the high voltage will be automatically switched off.
U	Voltage range for the upcoming test. After starting the test, the actual test voltage can only be set within this range.
f	This menu item is used to change the frequency of the VLF test voltage (0.01 Hz to 0.1 Hz). The HD 620 S1 and HD 621 S1 harmonisation documents recommend the 0.1-Hz frequency for VLF tests. As the maximum permitted test frequency depends on the determined cable capacitance and the test voltage being applied, it may be necessary to adjust the test frequency set and about which the user was informed at the start of the test.

Notes on selecting the test voltage and test time

The requirements for a meaningful cable test are found in the harmonisation documents HD 620 S1 and HD 621 S1 and often in company-internal testing guidelines as well.

The following table provides a selection of proven test parameters for various applications:

Application	Test voltage	Test duration in minutes
VLF test (new cables)	3 Uo	15 to 60
VLF test (on aged cables)	1.7 to 3 Uo	60

Starting the test

Once all the relevant parameters for the test as well as the phase(s) have been set, the test can be started using the ⏻ menu item and, after this, the test voltage set. After which 10 seconds remain to enable high voltage with the “HV ON” button.

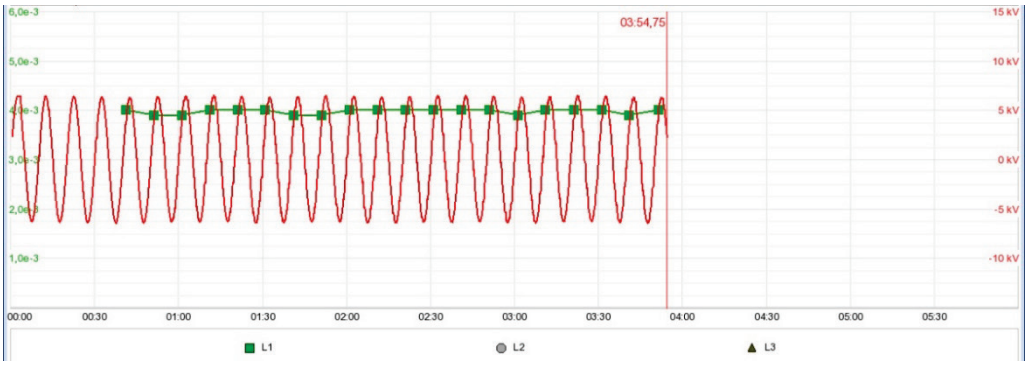
As soon as high voltage is enabled, the “HV OFF” button lights up red signalling “high voltage at the HV output”.

At the start of the test, a load detection is performed. If the load characteristics (capacitance and insulation resistance) do not permit a test with the set parameters, this is indicated on the screen by a system message.

If possible, testing using a lower frequency is offered. The user can then either cancel the test or start it using a different frequency.

Performing the test

The voltage curve can be followed on the screen during the test. After the test has started, the measuring sensor generally needs about 3 cycles to adapt optimally to the current and voltage level. In the case of the external test attachment, the self-calibration takes as much as 2 minutes for the first phase to be tested. Not until after this start-up phase will the tanδ values measured be displayed as coloured symbols (as per the legend below the diagram) on the curve line.



You can use the ☰ menu item any time to display a table with the last 10 measured values.

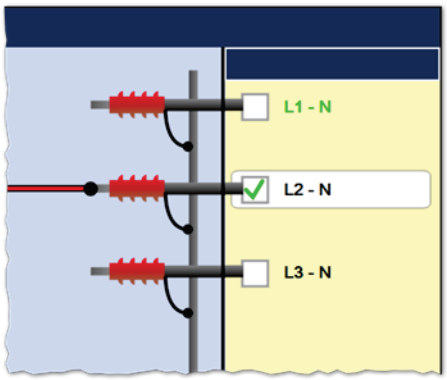
The test duration can be adjusted retrospectively even while the test is ongoing using the 🕒 menu item.

Alongside the voltage and tanδ values, some other relevant parameters and measurement values are shown at the bottom edge of the screen.

Symbol	Description
	Remaining test duration
	Set test duration
f	Actual test frequency
	Measured load capacitance Either the measured value is calculated just once at the start of the test (internal measuring sensor) or continually updated throughout the course of the measurement (external test attachment)
Ω	Measured insulation resistance Either the measured value is calculated just once at the start of the test (internal measuring sensor) or continually updated throughout the course of the measurement (external test attachment)
$\bar{\delta}$	Average of the individual measurement values so far
σ	Standard deviation of the individual measurement values so far

Changing phases during the course of the test

As soon as the testing of a phase has been completed, the phase selection opens again automatically and another phase can be selected (if not all phases have been tested yet). The phases which have already been tested are marked in green.



If wanted, the next phase to be tested can be selected and the electrical connection adjusted accordingly. The high voltage source is automatically switched off and the HV output is discharged.

WARNING	**Follow the five safety rules** To establish and ensure a voltage-free state when changing phases, the five safety rules (see page 7) must be followed.

After changing the phase, the message needs to be confirmed and the high voltage must be enabled again with the “HV On” button. After doing so, the system automatically continues with the measurement on the next phase.

Finishing the test

If a test time was defined, the high voltage is automatically switched off at the end of this time.

The measurement can be manually deactivated at any time via the “HV OFF” button or the **HV Off** menu item. A measurement which has been suspended this way can be resumed as long as the operating mode has not been exited in the meantime. The query at to whether the measurement should be continued or restarted will appear immediately after selecting the ⏻ menu item.

When resuming a measurement, the voltage run of the last phase measured begins from the start. This way, any confusion about phase changes can be corrected without having to start the complete measurement from the start all over again.

If a voltage breakdown occurs in the test object during the test time, the test is also interrupted.

Irrespective of whether the high voltage is switched off automatically or manually, the HV output is discharged. The test data logged up to the switch-off are recorded in the history database (see page 17).

Evaluation of the test results

A dielectric strength test carried out to standard is generally deemed to have been successfully passed if there are no breakdowns in the test object throughout the duration of the test. In addition to this clear statement, further conclusions can be drawn on the state of the test object using the trend over time of the measured tanδ values.

E.g. a falling measured tanδ value can indicate wet cables / accessories, while a tanδ increasing over time can be a definite indication of an emerging cable fault.

In the event of such a change in the measured values during the test it is strongly recommended that you carry out a Tan Delta step test following the test (see next section). The measurement results from this can be assessed using the relevant standards and will provide an even more accurate conclusion as to the ageing of the cable insulation.

5.5.2 Tan Delta step test

5.5.2.1 Preparing a step test

Automatic query of information

As soon as the operating mode has been selected using the TAN menu item, the information relevant for the measurement is queried in the following order:

Information	Description
Log data	You should use the automatically opening log form (see page 27) to enter the full cable data at the very least (cable description, number of cable sections, cable type). This is required by the software in order to carry out an automatic evaluation of the measured values. Concise logging also facilitates the storage and allocation of measured data and thus trend observation over an extended period. After completing input of the data, the screen must be closed using the ✓ menu item. You can disable the automatic retrieval of the log screen upon entering the operating mode in the basic settings if you wish.
Phases	The first phase to be tested must be selected. As soon as the testing of a phase has been completed, the phase selection opens again automatically and testing can be continued directly at the next phase with the same settings. Thereafter, the phase selection menu must be closed using →.
Nominal voltage	Nominal voltage (Uo) of the connected test object as an effective value. Once the value is confirmed, a calculation of the respective voltage values of the individual steps is carried out and displayed on the screen. You can use the U_0 menu item to amend the selection made right up until the actual start of the measurement. ⓘ The maximum nominal voltage that can be set depends on the maximum output voltage of the test system as well as on the set voltage levels (see the next page). If the nominal voltage of the cable is above the maximum value that can be set, the number of the voltage levels would have to be reduced accordingly first.
Insulation type	The insulation type is only queried if it has not already been entered in the log and if a standard is set for the automatic evaluation of the measurement results. Should no evaluation criteria for the insulation type selected exist in the currently preset standard, the corresponding message will appear after the selection has been made.

Setting the measurement parameters

Once you have entered the operating mode you can use the menu item to access a sub menu where you can adjust advanced measurement settings.

Changing these parameters can have a considerable effect on the total test duration! It is therefore recommended to check the estimated total test duration after performing any changes. This is displayed in the lower portion of the screen next to the icon and is updated with every change.

The following parameters can be adjusted:

Menu item	Description
NUM	Number of the voltage levels (1 to 6) that the test voltage runs through in the course of a test. The first voltage level is 0.5Uo. The voltage is increased by 0.5Uo with every additional voltage level. The sixth voltage level would accordingly be 3Uo. One requirement for the automatic evaluation of the test results is that the measurements were taken in respect of at least 3 voltage levels. Once the value is confirmed, a calculation of the respective voltage values of the individual levels is carried out while taking the nominal voltage into account and displayed on the screen. In practice, 4 levels with voltages of 0.5Uo, 1Uo, 1.5Uo and 2Uo have proven useful. To avoid possible breakdowns, it is recommended that already heavily aged cables are not be measured at voltage levels greater than 2Uo (≤1.5Uo is even safer).
n	Number of tanδ measured values (5 to 20) per voltage level. At least 8 measured values per voltage level should be recorded in order to obtain a calculated tanδ mean value that is statistically meaningful. The higher the number of values, the more reliable the calculated mean value. However, the stress placed on the test object also increases accordingly. As the goal is a non-destructive diagnosis, the number of measured values, especially in the case of high test voltages, should be kept limited (recommended are 8 to 10 values).

Menu item	Description
f~	Frequency of the VLF test voltage (0.01 Hz to 0.1 Hz). A setting of **0.1 Hz is definitely recommended**, since all the experience documented in the relevant technical literature or in the corresponding standards refer to this frequency as the diagnostic frequency. By measuring at different frequencies, a tanδ spectrum can furthermore be shown for the test object. This spectrum can provide further information on the condition of the test object. If the capacitance of the connected test object does not permit a measurement using 0.1 Hz and an automatic frequency adjustment is performed at the start of the measurement, the evaluation criteria that are independent of frequency should be looked more closely. These include, amongst others, the deviation of the absolute tanδ values between the phases of a cable system and the change of the tanδ with increasing voltage (Δtanδ).
Ø	Administrator rights (see page 24) are required to see this menu item You can use this menu item to activate or disable averaging for smoothing the measurement curve. Doing so will result in the display of the average value of the last 3 values measured in the diagram rather than the tanδ value actually measured. Averaging does not take place beyond two voltage levels. Accordingly the first two measured values of each voltage level are not shown when averaging is activated. If averaging is activated then automatic analysis of the measurement results is not possible. Furthermore, the duration of the voltage strain is increased. As such it is generally recommended that you only activate this function in the event of a significant fluctuation in measurement values.
	Administrator rights (see page 24) are required to see this menu item This menu item is used to specify the test voltage for the individual voltage levels (as a factor of U_0). In practise, the setting of 0.5 U_0 increments has proven itself viable. In addition, it is also possible to change the two voltage levels, from which the Δtanδ (see page 54) is to be calculated.

Menu item	Description
SEC	Administrator rights (see page 24) are required to see this menu item This menu item can be used to activate or disable a safety function which monitors the progression of the measured tanδ values during the measurement process and informs about critical variations. The measurement can then be suspended or continued. If the measurement is continued, a non-destructive diagnosis can no longer be guaranteed. The actual purpose of the safety feature is to prevent “water trees” from changing into “electrical trees” and thus avoid a breakdown. This effect, provoked by a VLF test, should of course be avoided in order to obtain a diagnosis that is as non-destructive as possible. If necessary, this dialogue window can be used to adapt the various triggering thresholds of the safety function. Here a differentiation is made between deviations from the moving average (average out of the last three measured values) and from the statistical average (average out of all measured values of the voltage level).

5.5.2.2 Performing a step test

Starting the test

Once all the relevant parameters for the measurement as well as the phase(s) have been set, the measurement can be started using the menu item and, after this, the test voltage set. After which 10 seconds remain to enable high voltage with the “HV ON” button.

As soon as high voltage is enabled, the “HV OFF” button lights up red signalling “high voltage at the HV output”.

A load detection is performed at the start of the measurement. If the load characteristics (capacitance and insulation resistance) do not permit a test with the set parameters, this is indicated on the screen by a system message.

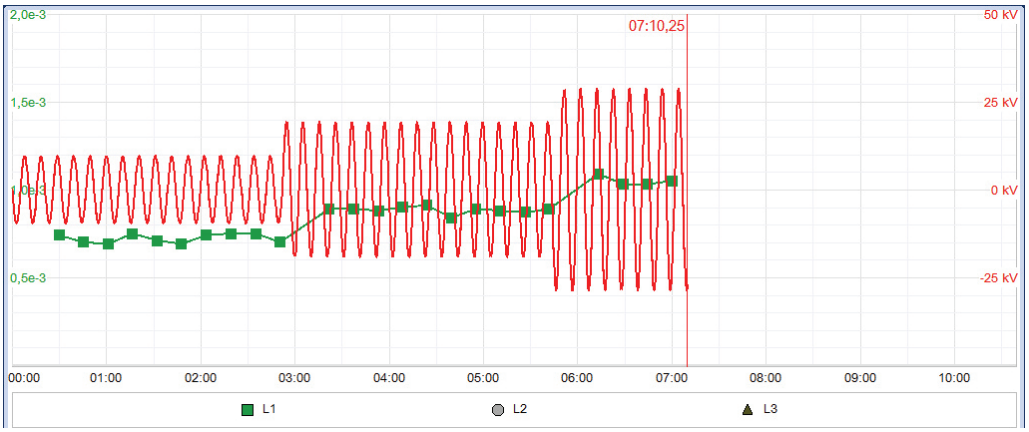
If possible, testing using a lower frequency is offered. The user can then either cancel the test or start it using a different frequency. However, the latter would result in the measurement being non-compliant and would prevent any automatic evaluation of the measurement results from being carried out.

Alternatively, the number of voltage levels could be reduced, resulting in an automatic drop in the maximum necessary test voltage. However, care should be taken here to ensure that, if possible, the 3 voltage levels required for meaningful measurement results are retained.

Course of the measurement

The test voltage runs through the selected number of voltage levels during the course of the measurement and remains at a voltage level for the selected number of measured values.

The measuring sensor generally needs about 3 cycles to adapt optimally to the current and voltage level after the measurement has started. In the case of the external test attachment, the self-calibration takes as much as 2 minutes for the first phase to be tested. Not until after this start-up phase will the tanδ values measured be displayed as coloured symbols (as per the legend below the diagram) on the curve line.



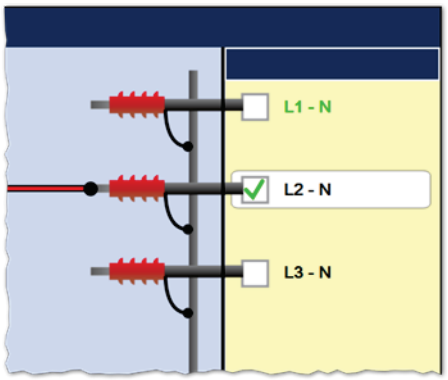
You can use the menu item any time to display a table with the last 10 measured values.

Alongside the voltage and tanδ values, some other relevant parameters and measurement values are shown at the bottom edge of the screen.

Symbol	Description
	Remaining test duration
	Set test duration
	Measured load capacitance Either the measured value is calculated just once at the start of the measurement (internal measuring sensor) or continually updated throughout the course of the measurement (external test attachment)
Ω	Measured insulation resistance Either the measured value is calculated just once at the start of the measurement (internal measuring sensor) or continually updated throughout the course of the measurement (external test attachment)
Δ	Difference of the tanδ mean values for two specified voltage levels (default: level 3 – level 1)
σ	Standard deviation of the individual measurement values so far
SEC	State of the safety feature (see page 44)

Changing phases during the course of the test

As soon as the testing of a phase has been completed, the phase selection opens again automatically and another phase can be selected (if not all phases have been tested yet). The phases which have already been tested are marked in green.



If wanted, the next phase to be tested can be selected and the electrical connection adjusted accordingly. The high voltage source is then automatically switched off and the HV output is discharged.

WARNING	**Follow the five safety rules** To establish and ensure a voltage-free state when changing phases, the five safety rules (see page 7) must be followed.

For measurements with leakage current compensation (only available for external test attachment), it should be noted that a different phase might need to be used for the transport of the leakage current if the previously used phase will be measured next. In this case, the electrical connection must be adjusted at the near and far cable ends.

After changing the phase, the message needs to be confirmed and the high voltage must be enabled again with the “HV On” button. After doing so, the system automatically continues with the measurement on the next phase.

Completing the test

After all the set phases have run through the voltage levels, the measurement process ends automatically and high voltage is switched off.

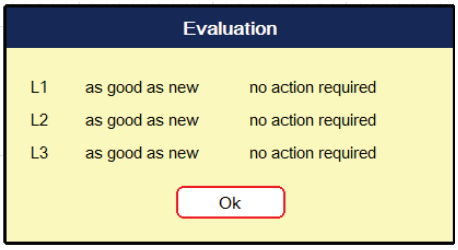
The measurement can be manually deactivated at any time via the “HV OFF” button or the **HV Off** menu item. A measurement which has been suspended this way can be resumed as long as the operating mode has not been exited in the meantime. The query at to whether the measurement should be continued or restarted will appear immediately after selecting the ⏻ menu item.

When resuming a measurement, the voltage run of the last phase measured begins from the start. This way, any confusion about phase changes can be corrected without having to start the complete measurement from the start all over again.

If a voltage breakdown occurs in the test object during the test time, the test is also interrupted.

Irrespective of whether the high voltage is switched off automatically or manually, the HV output is discharged. The test data logged up to the switch-off are recorded in the history database (see page 17).

If all the conditions for an automatic evaluation of measurement results (see page 51) are met, this is shown straight away upon completion of the measurement:



Instead of the voltage curve, the diagram area now shows the tan delta trend view across all voltage levels and phases. The values form the mean value of the tanδ values measured at the respective voltage level. The following illustration shows, by way of example, a trend view over five voltage levels for all three phases:

You can use the **STD / TRD** menu item to switch back from this trend view to the standard diagrams.

5.5.2.3 Automatic evaluation of the test results

Requirements

An automatic evaluation of the test results is only carried out, if the following requirements have been fulfilled:

- A standard for the evaluation of the test results has been selected.
- The selected standard contains criteria for the evaluation of the insulation type of the connected cable.
- The test was conducted in respect of at least 3 voltage levels.
- The test was carried out on a test voltage with a frequency of 0.1 Hz.

Displaying the evaluation

If the software was able to carry out an automatic evaluation, this will be shown together with the resulting recommendations for action straight away following completion of the measurement.

Using the following menu items shown in the sub menu you can adjust the evaluation criteria even after the measurement and display the evaluation again:

Symbol	Description
	Standard according to which the recorded measurement results should be evaluated. In the **manual** setting there is no automatic evaluation.
TYPE	Insulation type of the connected cable. Automatic evaluation is not possible in the **mixed** setting.
+/-	Menu item for displaying the automatic evaluation and recommendations for action. If automatic evaluation is not possible, the non-fulfilled requirements are indicated instead.

If the measurement has been performed at a deviant frequency or with too few voltage levels, it must either be repeated or the measurement results must be evaluated manually (see page 54).

The evaluation criteria may be adapted as many times as required and the log with the updated evaluation printed out again.

If, for example, the criteria of a stored standard have been adapted on account of new findings (see next section), even past measurement results can be re-evaluated thanks to the history database (see page 17).

5.5.2.4 Specifying your own evaluation criteria

Introduction

With IEEE 400.2 - 2013 a key standard for evaluating measurement results is already implemented in the software.

Furthermore, the software features an assistant which allows customised evaluation criteria to be specified and stored as 'in-house' standard.

You may only create, edit and delete your own standards upon acquiring the administration rights (see page 24).

Creating a custom standard

Proceed as follows to create a custom standard:

Step	Action
1	Select the menu item from the submenu .
2	Select the **Create standard** menu item.
3	Enter a descriptive name for the new standard and then select the **Next** button.
4	Mark all the types of insulation for which you wish to store evaluation criteria in this standard.
5	Mark all the evaluation criteria (see page 54), which should be included in the evaluation of the condition and then select the **Next** button. Select the evaluation criteria with care. As soon as just one of the criteria has exceeded the specified threshold, the condition of the cable insulation will be given a poorer evaluation. An evaluation based on several criteria can therefore be more severely affected by measurement inaccuracies.
6	For every combination of insulation type and evaluation criterion, enter the lower and upper threshold for the condition description **aged** and then select the **Next** button.
7	After entering all thresholds, save the new standard using the menu item **Finish**. The new standard can now be selected as the basis of an evaluation for every measurement using the menu item .

Editing a custom standard

Proceed as follows to edit a custom standard:

Step	Action
1	Select the menu item from the submenu .
2	Mark the standard you wish to edit.
3	Select the **Edit standard** menu item.
4	Proceed the same way as under steps 3 – 7 describing the procedure for creating a new standard (see above).

Deleting a custom standard

Proceed as follows to delete a custom standard:

Step	Action
1	Select the menu item  from the submenu  .
2	Mark the standard you wish to delete.
3	Select the **Delete standard** menu item.
4	Confirm the query with **Yes**.

5.5.2.5 Manual evaluation of the test results

Introduction

An automatic evaluation of the measurement results made by the software should be understood as a valuable tool, however by no means should it be used as a sole decision-making criterion.

Criteria such as deviating measurement results within a cable system, the influence of leakage currents as well as outside influencing parameters can only be analysed to a limited extent by software. The technician performing the test is therefore urged to scrutinize the evaluation critically and, if necessary, to conduct own analyses to avoid incorrect conclusions.

Evaluation criteria

After completing a test, an overview of the following evaluation criteria derived from the individual tan δ values can be called up by selecting the menu item Σ:

Criterion	Description
tanδ at **xUo**	The mean value of the measured absolute tanδ values is specified separately for each voltage level. The condition should not however be evaluated solely on the basis of these absolute values since these may be influenced by the following factors: • Number of joints in the cable • Tyoe of joints • Temperature of the cable • Air humidity • Leakage currents over the termination Nevertheless, important information can be derived from the mean value. For example, a comparison can be made of the absolute values for all three phases of a cable system under identical conditions. As a rule, all three phases of a cable stretch are subject to the same conditions. They have the same number of accessories and are subject to the same environmental influences. By taking the measurements within a short time frame, an almost uniform cable temperature can also be ensured. Consequently, the mean values of the three phases should be almost identical. Substantial deviations upwards indicate that the condition of the affected phase is poor. In such a case further investigations should be made (e.g. a PD measurement).
σ	The standard deviation is specified separately for each voltage level and is a measure of the dispersion of the absolute tanδ values about the mean value of the respective level.
1,5Uo – 0,5Uo (Δtanδ)	The most important criteria for a meaningful evaluation of the insulation condition is the Δtanδ which reflects the voltage dependency of the absolute tanδ value. The Δtanδ is calculated from the difference between the tanδ mean value of the voltage levels 0.5 U_0 and 1.5 U_0. $\Delta\tan\delta = \tan\delta_{1.5 \cdot Uo} - \tan\delta_{0.5 \cdot Uo}$ The Δtanδ can only be furnished in respect of measurements taken in respect of at least 3 voltage levels.

Evaluation of XLPE cables

For XLPE cables, an insulation in good condition is indicated by a low Δtanδ, which corresponds to a nearly constant tanδ over increasing test voltages. For an aged insulation, the tanδ value increases slightly with increasing voltage. For a critically aged insulation, the tanδ value clearly increases with increasing voltage.

Using the relevant literature as an aid, the absolute tanδ values measured on a XLPE cable (homopolymeric) can also be used to derive conclusions about the condition (with the restrictions presented on the previous page). The IEEE 400.2 - 2013 differentiates between different regions of the world. For countries **outside of North America**, the following limit values apply:

Mean value at 2Uo [10^{-3}]		**σ at Uo** [10^{-3}]		**Δtanδ (2Uo – Uo)** [10^{-3}]	**Condition assessment**
<1.2	and	<0.1	and	<0.6	No action required
1.2 bis 2	or	0.1 bis 0.5	or	0.6 bis 1	Further study advised
>2	or	>0.5	or	>1	Action required

For the **North American area**, however, significantly higher limit values are defined due to differences in the design of the cables:

Mean value at Uo [10^{-3}]		**σ at Uo** [10^{-3}]		**Δtanδ (1,5Uo – 0,5Uo)** [10^{-3}]	**Condition assessment**
<4	and	<0.1	and	<5	No action required
4 to 50	or	0.1 to 0.5	or	5 to 80	Further study advised
>50	or	>0.5	or	>80	Action required

Evaluation of PILC cables

The interpretation of the dielectric loss factor in evaluating the condition of PILC cables has not yet been thoroughly investigated. An exact, qualitative evaluation can therefore only be derived to a limited extent from the measurement results received, as compared to XLPE cables.

In principle, it can be said that the dielectric loss factor of a PILC cable is always considerably higher than that of a XLPE cable. Even a vulnerable XLPE cable will show lower tanδ absolute values measured as compared to a healthy PILC cable.

The IEEE 400.2 - 2013 differentiates between different regions of the world. For countries **outside of North America**, the following limit values apply:

Mean value at 2Uo [10^{-3}]		**σ at Uo** [10^{-3}]		**Δtanδ (2Uo – Uo)** [10^{-3}]	**Condition assessment**
<50	and	<-0.5	and	-20 to 20	No action required
50 to 100	or	0.5 to 1	or	-20 to -50 or 20 to 50	Further study advised
>100	or	>1	or	<-50 or >50	Action required

For the **North American area**, however, significantly higher limit values are defined due to differences in the design of the cables:

Mean value at Uo [10^{-3}]		σ at Uo [10^{-3}]		Δtanδ (1,5Uo – 0,5Uo) [10^{-3}]	Condition assessment
<85	and	<0.1	and	-35 to 10	No action required
85 to 200	or	0.1 to 0.4	or	-35 to -50 or 10 to 100	Further study advised
>200	or	>0.4	or	<-50 or >100	Action required

Evaluation of EPR cables

EPR cables by their nature exhibit a higher dielectrical loss factor as compared to XLPE cables. However, this still lies below the level of PILC cables.

The threshold values given in the following table are to be regarded merely as guiding values:

Mean value at Uo [10^{-3}]		σ at Uo [10^{-3}]		Δtanδ (1,5Uo – 0,5Uo) [10^{-3}]	Condition assessment
<35	and	<0.1	and	<5	No action required
35 to 120	or	0.1 to 1.3	or	5 to 100	Further study advised
>120	or	>1.3	or	>100	Action required

You can find a detailed breakdown of EPR insulations by material composition in the IEEE standard IEEE 400.2 - 2013.

5.5.2.6 Processing the measured data

Printing the log

The log with the measured data can be printed out immediately after completing the measurement and selecting the evaluation criteria using the menu item.

The menu item in the sub menu offers even more options for adapting the scope of the report. While only the trend diagram is embedded in the standard report, the more detailed report includes a complete measured value and voltage diagram for each phase measured.

Exporting the measured data

The menu item in the sub menu can be used to export the measured values of the last performed measurement in CSV (Comma Separated Values) format. These data can later be conveniently displayed on the PC with any CSV-capable application (e.g. Excel).

The table basically contains the information as it is shown in the measured value table. In addition, the standard deviation and the mean are displayed for each voltage level.

The file is backed up directly to the Windows home directory (*TanDelta* sub directory).

5.5.3 Partial discharge diagnosis

In combination with a partial discharge coupler (e.g. PDS 60), partial discharge measurements can also be carried out using the notebook. Those are conducted using the "PD Detector" software, the description of which is not part of this manual.

Detailed information about the electrical connection, and about carrying out the partial discharge test, can be found in the operating manual for the partial discharge measurement system.