OMICRON

TESTRANO 600

User Manual

Manual version: ENU 1161 05 04

The product information, specifications, and technical data embodied in this manual represent the technical status at the time of writing and are subject to change without prior notice.

We have done our best to ensure that the information given in this manual is useful, accurate and entirely reliable. However, OMICRON does not assume responsibility for any inaccuracies which may be present.

The user is responsible for every application that makes use of an OMICRON product.

OMICRON translates this manual from the source language English into a number of other languages. Any translation of this manual is done for local requirements, and in the event of a dispute between the English and a non-English version, the English version of this manual shall govern.

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Using this manual

This User Manual provides information on how to use the *TESTRANO 600* test system safely, properly and efficiently. The TESTRANO 600 User Manual contains important safety rules for working with *TESTRANO 600* and gets you familiar with operating *TESTRANO 600*. Following the instructions in this User Manual will help you to prevent danger, repair costs, and avoid possible down time due to incorrect operation.

The TESTRANO 600 User Manual always has to be available on the site where *TESTRANO 600* is used. The users of *TESTRANO 600* must read this manual before operating *TESTRANO 600* and observe the safety, installation, and operation instructions therein.

Reading the TESTRANO 600 User Manual alone does not release you from the duty to comply with all national and international safety regulations relevant to working on high-voltage equipment.

Safety symbols used

In this manual, the following symbols indicate safety instructions for avoiding hazards.

DANGER

Death or severe injury will occur if the appropriate safety instructions are not observed.

WARNING

Death or severe injury can occur if the appropriate safety instructions are not observed.

CAUTION

Minor or moderate injury may occur if the appropriate safety instructions are not observed.

NOTICE

Equipment damage or loss of data possible

1 Safety instructions

1.1 Operator qualifications

Working on high-voltage assets can be extremely dangerous. Consequently, only personnel qualified, authorized and skilled in electrical engineering and trained by OMICRON are allowed to operate *TESTRANO 600* and its accessories. Before starting to work, clearly establish the responsibilities.

Personnel receiving training, instructions, directions, or education on *TESTRANO 600* must be under constant supervision of an experienced operator while working with the equipment. The operator is responsible for the safety requirements during the whole test.

1.2 Safety standards and rules

1.2.1 Safety standards

Testing with *TESTRANO 600* must comply with the internal safety instructions and additional safety-relevant documents.

In addition, observe the following safety standards, if applicable:

- EN 50191 (VDE 0104) "Erection and Operation of Electrical Test Equipment"
- EN 50110-1 (VDE 0105 Part 100) "Operation of Electrical Installations"
- IEEE 510 "IEEE Recommended Practices for Safety in High-Voltage and High-Power Testing"

Moreover, observe all applicable regulations for accident prevention in the country and at the site of operation.

Before operating *TESTRANO 600* and its accessories, read the safety instructions in this User Manual carefully.

Do not turn on or operate *TESTRANO 600* if you do not understand the safety information in this manual. If you have questions or do not understand some safety instructions, contact OMICRON before proceeding.

Maintenance and repair of *TESTRANO 600* and its accessories is only permitted by qualified experts at OMICRON service centers (see "Support" on page 231).

1.2.2 Safety rules

Always observe the five safety rules:

► Disconnect completely.

► Secure against re-connection.

► Verify that the installation is dead.

► Carry out grounding and short-circuiting.

► Provide protection against adjacent live parts.

1.2.3 Safety accessories

OMICRON offers a range of accessories for added safety during the operation of our test systems. For further information and specifications, refer to the corresponding Supplementary Sheet or contact OMICRON Support (see "Support" on page 231).

1.3 Operating the measurement setup

- ► Before connecting or disconnecting test objects and/or cables, make sure that *TESTRANO 600* is turned off. Either use the power switch or press the **Emergency Stop** button.
- ► Do not connect or disconnect a test object while the outputs are active.
- ► After switching off *TESTRANO 600*, wait until the red warning light on the front panel is fully extinguished (see 3.1.1 "TESTRANO 600 front panel" on page 14). As long as this warning light is lit, there is still voltage and/or current potential on one or more of the outputs.
- ► Make sure that the test object's terminals to be connected to *TESTRANO 600* do not carry any voltage potential.
- ► Make sure that during a test, *TESTRANO 600* is the only power source for a test object.
- ► Switch off the high voltage. Always obey the five safety rules and follow the detailed safety instructions.
- ► Before switching on the high voltage, leave the high-voltage test area.

Before performing tests using high voltage, observe the following instructions:

- ► Before operating *TESTRANO 600*, ground it as described in sections 1.2.2 "Safety rules" on page 8 and 5 "Application" on page 25.
- ► Make sure that the ground terminal of the test object is in good condition, clean, and free of oxidation.
- ► Do not connect any cable to the test object without a visible grounding of the test object.
- ► Do not remove any cables from *TESTRANO 600* or the test object during a test.
- ► Do not use inadequately rated supply cords.
- ► Before connecting cables to *TESTRANO 600*'s high-voltage or current outputs, or other conducting parts that are not protected against accidental contact, press the **Emergency Stop** button. Do not release it unless an output signal is absolutely necessary for the test.
- ► Do not stand right next to or directly underneath a connection point. The clamps may fall off and hit you.

The red warning light on the *TESTRANO 600* front panel indicates hazardous voltage and/or current levels on the outputs. The green light indicates that the *TESTRANO 600* outputs are not active.

Note: If none or both lights on the front panel are lit, *TESTRANO 600* is either not supplied by mains or it is defective. In this case do not use it anymore.

- ► Always lock connectors properly.
- ► The counterpart of the sockets are locking connectors. To lock these connectors safely, insert them carefully and turn clockwise until you feel them click into place. Check if they are locked by trying to turn counterclockwise without pulling the silver latch.
- ► To remove the locking connectors, unlock them by pulling the silver latch.
- ► Do not insert any objects into any input/output socket.

- ► Do not operate *TESTRANO 600* under ambient conditions that exceed the temperature and humidity limits listed in chapter 15 "Technical data" on page 218.
- ► Check any additional equipment (for example, your computer) for environmental conditions before use.
- ► Use dry and clean cables. In dusty regions, use protective caps. To avoid leakage current, make sure that the cables have ground contact.
- ► Only use cables supplied by OMICRON.
- ► Position the measurement setup in a way that you can easily disconnect *TESTRANO 600* from mains. If permanently connected, make sure that the measurement setup is positioned in a way that the switch or circuit breaker can be easily reached.
- ► Do not operate *TESTRANO 600* and its accessories in the presence of explosives, gas or vapors.
- ► If *TESTRANO 600* or its accessories do not seem to function properly (for example, in case of cable damages, abnormal warming or overheating of components), stop using them and contact OMICRON support (see "Support" on page 231).
- ► Observe the high-voltage areas.
- ► Always obey the internal safety instructions for working in areas with high voltage to avoid injury.

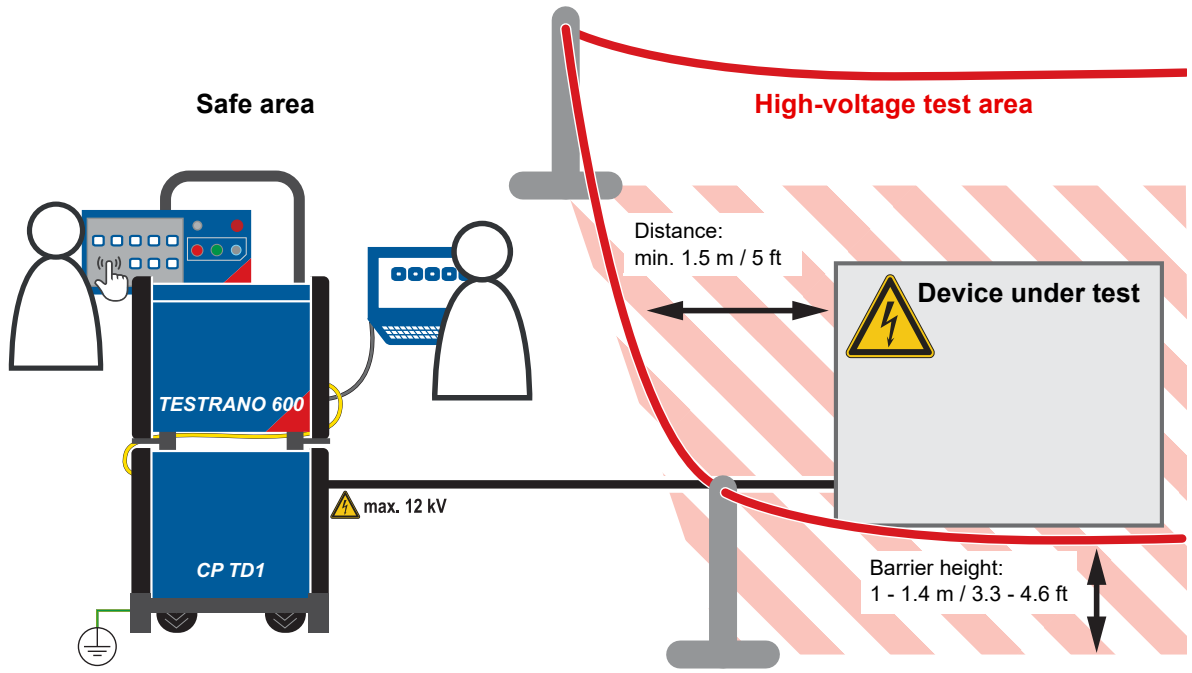


Figure 1-1: Illustration of safe area and high-voltage area established for working with *TESTRANO 600* and *CP TD1*

1.4 Orderly measures

The TESTRANO 600 User Manual or alternatively the e-book always has to be available on the site where *TESTRANO 600* is operated.

The users of *TESTRANO 600* must read this manual before operating *TESTRANO 600* and observe the safety, installation, and operation instructions therein.

TESTRANO 600 and its accessories may be used only as described in this User Manual. Any other use is not in accordance with the regulations. The manufacturer and the distributor are not liable for damage resulting from improper use. The user alone assumes all responsibility and risk.

Following the instructions provided in this User Manual is also considered part of being in accordance with the regulations.

Opening *TESTRANO 600* or its accessories invalidates all warranty claims.

1.5 Disclaimer

Using *TESTRANO 600* in any way differing from the one mentioned above is considered improper use, and will invalidate all customer warranty claims and exempt the manufacturer from any liability to recourse.

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

1.6 Compliance statement

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 the electromagnetic compatibility (EMC) directive, the low voltage directive (LVD) and the RoHS directive.

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.

Declaration of compliance (Canada)

This Class A digital apparatus complies with Canadian ICES-003.
Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

1.7 Recycling

This test set (including all 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)

OMICRON test sets are subject to the EU Waste Electrical and Electronic Equipment Directive 2012/19/EU (WEEE directive). As part of our legal obligations under this legislation, OMICRON offers to take back the test set and ensure that it is disposed of by authorized recycling agents.

For customers outside the European Economic Area

Please contact the authorities in charge for the relevant environmental regulations in your country and dispose the OMICRON test set only in accordance with your local legal requirements.

2 Introduction

2.1 Designated use

In combination with the *CP TD1* or as a stand-alone unit, *TESTRANO 600* is a multi-purpose power transformer test system for routine and diagnostic testing of power transformers during manufacturing, commissioning and maintenance.

The various partly automated tests are defined and parameterized via the front panel control of a built-in embedded PC or via an externally connected laptop.

2.2 Device variants

TESTRANO 600 is available with two interface variants.

With multi-touch screen and USB port
Controlled via the embedded PC using *TouchControl* or via a connected laptop using the *Primary Test Manager* software

***Without* touch screen and embedded PC**
Controlled only via laptop using the *Primary Test Manager* software

3 Hardware overview

3.1 TESTRANO 600

► Refer to user manual chapter 15 "Technical data" on page 218 for detailed hardware information.

3.1.1 TESTRANO 600 front panel

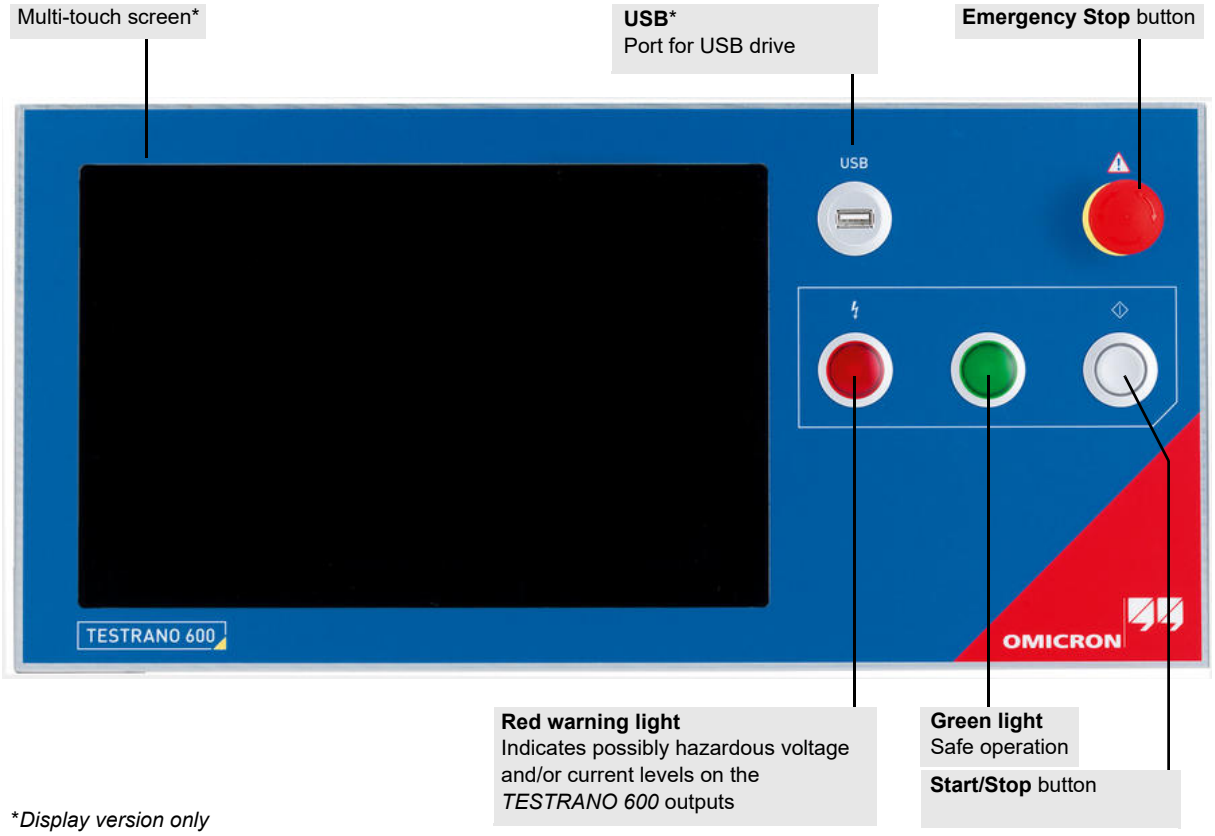
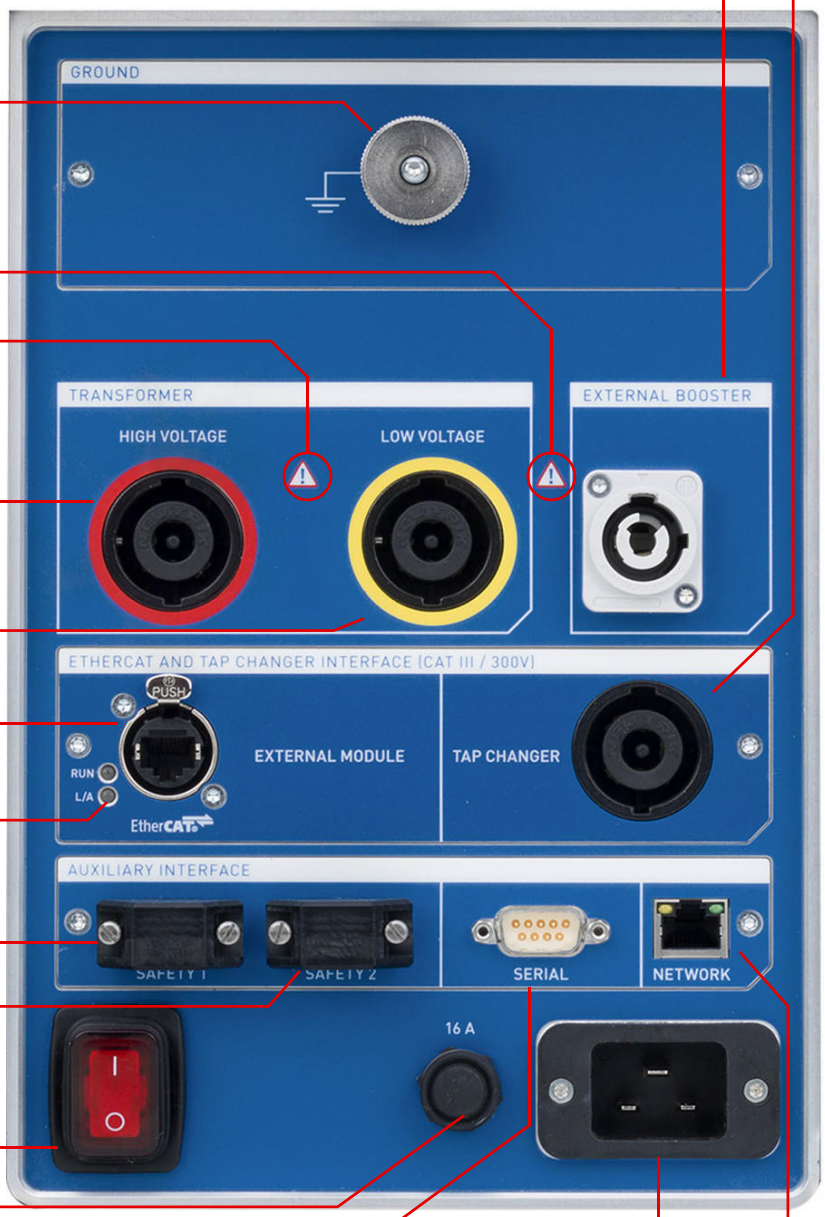


Figure 3-1: *TESTRANO 600* front panel with display

3.1.2 TESTRANO 600 side panel



TAP CHANGER: Connection to tap changer

EXTERNAL BOOSTER*: Connection to *CP TD1*

Equipotential ground terminal

Warning light 2 (steady-on orange): voltage > 42 V

Warning light 1 (flashing red): current > 3 mA

HIGH VOLTAGE terminal* for connection to primary side

LOW VOLTAGE terminal* for connection to secondary side

EtherCAT® RJ-45 socket for connecting an external EtherCAT® slave to *TESTRANO 600*

LEDs indicating the EtherCAT® communication state

SAFETY 1 (IN for remote control) Master connector for OMICRON safety accessories

SAFETY 2 (OUT for remote control) Slave connector for OMICRON safety accessories

Power switch

16A Resetable mains overcurrent protection

SERIAL Connection to *CP TD1*

Mains power socket (one-phase)

NETWORK RJ-45 socket for connecting *TESTRANO 600* to an external computer

* Max. output voltage: 300 V_{RMS}

Figure 3-2: *TESTRANO 600* side panel

3.1.3 Safety and warning indicators

TESTRANO 600 provides the following indicators for safe and dangerous operating conditions.

Table 3-1: Warning indicators

Indicator	Description	Device State	Operating condition
Front panel			
	Green light on the front panel is on	*TESTRANO 600* is up and running in the stand-by mode.	Safe operating condition as long as no voltage is applied from outside – as long as the warning lights are off.
	Blue ring on the **Start/Stop** button is lit	A test is ready to start.	
	Blue ring on the **Start/Stop** button is flashing	The **Start/Stop** button has just been pressed. There may be hazardous voltage and/or current levels on the *TESTRANO 600* outputs.	 **Dangerous operating condition**
	Red warning light on the front panel is flashing	A test is running. There probably are hazardous voltage and/or current levels on the *TESTRANO 600* outputs.	
Side panel			
	Warning light 1 on the side panel is flashing (red)	There are hazardous current levels (>3 mA) on the *TESTRANO 600* inputs/outputs independent of the measurement state.	 **Dangerous operating condition**
	Warning light 2 on the side panel is on (orange)	There are hazardous voltage levels (>42 V) on the *TESTRANO 600* inputs/outputs independent of the measurement state.	
Acoustic signals			
	1 x beep	*Primary Test Manager* has established the connection to *TESTRANO 600*.	Safe operating condition as long as no test has been started – as long as the warning lights are off.
	2 x beep	*TESTRANO 600* has booted or a test is ready for execution.	
	Continuous beeping	*TESTRANO 600* outputs are active or device is discharging ► Observe the warning lights on the front and side panel.	 **Dangerous operating condition**

Warning lights

► Always observe the warning lights while working with *TESTRANO 600*.

► Do not cover the warning lights during operation.

If no or both warning lights are on, the unit is defective or not supplied by mains.

Beeper

The beeper is an additional indicator for the main device status but does not compensate for the warning lights on the *TESTRANO 600* front and side panel.

If the beeper has been disabled, no acoustical signal will be emitted while the *TESTRANO 600* outputs are active.

► Refer to section "Beeper" on page 37 of this manual on how to disable and activate the beeper.

If the beeper is activated but does not emit a signal for the scenarios listed above in Table 3-1, *TESTRANO 600* might be defective.

► If *TESTRANO 600* appears to be defective, do not use it anymore. Contact OMICRON support (see "Support" on page 231).

3.1.4 Emergency Stop button

Pressing the **Emergency Stop** button *immediately* shuts off all *TESTRANO 600* outputs and stops the running measurement. When the **Emergency Stop** button is pressed, you cannot start any measurements.

► Only use the **Emergency Stop** button in an emergency or to guaranty the safe connection/disconnection of cables.

► During regular operation, stop tests via the **Start/Stop** button or the software.

3.1.5 TESTRANO 600 measuring cables

► To connect a measuring cable to *TESTRANO 600*, insert the connector and turn it to the right until it locks with a "click".

For disconnection:

► Hold the connector and pull back the silver latch.

► Turn the connector to the left and gently pull it out.

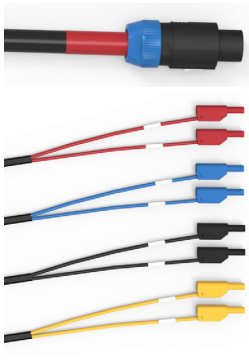
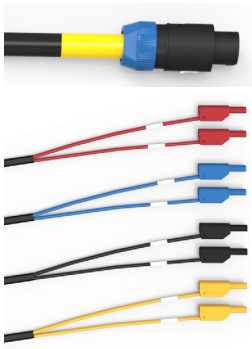
NOTICE

Equipment damage possible

► Do not pull the cable when disconnecting.

► Hold, turn and gently pull the connector for disconnection.

Table 3-2: *TESTRANO 600* measuring cables

Item	Picture	Description
High-voltage cable marked red		• Polarity protection: only suitable for **HIGH VOLTAGE** and **LOW VOLTAGE** sockets • 15 m length • 8 poles • cross-section: 4 × 4 mm^2 for output 4 × 1 mm^2 for measurement • Neutrik® plug
Low-voltage cable marked yellow		
Tap changer cable		• Polarity protection: only suitable for **TAP CHANGER** socket • 15 m length • 8 poles • 8 × 2.5 mm^2 cross-section • Neutrik® plug

3.2 CP TD1

► Refer to the CP TD1 User Manual for detailed information and safety instructions.

3.2.1 Grounding terminal and booster input

Figure 3-3: Left side view of the *CP TD1*

3.2.2 Serial interface connector and measuring inputs

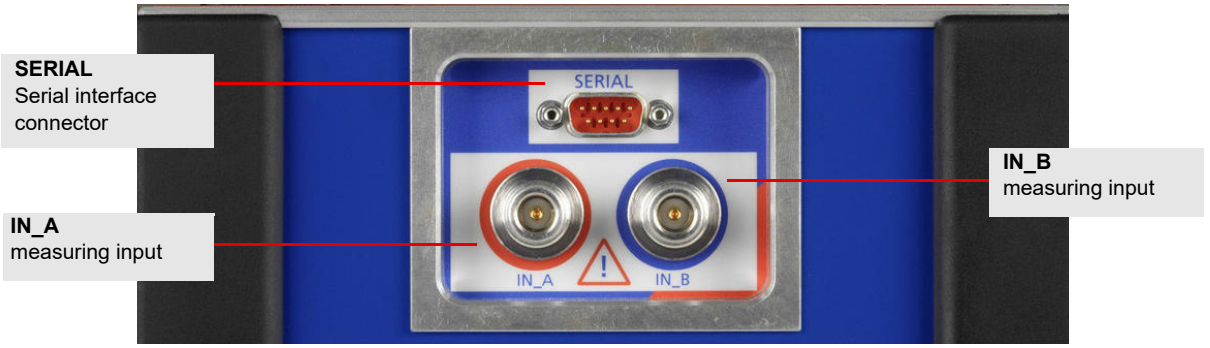


Figure 3-4: Right side view of the *CP TD1*

3.2.3 High-voltage connector

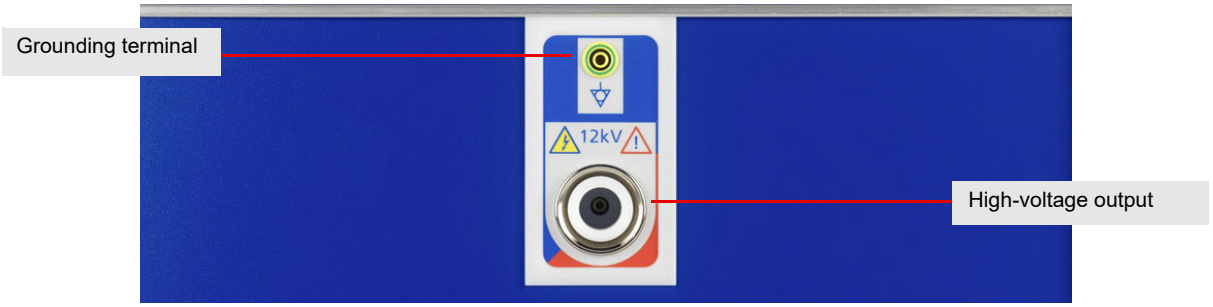


Figure 3-5: Back side view of the *CP TD1*

3.3 Trolley

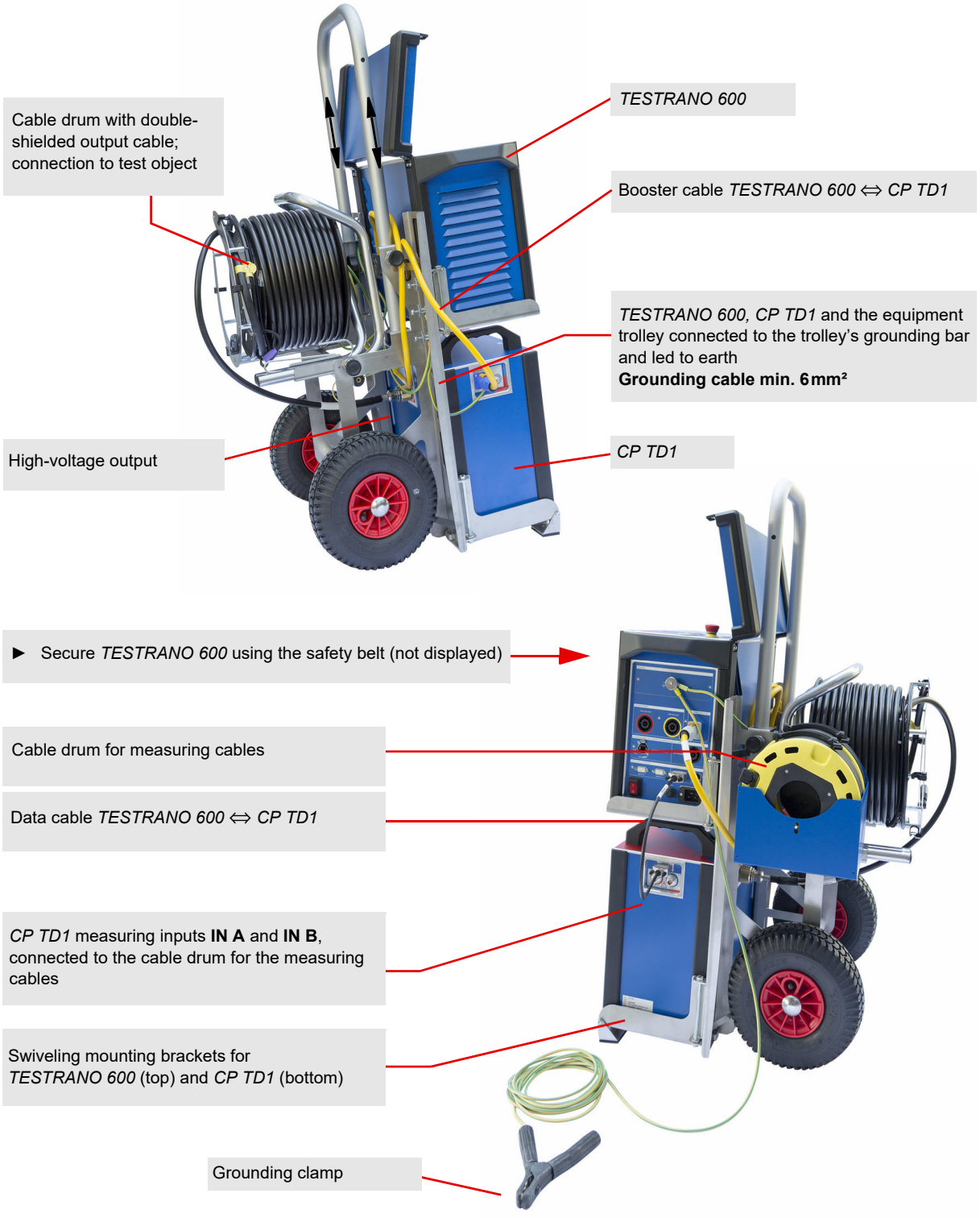


Figure 3-6: Equipment trolley with *TESTRANO 600* and *CP TD1*

3.4 Cleaning

WARNING

Death or severe injury caused by high voltage or current possible

- ► Do not clean *TESTRANO 600*, the *CP TD1* or any other device when connected to the test object.
- ► Disconnect the test object, accessories and connection cables before cleaning.

► Use a cloth dampened with isopropanol alcohol to clean *TESTRANO 600* and its accessories.

4 Functional scheme

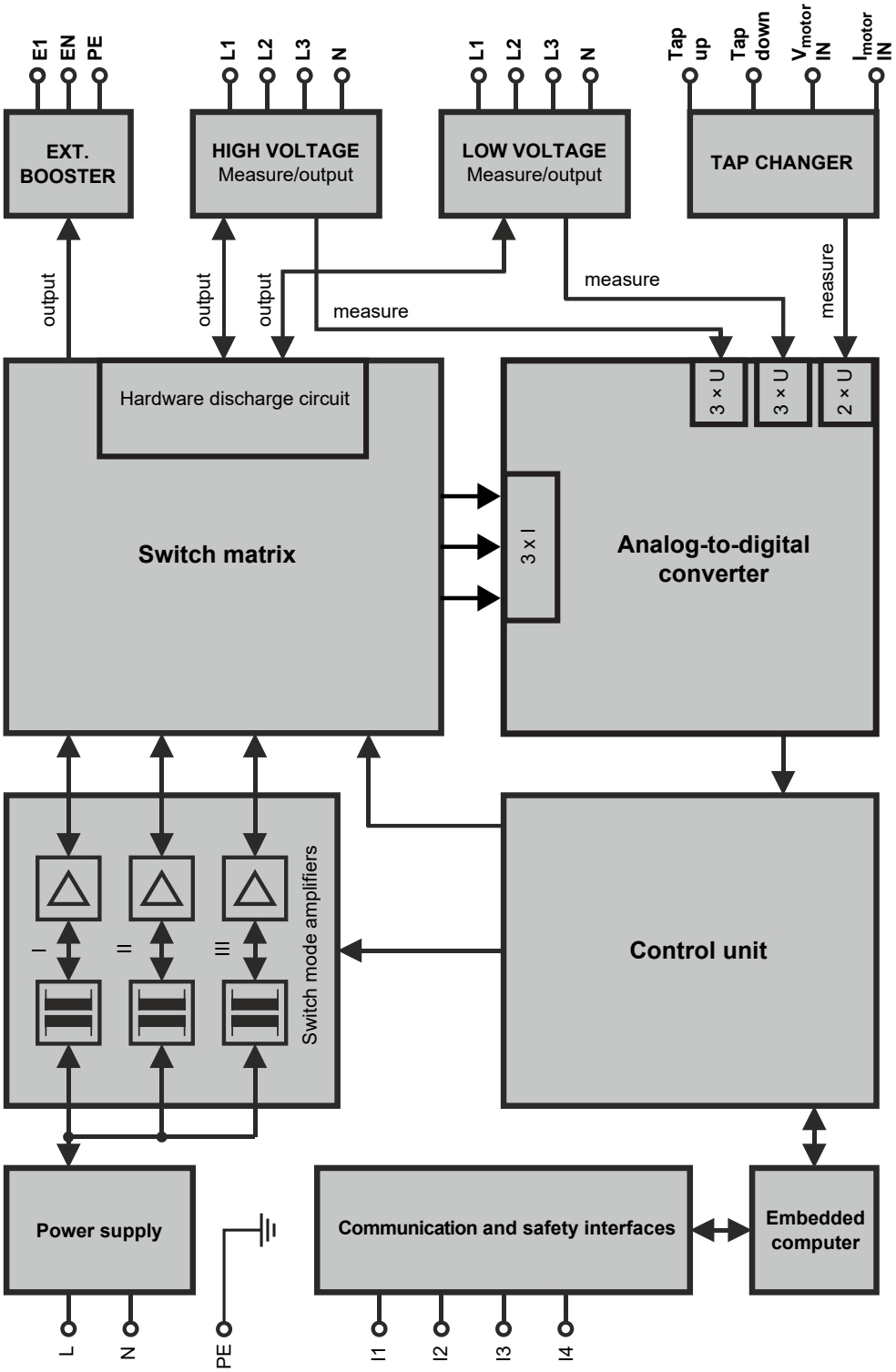


Figure 4-1: Functional scheme for *TESTRANO 600*

Table 4-1: Terminals of *TESTRANO 600*

Terminal	Description
Mains interface	
L	Mains phase
N	Mains neutral
PE	Equipotential ground
Communication and safety interfaces	
I1	1 × external EtherCAT® module
I2	1 × Ethernet
I3	1 × serial
I4	2 × safety
EXTERNAL BOOSTER	
E1	External booster phase
EN	External booster neutral
PE	Equipotential ground
HIGH VOLTAGE	
L1	Phase 1 high voltage
L2	Phase 2 high voltage
L3	Phase 3 high voltage
N	Neutral high voltage
LOW VOLTAGE	
L1	Phase 1 low voltage
L2	Phase 2 low voltage
L3	Phase 3 low voltage
N	Neutral low voltage
TAP CHANGER	
Tap up	Command for upward switching direction
Tap down	Command for downward switching direction
V_{motor} IN	Motor voltage input
I_{motor} IN	Motor current input

5 Application

5.1 Safety precautions in the substation

Before setting *TESTRANO 600* into operation and carrying out a test, it is essential that you have read and understood chapter 1 "Safety instructions" on page 8.

- ► Be aware that all output sockets of *TESTRANO 600* can carry life-hazardous voltage and current.
- ► Only use *TESTRANO 600* with a solid connection to ground.
- ► Separate your working area – see Figure 1-1: "Illustration of safe area and high-voltage area established for working with TESTRANO 600 and CP TD1" on page 10.
- ► Tests with high voltages and currents must only be carried out by authorized and qualified personnel.
- ► Personnel receiving training, instructions, directions, or education on high- voltage/current tests should remain under the constant supervision of an experienced operator while working with the equipment.
- ► The instructions have to be renewed at least once per year.
- ► The instructions must be available in written form and signed by each person assigned to do high-voltage/current tests.

Prior to connecting a test object to *TESTRANO 600*, the following steps need to be carried out by an authorized employee of the utility:

- ► Protect yourself and your working environment against an accidental re-connection of high voltage by other persons and circumstances.
- ► Verify that the test object is safely isolated.
- ► Earth-connect and shorten out the test object’s terminals using a grounding set.
- ► Protect yourself and your working environment with a suitable protection against other (possibly live) circuits.
- ► Protect others from accessing the high-voltage area and accidentally touching live parts by setting up a suitable barrier and, if applicable, warning lights.
- ► If there is a longer distance between the location of *TESTRANO 600* and the area of danger, a second person with an additional **Emergency Stop** button is required.

5.2 Preparing the test setup

DANGER

Death or severe injury caused by high voltage or current

The output sockets of *TESTRANO 600* can carry life-hazardous voltage potential and life-hazardous currents.

- ► Do not use *TESTRANO 600* without a solid connection to ground.
- ► Before switching on *TESTRANO 600*, make sure it is completely dry.
- ► Before connecting any cables, check them for damage. Make sure that the connectors are clean and dry and that the insulation is intact.

1. Make sure that the power switch on the *TESTRANO 600* side panel is turned off.
2. Press the **Emergency Stop** button.
3. Connect *TESTRANO 600* to:
   - equipotential ground: Ground *TESTRANO 600* with a cable of at least 6 mm^2 cross-section as close as possible to the operator.
   - the computer (optional if *TESTRANO 600* is used with *TouchControl*)
   - the mains power supply

Optional

Connect the *CP TD1* to *TESTRANO 600*

a) Connect to ground.

Without trolley:

► Properly connect the *TESTRANO 600* and *CP TD1* grounding terminals to substation ground.

With trolley *(optional)*:

► Properly connect the *TESTRANO 600* and *CP TD1* grounding terminals to the trolley's ground bar.

► Connect the trolley's ground bar to earth.

b) Connect the *CP TD1* **BOOSTER IN** to the *TESTRANO 600* **EXTERNAL BOOSTER** using the booster cable.

c) Connect the *CP TD1* **SERIAL** to *TESTRANO 600* **SERIAL** with the data cable.

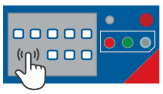
Note: The serial cable also provides the power supply for the *CP TD1*.

4. Turn on the power switch on the *TESTRANO 600* side panel.
5. The green light and the blue ring of the **Start/Stop** button are switched on, showing that *TESTRANO 600* does not output dangerous voltage or current.
6. If the PE connection is defective or if the power supply has no galvanic connection to ground, a warning message appears.

Note: If *TESTRANO 600* is supplied by mains and switched on, and no or both warning lights are on, the unit might be defective. Contact OMICRON support (see "Support" on page 231).

5.3 Connecting to the transformer

Preparing the software

TouchControl	*Primary Test Manager*
	
► Select a test.	► Create a job with tests or select a manual test.
► After defining the asset's vector group, tap **Wiring**  to display the wiring diagram for the test.	► View the wiring diagram in the **General** tab of the test.
► Lock *TESTRANO 600* using the **Software lock**.	► Lock your computer.
► Connect the test leads to *TESTRANO 600* (or the *CP TD1*, if applicable).	

Connection to the transformer

DANGER

Death or severe injury caused by high voltage or current possible

- ► Before connecting any test leads to the transformer, turn off and disconnect any voltage to and from the transformer (e. g. high voltage on the main terminals, control voltage of the tap changer).
- ► Ground and short-circuit its terminals using a grounding set.

1. Connect the test leads to *TESTRANO 600* as shown in the wiring diagram and in the order given below:

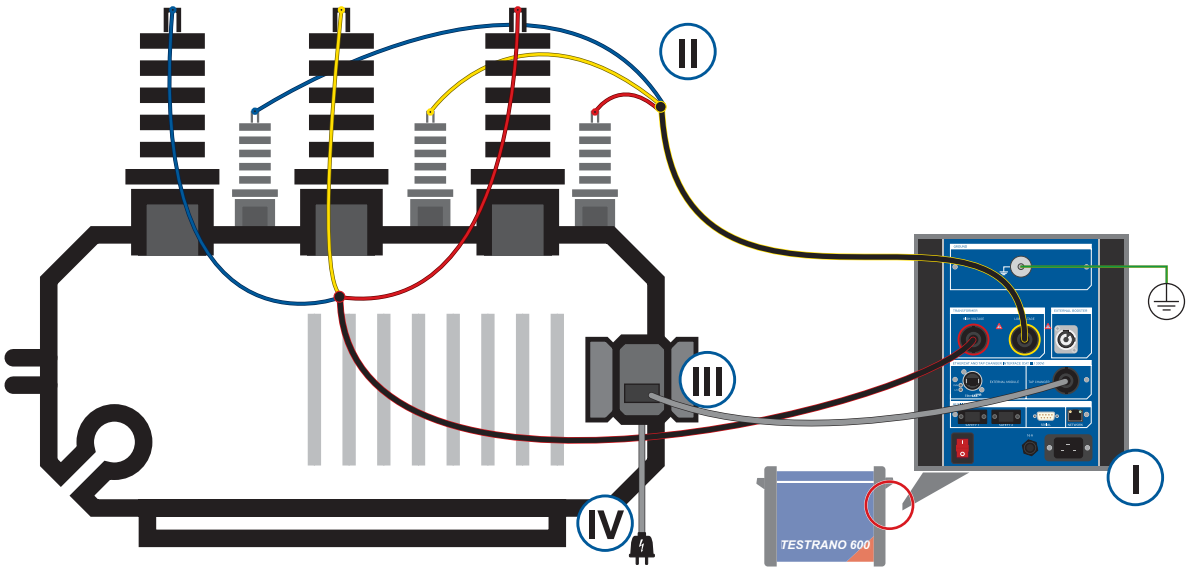


Figure 5-1: Connection sequence *TESTRANO 600* to transformer

I.	Connect the high-voltage (red), low-voltage (yellow) and tap changer cables to *TESTRANO 600*.
II.	Connect the high-voltage (red) and low-voltage (yellow) cables to the transformer's main terminals.
III.	Connect the tap changer cable to the appropriate terminals in the control cabinet of the transformer (see Figure 5-2 below).
IV.	Re-connect and turn on the voltage of the tap changer.

Note: If the tap changer control voltage exceeds 42 V, the orange warning light 2 on the side panel will indicate a hazardous voltage on the *TESTRANO 600* inputs (see 3.1.3 "Safety and warning indicators" on page 16).

Tap changer connection

► For the measurement of motor current and voltage, connect **VIn+** and **VIn-** (green) as illustrated below. On a three-phase motor **VIn+** can be connected to either L1, L2 or L3.
Connect the current clamp to **CurrentIn+** and **CurrentIn-**.

► For tap changer control connect **TapUp+** and **TapUp-** (blue) to the connectors controlling the upward switching of the tap changer.
Connect **TapDown+** and **TapDown-** (purple) to the connectors controlling the downward switching of the tap changer.

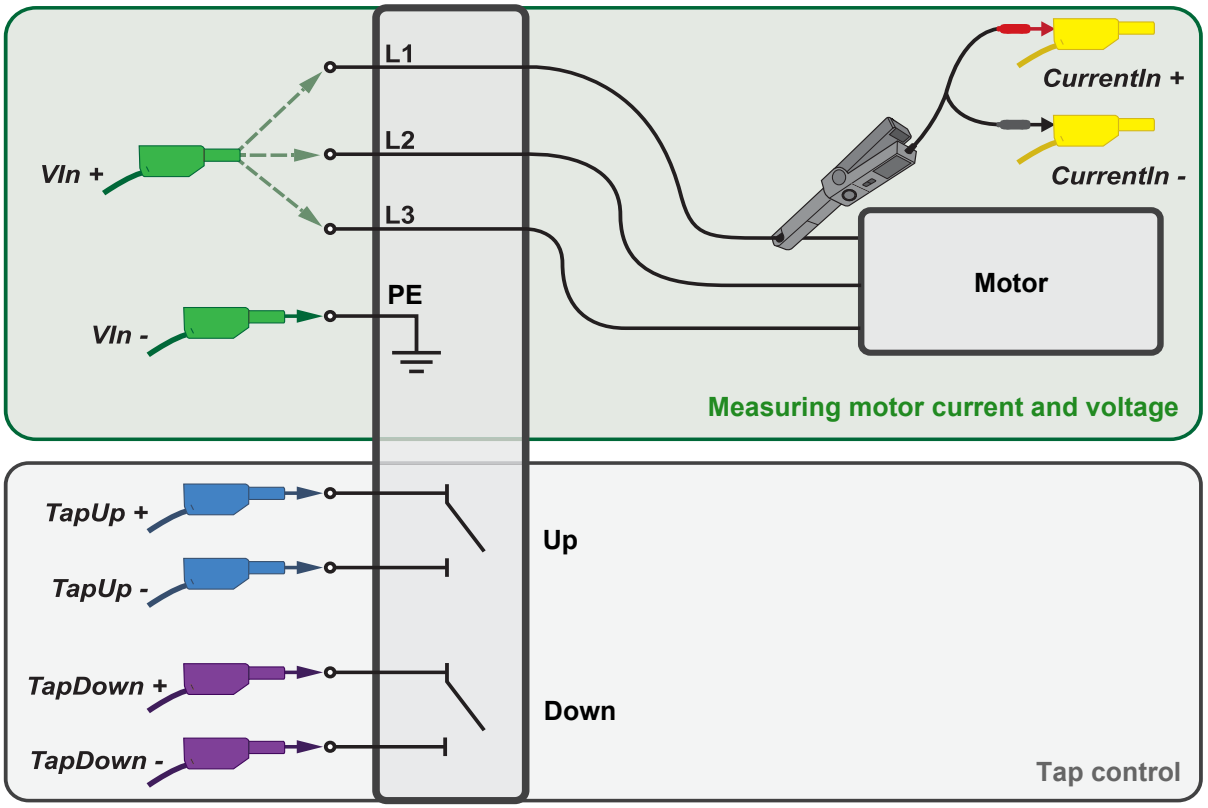


Figure 5-2: Connection scheme tap changer cable to tap changer

Optional

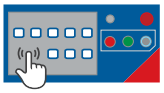
Connect the *CP TD1* to the transformer

If you connected the *CP TD1* to *TESTRANO 600* (step 4 in section 5.2), connect the **IN_A**, **IN_B** and high-voltage output of the *CP TD1* to the transformer.

► Refer to the CP TD1 User Manual for more information on safely connecting the *CP TD1* to a device under test.

2. Erect a barrier separating the safe area from the high-voltage test area (see page 10).
3. Remove the grounding set from the test object.
4. Release the **Emergency Stop** button.

5.4 Measurement

TouchControl	*Primary Test Manager*
	
► Disable the **Software lock**.	► Establish the connection between PTM and TESTRANO.
► Enter/adjust the test settings in the **Settings** view.	► Enter/adjust the test settings in the **Settings and conditions** area.
	► Select a standard in the **Assessment** area (if applicable).
► Tap START	► Press Start
The blue ring on the **Start/Stop** button lights up. ► Press the **Start/Stop** button to start the test.	
The blue ring and the red warning light are now flashing for approx. 3 seconds. ► To suspend the test, press the **Start/Stop** button on the *TESTRANO 600* front panel. ► In an emergency, press the **Emergency Stop** button to stop the test.	
After the measurement is completed or stopped, the green warning light switches on.	
TouchControl displays the results in the **Measurement** view of the test.	*Primary Test Manager* displays the results in the **Measurements** section of the test.

► To perform additional tests, repeat the steps in chapters 5.3 to 5.4.

5.5 Disconnection

1. Wait until the green light on the *TESTRANO 600* front panel is on and the warning lights on the front and side panel are off.

   Note: If the tap changer control voltage exceeds 42 V, the orange warning light 2 on the side panel will indicate a hazardous voltage on the *TESTRANO 600* inputs (see 3.1.3 "Safety and warning indicators" on page 16).

   ► Disconnect the tap changer cable to extinguish warning light 2.

2. Press the **Emergency Stop** button on the *TESTRANO 600* front panel.

DANGER

Death or severe injury caused by high voltage or current

► Never unplug any cables while the measurement is running.

► Only disconnect cables when **all** of the following apply:

- The red warning light on the front panel is **off**.
- The warning lights on the side panel are **off**.
- The green light on the front panel is **on**.

If all lights on *TESTRANO 600* are off, the device is defective or not supplied by mains.

3. To prevent anyone from starting a test, use the **Software lock** in the *TouchControl* software (see chapter 6.5 "Software lock" on page 38) and/or lock your computer.
4. Remove the barrier between the high-voltage area and the safe area.

DANGER

Death or severe injury caused by high voltage or current possible

► Before touching any part of the transformer, ground and short-circuit its terminals using a grounding set.

5. Disconnect all cables from the transformer.
6. Disconnect all cables from *TESTRANO 600* and, if applicable, from the *CP TD1*.
7. Switch *TESTRANO 600* off by pressing the mains power switch on the side panel.
8. Disconnect the mains power cord.
9. Remove the equipotential ground as the last connection that is removed first from *TESTRANO 600* and then on the substation side.

6 TESTRANO 600 TouchControl

The *TESTRANO 600* display variant can either be controlled via the *TouchControl* software or using a laptop with *Primary Test Manager* installed.

6.1 Selecting tests

After the first start of *TouchControl*, the available manual tests are displayed in the **Select a test** view.

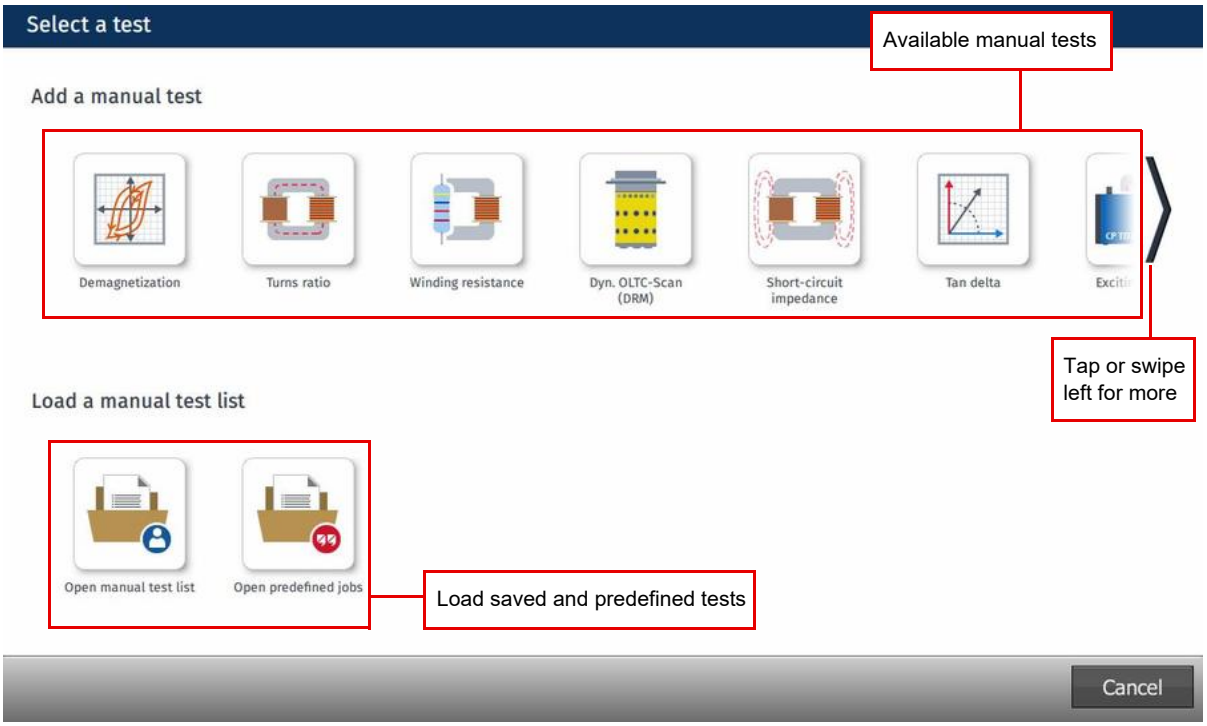


Figure 6-1: *TouchControl* **– Select a test** view

In this view, you have the following options:

- Add a manual test
- Load a test list from the internal memory or a USB drive
- Open jobs predefined by OMICRON

6.1.1 Explorer

► Tap **Open manual test list** in this view or **Explorer** in the side bar to access the *TouchControl* file system for the following options:

- Save, load and move test lists to/from the internal or external memory
- Create, rename, duplicate and delete folders and test lists

► Tap **Eject** to safely remove the USB drive.

► Long-tap tests to select several.

Note: Test lists cannot be edited or deleted in the explorer as long as they are still open in the manual test list.

Table 6-1: Explorer buttons

Name	Icon	Function
Up		Go back to parent folder.
New folder		Create a new folder.
Copy		Copy one or more tests **Note:** Results are not copied.
Paste		Paste one or more tests
Rename		Rename the selected test (max. 60 characters).
Delete		Delete the selected test. ► To delete a folder, long-tap to mark, then delete it. ► To rename a folder, long-tap the folder name and tap **Rename**.

6.1.2 Predefined jobs

TESTRANO 600 comes with two test lists predefined by OMICRON:

- **`three winding.ptma`** for three-winding transformers
- **`two winding.ptma`** for two-winding transformers

The test lists can be edited and saved. They comprise all available standard tests, a Winding DF and Cap test and Bushing tests.

To save time configuring your tests, enter the relevant data in the **Settings** view of the first test and tap **Copy to all** to apply the configuration to all tests in the list.

6.2 Side bar

The side bar contains the various commands for the manual test list you are working on.

► In the test view, tap **Menu** in the sidebar to expand the **Manual test list**.

6.2.1 Manual test list

Table 6-2: Sidebar buttons for actions in the manual test list

Name	Icon	Function
Menu		Display the manual test list and access the functions described in table 6-3.
Save		Save the test list and its settings.
		Test has been saved ► Long-tap to display the **Save as** button
Save as		This icon is displayed when you long-tap the **Save** button. ► Tap to save the open test list under a different name.
Add		Add a new manual test or load an existing manual test list from the internal memory or from a USB drive.
Explorer		Browse the internal memory or the connected USB drive and load previously saved test lists (see 6.1.1 "Explorer" on page 33).
New Test List		Create a new test list. **Note:** You will be prompted to save the currently open test list.

Table 6-3: Sidebar options for tests in the manual test list

Name	Icon	Function
Add		Add a new manual test or load an existing manual test list from the internal memory or from a USB drive.
Rename		Rename the selected test (max. 60 characters).
Duplicate		Duplicate the selected test and its settings. **Note:** Results are not copied.
Up		Move the selected test up in the list.
Down		Move the selected test down in the list.

Table 6-3: Sidebar options for tests in the manual test list (continued)

Name	Icon	Function
Comment		Write a comment for the selected test.
		View and edit a previously written comment.
Delete		Delete the selected test.

6.2.2 Asset info

Tap the **Asset info** button on top of the manual test list to enter general asset settings. When you import tests into *Primary Test Manager*, tests will be attributed to the asset with the same serial number.

Asset

► Tap the **Asset type** drop-down box to select from the following asset types:
  – Two-winding
  – Three-winding
  – Auto w/o tert: Auto transformer without tertiary winding
  – Auto w tert: Auto transformer with tertiary winding
  – Voltage regulator
► Enter the **Serial number** and **Manufacturer**

Bushing

► Select the number of **Bushings** from the drop-down box.
► Enter their **Serial numbers**.
► Tap **Copy to all**  to copy the first serial number to all serial number fields.

Test execution states

In the manual test list, tests are listed with their execution states.

Table 6-4: Execution state icons

Icon	State
	Data necessary for test execution are missing
	Test not yet executed – ready for execution
	Test partially executed
	Test executed

6.3 Status indicators

The USB and *CP TD1* icons in the lower menu bar of the *TouchControl* software represent the device statuses.

Table 6-5: Status icons in the lower menu bar

Icon	Description
	No *CP TD1* connected
	*CP TD1* connected and ready
	No USB drive connected
	USB drive connected ► Tap to safely remove the USB drive. Any unsaved changes will be saved.
	*TESTRANO 600* cannot detect a connection to protective earth.

6.4 TouchControl settings

The **Settings** view comprises the following:

- **General**: General *TouchControl* settings
- **Legal**: Legal information
- **Version**: Software version, serial number and calibration date
- **Time and date**: Time and date format
- **Logging:** Settings for data logging

6.4.1 General settings

► Tap the **Language** drop-down box to change the system language.

► Tap the **Profile** drop-down box to choose between the **IEEE** and **IEC** profile – depending on the standard commonly used in your location.

Note: Changing the language or standard profile does not effect the name of the currently open test.

► Set **Auto save** to **ON** to have your results saved automatically when a measurement is finished.

► Move the slider to adjust the **Display brightness**.

Beeper

TESTRANO 600 is equipped with a beeper emitting an acoustic warning signal while the device is discharging or the outputs are active. The beeper is an additional indicator for the main device status but does not compensate for the warning lights on the *TESTRANO 600* front and side panel.

► Refer to Table 3-1: "Warning indicators" on page 16 and "Beeper" on page 17 for more information.

If the beeper is set to **OFF**, no acoustical warning signal will be emitted while the device outputs are active.

Presentation mode

You can use a VNC client to display the *TESTRANO 600 TouchControl* on a computer.

► Install a VNC software on your computer.

► Set **Presentation mode** to **ON** in the **Settings – General** view on your *TESTRANO 600*.

► Connect to the computer using the IP address of your *TESTRANO 600* displayed in the *OMICRON Device Browser*.

Device self-test

If *TouchControl* repeatedly displays a hardware error message, we recommend performing a device self-test. The self-test checks functionality of the *TESTRANO 600* hardware components.

► If the self-test passes but the error messages persist, check the wiring.

Note: During the self-test, the **Emergency Stop** button must be released.

Logging

► Use the drop-down lists **Logging level** (for software performance) and **Device logging level** (for hardware performance) to adjust the settings described in Table 6-6 below.
The logging function provides information to help find the cause for an error in cooperation with an OMICRON support engineer.

Note: Log files do not contain any personal information.

Table 6-6: Logging levels

Logging level	Description
Disabled	Logging is disabled.
Errors only	Only errors are logged. Recommended setting
Info	Errors and some additional information are logged.

► Press **Download to flash drive** to transfer your device's log files to the connected USB drive.

6.5 Software lock

It is possible to lock *TESTRANO 600* in a safe and de-energized state. This allows you to temporarily leave the test setup in a safe state for a limited period of time.

► Tap **Lock** to access the **Lock screen**.

► Enter a four-digit code. Tap **Show** to display the numbers.

► Tap **Lock** to lock the device.

► To unlock the screen, enter the four-digit code and tap .

► Alternatively, switch *TESTRANO 600* off to disable the software lock.

Note: Test settings that were changed before locking *TESTRANO 600* can still be saved in the lock screen.

7 Testing with TouchControl

7.1 Getting started

The following table lists the basic steps necessary to complete a measurement using *TouchControl*.

► For more information on each step refer to the chapters listed on the right.

Step		User manual chapter
	**1. SAFETY**	Safety instructions Hardware overview Safety and warning indicators Emergency Stop button Application
	**2. Start *TESTRANO 600***	TESTRANO 600 side panel
	**3. Enter asset info**	Asset info
	**4. Add tests**	TouchControl tests
	**5. Connect to transformer**	Safety instructions TESTRANO 600 measuring cables Application Wiring diagrams
	**6. Prepare test**	Settings view
	**7. Measurement**	Measurement

7.2 Test view

The *TESTRANO 600* tests are divided into the **Settings** and **Measurement** views.

► Swipe right or left or tap the arrow on the side of the screen to change between the views.

In the **Settings** view, you can enter asset data and the values necessary for your test. The **Measurement** view displays test results in a live, table or plot view, depending on the test.

7.2.1 Settings view

In the **Settings** view, you can enter the data relevant for the test.

If mandatory data are missing, the corresponding submenu and the **Start** button are marked . Once all necessary information has been entered, the **Start** button turns green and the test can be performed.

► Tap **Copy to all** to copy the **Winding** settings to all tests that have not yet been executed.

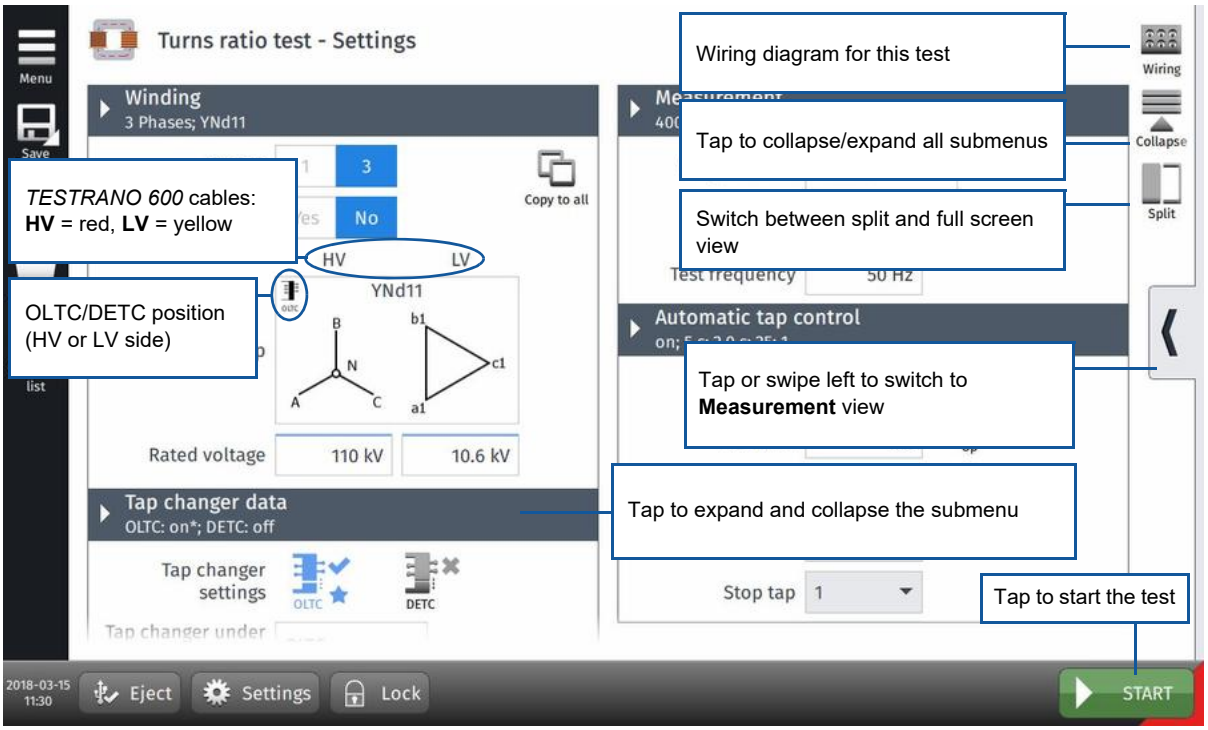


Figure 7-1: Turns ratio test - **Settings** view

Entering values

► Tap a box, then use the numpad to enter or correct a value.

► If needed, tap the metric prefixes below after entering a value:

– k for kilo-

– M for mega-

– m for milli-

► Use the slider to increase or decrease the displayed value. Release the slider to stop at the desired value.

Note: The slider will stop at the minimum/maximum value.

Defining a tap changer

► To define a tap changer press the tap changer icon in the test's **Settings** view.

Table 7-1: Steps in the **Define Tap Changer** view

Tap changer settings – Define Tap Changer	
Available	► Mark the type of tap changer on the left and tap **Yes** to confirm and display the settings.
Position	► Choose the tap changer's transformer side: **HV** or **LV**.
Tap scheme	► Select the notation scheme for tap identification from the drop-down box.
No. of taps	► Enter the number of taps.
Voltage table	The **Voltage table** displays the voltage for each tap. You can either enter each values manually or have them calculated. ► Enter at least the first two values and press **Calculate** . ► Compare the calculated values with the nominal values on the nameplate before proceeding.
	Add more taps at the end of the voltage table.
	Delete a tap from the voltage table.
	Delete all taps from the voltage table.
	Insert a tap below the marked tap.
Middle	► Enter the voltage for the middle tap (rated voltage) and the deviation value for the calculation, then press **Calculate**.
First/middle/last	► Enter the voltages for the first, middle and last tap, then press **Calculate**.

7.2.2 Measurement view

The **Measurement** view displays test results in a live, table or plot view. Depending on the test, you can select from different display modes, apply filters and sort lists by certain values.

Measurement values marked with a * are adjusted when settings are changed after measurement.

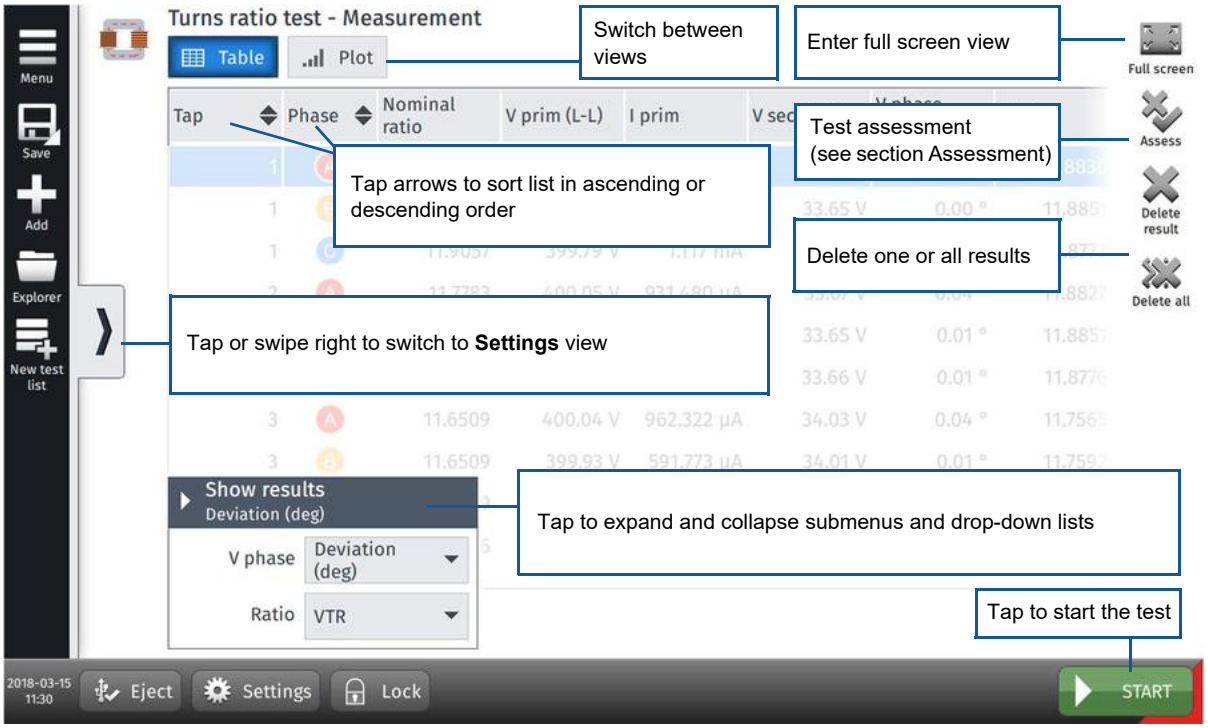


Figure 7-2: Turns ratio test – **Measurement** view

Assessment

► Tap **Assess** to expand the available assessment states:

Pass: results accepted; measurement OK

Fail: results rejected; measurement failed

Investigate: marked for further investigation

Note: Each measurement of an assessed test will individually be tagged with the selected assessment when displayed in *Primary Test Manager* or a report.

7.2.3 Wiring diagrams

► Tap **Wiring** to display the wiring diagram for the test and vector group.

The colors in the wiring diagram represent the cable ends (see 3.1.5 "TESTRANO 600 measuring cables" on page 18).

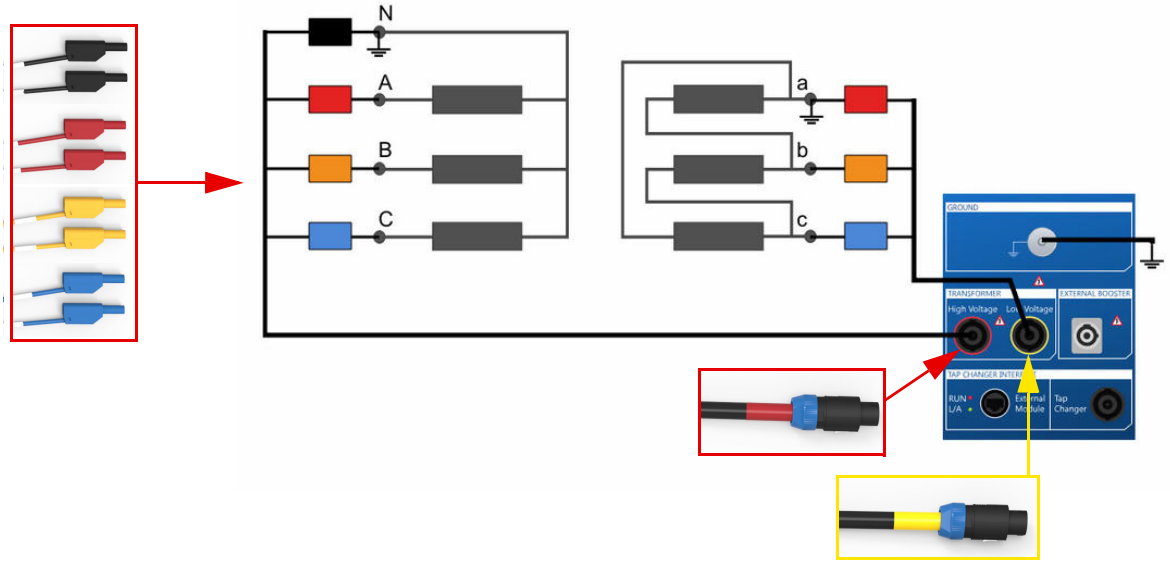


Figure 7-3: Wiring diagram for a TTR on a transformer with vector group YNd5

7.3 Measurement

► Refer to chapter 1 "Safety instructions" on page 8 for detailed information about safe testing.
► If in doubt, contact OMICRON support (see "Support" on page 231).

DANGER

Death or severe injury caused by high voltage or current

► Do not unplug any cables while the measurement is running.
► Only remove cables when **all** of the following apply to *TESTRANO 600*:
  • The red warning light on the front panel is **off**.
  • The warning lights on the side panel are **off**.
  • The green light on the front panel is **on**.

If all lights on *TESTRANO 600* are off, the device is defective or not supplied by mains.

WARNING

Death or severe injury caused by high voltage or current possible

► Do not enter the high-voltage area during the test.
► Do not touch any part of the transformer before grounding and short-circuiting its terminals.

1. Tap **Start**.

2. The blue ring on the **Start/Stop** button lights up.
3. Press the **Start/Stop** button to start the test.

4. The blue ring and the red warning light are now flashing for approx. 3 seconds.
   ► To suspend the test, press the **Start/Stop** button on the *TESTRANO 600* front panel.
   ► In an emergency, press the **Emergency Stop** button to stop the test.

5. After the measurement is completed or stopped, the green warning light switches on and *TouchControl* displays the results in the **Measurement** view.

8 TouchControl tests

This chapter lists the tests available for *TESTRANO 600 TouchControl*.

► For details on safely performing tests, refer to chapters 1 "Safety instructions" on page 8 and 5 "Application" on page 25.

Chapter	Page
8.1 Demagnetization	46
8.2 Turns ratio	50
8.3 Winding resistance	54
8.4 Dynamic OLTC-Scan (DRM)	59
8.5 Leakage reactance/Short-circuit impedance	64
8.6 Tan Delta	69
8.7 Exciting current test	73
8.8 High voltage turns ratio	78
8.9 Power losses at low voltage	83
8.10 Quick	86
8.11 Vector group check	89

8.1 Demagnetization

Whenever a power transformer is isolated from the power system, residual magnetism remains in its core due to a phase shift. Due to residual magnetism in the core, high inrush currents, up to the maximum short-circuit current can occur. This puts undesired stress on the transformer when it is switched back into service. In addition, many diagnostic measurements can be affected by residual magnetism, making a reliable assessment very difficult.

Therefore, it is recommended to demagnetize the core before switching the transformer back into service and after DC voltages have been applied during diagnostic testing.

8.1.1 Demagnetization – Settings

► Adjust the settings and enter the necessary values for your test.

► Tap **Wiring** to display the wiring diagram for this test and vector group.

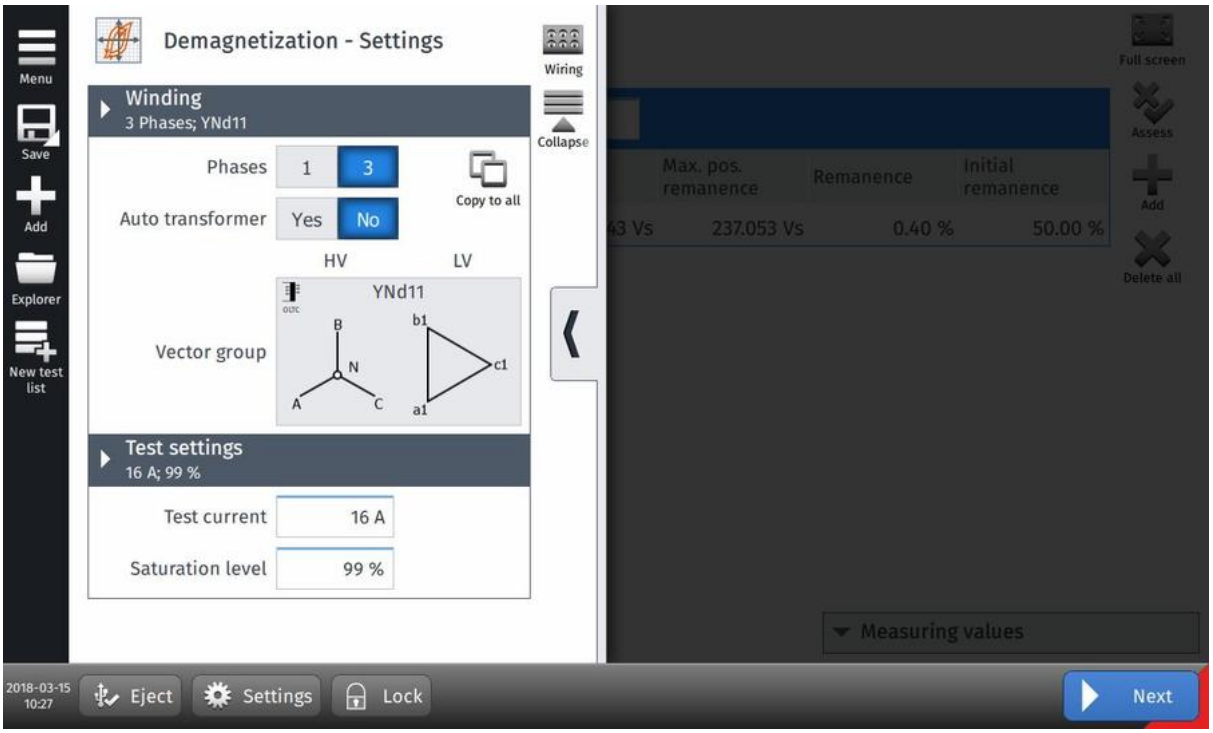


Figure 8-1: Demagnetization test – Settings view

Table 8-1: Demagnetization – Settings

Option	Description
Winding	
Phases	► Set the number of transformer phases.
Auto transformer	► Tap **Yes** if you are testing an auto transformer.
Vector group	► Tap **Copy to all** to copy the winding and tap changer configuration to all tests that have not yet been executed.

Table 8-1: Demagnetization – Settings (continued)

Option	Description
Test settings	
Test current	► Enter the maximum test current.
Saturation level	Desired saturation level during the demagnetization process. This value is only adapted in special cases.

8.1.2 Demagnetization – Measurement view

In the **Measurement** view, the results are displayed in the **Table** view.

► Expand the **Measuring values** section to display the measuring values during and after measurement.

► Tap **Add** to add further measurements (max. 30 measurements possible).

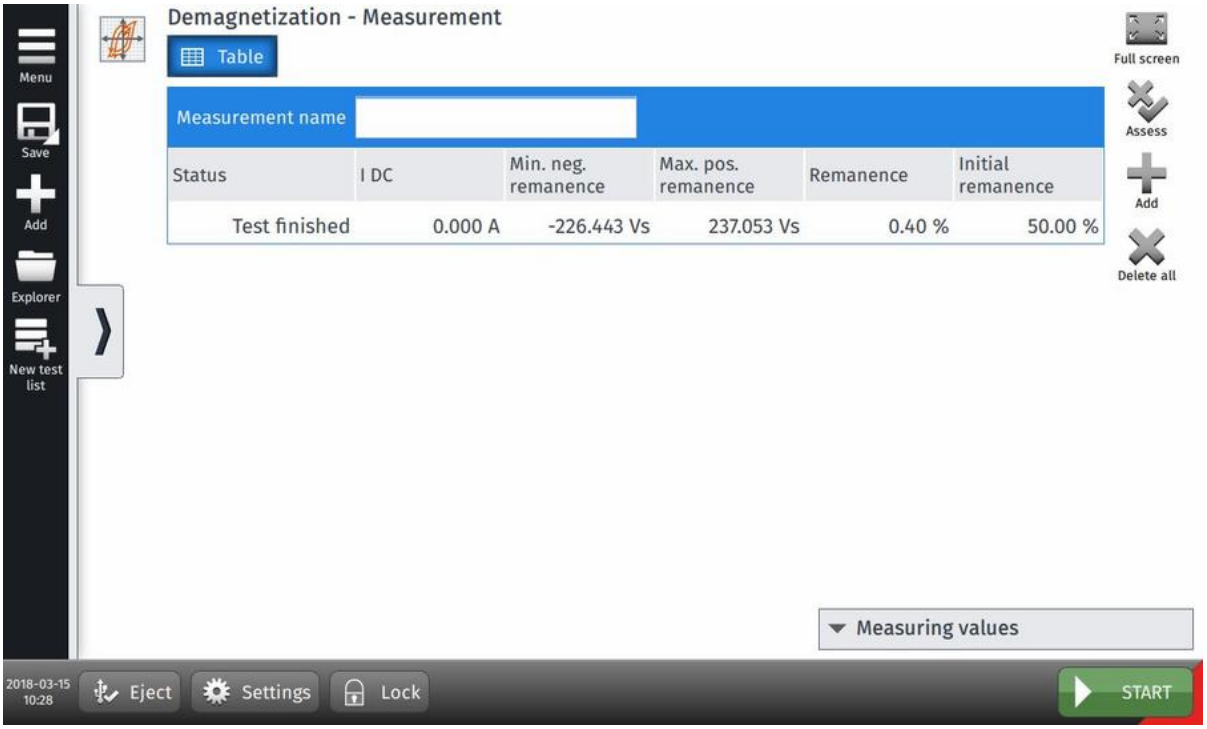


Figure 8-2: Demagnetization test – Measurement view with expanded measuring values

Table 8-2: Demagnetization – Measurement

Option	Description
Measurement	
Measurement name	Text field for description or comment
Status	During demagnetization: • Positive saturation running • Negative saturation running • Demagnetization running After demagnetization: • Demagnetization passed • Saturation failed • Demagnetization aborted
I DC	Measured current
Min. neg. remanence	Maximum remanence in negative direction of the hysteresis curve
Max. pos. remanence	Maximum remanence in positive direction of the hysteresis curve
Remanence	Measured remanence
Initial remanence	Remanence measured at the beginning of the test

Table 8-3: Demagnetization – Measuring values

Option	Description
Initial remanence	Measured remanence at the start of the test
Max. pos. remanence	Maximum remanence in positive direction of the hysteresis curve
Min. neg. remanence	Maximum remanence in negative direction of the hysteresis curve
Remanence	Measured remanence
Level	Saturation level of the transformer
Max. current	Maximum demagnetizing current (*TESTRANO 600* output)
Pos. sat. flux	Maximum saturation flux in positive direction of the hysteresis curve
Neg. sat. flux	Maximum saturation flux in negative direction of the hysteresis curve
Resistance	Resistance measured at maximum positive saturation flux
Remaining saturation	Saturation remaining in currently running demagnetization cycle

Table 8-3: Demagnetization – Measuring values (continued)

Option	Description
Status	During demagnetization: • Positive saturation running • Negative saturation running • Demagnetization running After demagnetization: • Demagnetization passed • Saturation failed • Demagnetization aborted
Output voltage	Current output voltage
Output current	Output current

8.2 Turns ratio

Transformer turns ratio (TTR) measurements are performed to verify the fundamental operating principle of a power transformer. By measuring the ratio and phase angle from one winding to the other, open circuits and shorted turns can be detected. The turns ratio is determined during factory acceptance tests and needs to be checked routinely once the transformer is in service.

8.2.1 Turns ratio – Settings

► Adjust the settings and enter the necessary values for your test.

► Tap **Wiring** to display the wiring diagram for this test and vector group.

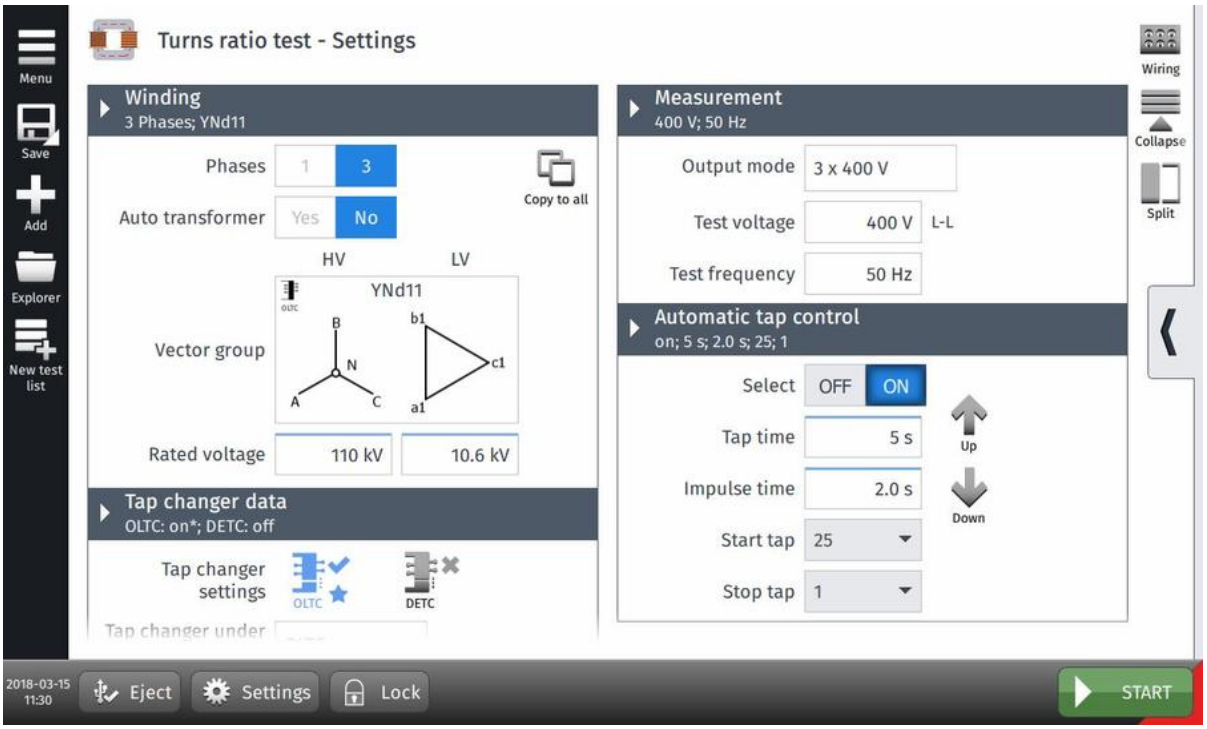


Figure 8-3: Turns ratio test – Settings view

Table 8-4: Turns ratio – Settings

Option	Description
Winding	
Phases	► Set the number of transformer phases.
Auto transformer	► Tap **Yes** if you are testing an auto transformer.
Vector group	► Set the vector group: Tap **Select winding configuration**.
Rated voltage	► Enter the transformer's rated voltage.

Table 8-4: Turns ratio – Settings (continued)

Option	Description
Tap changer data	
Tap changer settings	► Adjust the tap changer settings by tapping the corresponding icon .
	No tap changer defined
	Tap changer has been defined and will be included in the measurement
Tap changer under test	► Select which tap changer to include in the measurement if both an OLTC and a DETC have been defined. The tap changer under test is marked with a star .
OLTC position	OLTC tap position during tap switching on the DETC
DETC position	DETC tap position during tap switching on the OLTC
Tap changer settings – Define Tap Changer	
► Refer to "Defining a tap changer" on page 41.	
Measurement	
Output mode	Standard setting: 3 x 400 V ► Select the 3 x 120 V output mode if an increased magnetizing current is necessary. ► Refer to "AC high range low current" in Table 15-2, page 219.
Test voltage	Output voltage
Test frequency	Output frequency: • IEEE: 60 Hz • IEC: 50 Hz
Automatic tap control	
► See "Keeping results" on page 53 for more information.	
Select	► Select **ON** to activate the automatic tap control.
Up Down	► If automatic tap control is **ON**, use the **Up** and **Down** buttons in the **Settings** view to switch between the taps and check if your wiring is correct.
Tap time	Time for the change between two tap positions
Impulse time	Duration of the impulse triggering the tap change
Start tap	Start tap position of the test
Stop tap	Stop tap position of the test

8.2.2 Turns ratio – Measurement view

In the **Measurement** view, the results are displayed in the **Table** or **Plot** view.

► Use the **Current tap position** drop-down box to choose the correct label for the currently measured tap.

► Tap the arrows in the table head to sort the results by tap or phase number.

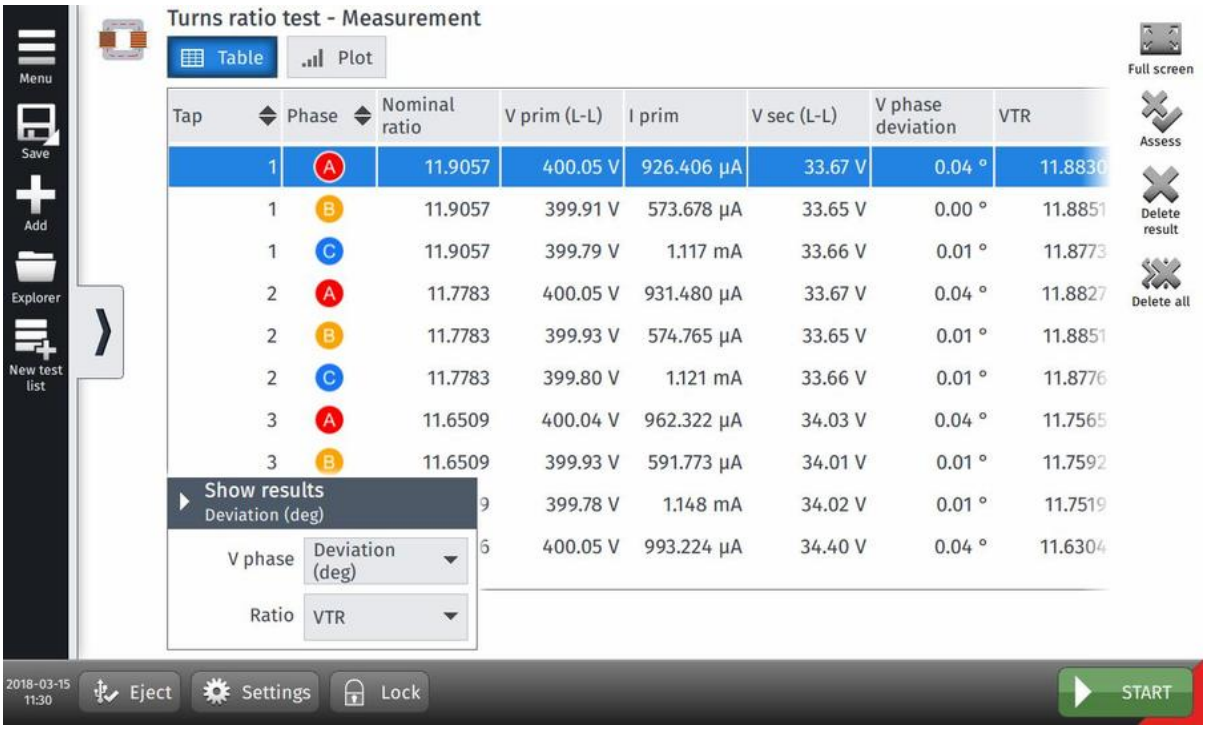


Figure 8-4: Turns ratio test – Measurement view with results

Table 8-5: Turns ratio – Measurement, table view

Option	Description
Tap	Tap under test
Phase	Phase under test
Nominal ratio	Nominal transformer ratio
V prim (L-L)	Output voltage; measured line to line
I prim	Measured current on the primary side of the transformer
I phase	Measured primary current per phase
V sec (L-L)	Secondary voltage; measured line to line
V phase absolute	Phase shift of the transformer
V phase deviation	Deviation of measurement result from the expected result
Voltage ratio	Voltage ratio primary:secondary
TTR	Measured transformer turns ratio

Table 8-5: Turns ratio – Measurement, table view (continued)

Option	Description
VTR	Measured voltage ratio
Ratio deviation	Deviation of the nominal ratio from the voltage ratio
Current tap position	
Middle	► Tap to view the middle tap position.
Up Down	► If automatic tap control is **OFF**, use the **Up** and **Down** buttons in the **Measurement** view to switch taps during measurement.
Show results	
V phase	► Choose from the drop-down box which value to display in the table.
Ratio	► Choose between TTR (transformer turns ratio) and VTR (voltage ratio) to be displayed in the result table.

Table 8-6: **Turns ratio** – Measurement, plot view

Option	Description
Plot type	**TTR/VTR**: Transformer/voltage ratio over tap position
	TTR deviation: Ratio deviation over tap position
	Exciting current: Low-voltage exciting current over tap position
	Phase deviation: Phase deviation over tap position
Filter graph	► Select the phases to be displayed in the graph.
Current tap position	
Middle	► Tap to view the middle tap position.
Up Down	► If automatic tap control is **OFF**, use the **Up** and **Down** buttons in the **Measurement** view to switch taps during measurement.

Keeping results

Automatic tap control = **ON**: *TouchControl* automatically saves results when the **Tap time** is over.

Automatic tap control = **OFF**: Tap **Keep results** to manually save results.

8.3 Winding resistance

Winding resistance measurements are performed to assess possible damages in windings or contact problems between bushings and windings, windings and tap changer, etc.

8.3.1 Winding resistance – Settings

► Adjust the settings and enter the necessary values for your test.

► Tap **Wiring** to display the wiring diagram for this test and vector group.

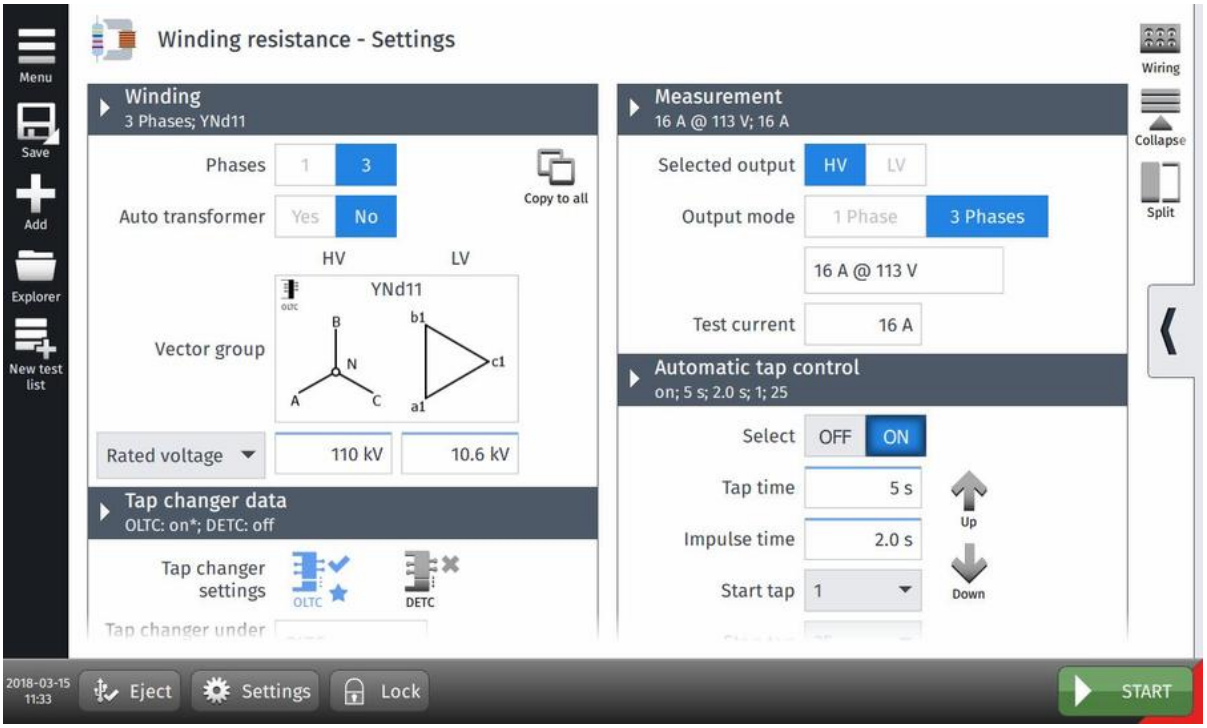


Figure 8-5: Winding resistance test – Settings view

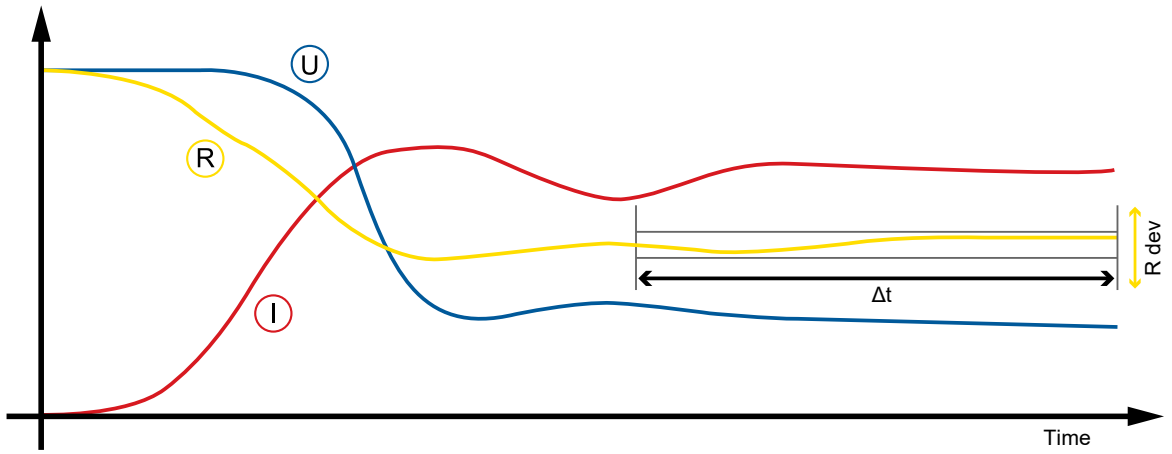
Table 8-7: Winding resistance – Settings

Option	Description
Winding	
Phases	► Set the number of transformer phases.
Auto transformer	► Tap **Yes** if you are testing an auto transformer.
Vector group	► Set the vector group: Tap **Select winding configuration**.
Rated voltage Rated current	► Tap the drop-down box to choose between **Rated voltage** and **Rated current** and enter the applicable value. **Note:** With **LV** as the selected output, you need to specify the rated voltage or current. Otherwise the output voltage will be limited to 2 V to prevent overvoltage.
► Tap **Copy to all** to copy the winding and tap changer configuration to all tests that have not yet been executed.	

Table 8-7: Winding resistance – Settings (continued)

Option	Description
Tap changer data	
Tap changer settings	► Adjust the tap changer settings by tapping the corresponding icon .
	No tap changer defined
	Tap changer has been defined and will be included in the measurement
Tap changer under test	► Select which tap changer to include in the measurement if both an OLTC and a DETC have been defined. The tap changer under test is marked with a star .
OLTC position	The OLTC tap position during tap switching on the DETC
DETC position	The DETC tap position during tap switching on the OLTC
Tap changer settings – Define Tap Changer	
► Refer to "Defining a tap changer" on page 41.	
Measurement	
Selected output	Selected output cable: HV (red) or LV (yellow) ► See 3.1.5 "TESTRANO 600 measuring cables" on page 18. **Note:** With LV as the selected output, you need to specify the rated voltage or current. Otherwise the output voltage will be limited to 2 V to prevent overvoltage.
Output mode	16 A @ 340 V Fast magnetization with elevated voltage
	33 A @ 170 V For assets with expected low resistances
	100 A @ 56 V For assets with expectedly very low resistances
Test current	Current output during the test
Automatic tap control	
► See "Keeping results" on page 58 for more information.	
Select	► Select **ON** to activate the automatic tap control.
Up Down	► If automatic tap control is **ON**, use the **Up** and **Down** buttons in the **Settings** view to switch between the taps and check if your wiring is correct.
Tap time	Time for the change between two tap positions
Impulse time	Duration of the impulse triggering the tap change
Start tap	Start tap position of the test
Stop tap	Stop tap position of the test
Up/Down test	► Select **ON** to activate the automatic change of switching direction after the first/last tap.

Table 8-7: Winding resistance – Settings (continued)

Option	Description
Automatic result	
Automatic result	► Select **ON** to automatically keep measurement results, depending on **Tolerance R dev** and the **Settling time**.
	
Tolerance R dev	Tolerance for the deviation of measurement results within the settling time
Settling time (Δt)	If during the settling time the deviation remains below the defined **Tolerance R dev**, the result is recorded.
Test conditions	
Temperature correction	► Tap **ON** to activate temperature correction.
Material	► Select the winding material: copper or aluminium.
Temperature	Winding temperature
Reference temperature	Reference temperature for the temperature correction
Correction factor	Temperature correction factor calculated from the values entered above

8.3.2 Winding resistance – Measurement view

In the **Measurement** view, the results are displayed in the **Table** or **Plot** view.

► Use the **Current tap position** drop-down box to choose the correct label for the currently measured tap.

► Tap the arrows in the table heads to sort the results by switching direction, tap position or phase number.

If **Automatic tap control** and **Up/down test** are **ON**, the left-most column displays the switching direction: up or down .

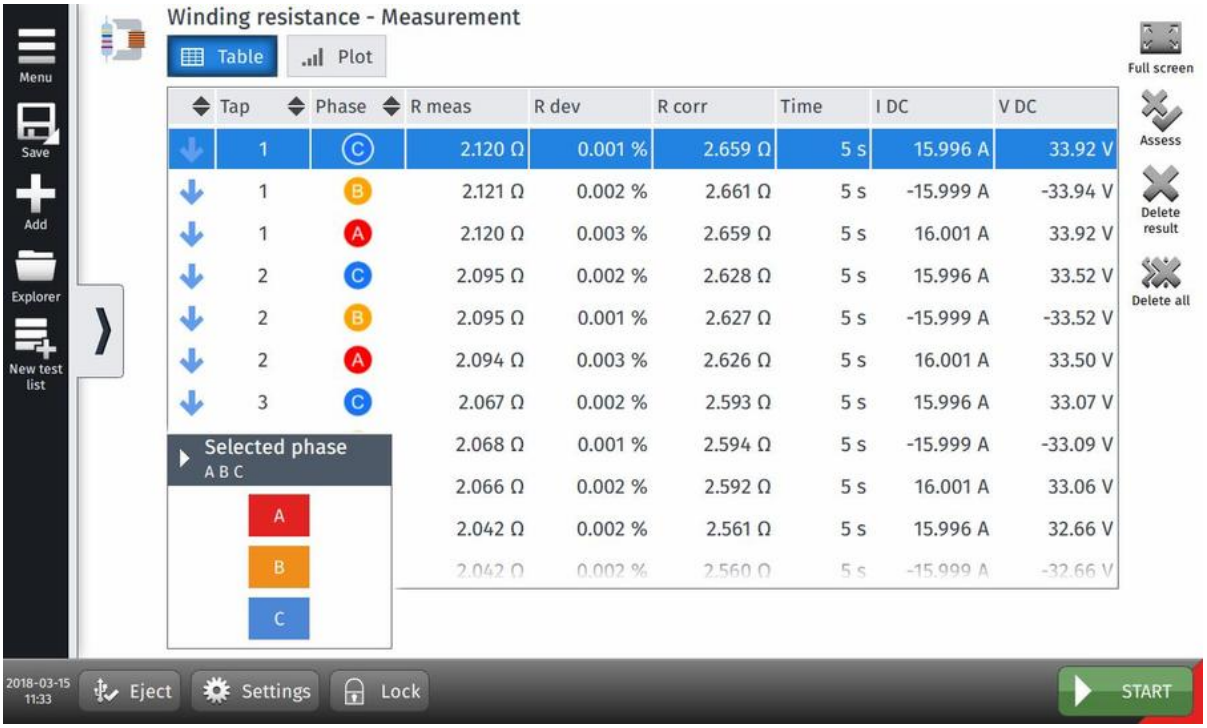


Figure 8-6: Winding resistance test – Measurement view

Table 8-8: Winding resistance – Measurement

Option	Description
Tap	Tap under test
Phase	Output phase
R meas	Measured resistance
R dev	Percentage deviation among the last 20 values measured.
R corr	Corrected measured resistance
Time	Time until a stable condition was reached
I DC	Measured current
V DC	Measured voltage

Table 8-8: Winding resistance – Measurement (continued)

Option	Description
Current tap position	
Middle	► Tap to view the middle tap position.
Up Down	► If automatic tap control is **OFF**, use the **Up** and **Down** buttons in the **Measurement** view to switch taps during measurement.
Selected phase – Table view	
► After rewiring, select the next phase and press **Start**.	
Filter graph – Plot view	
► Select the phases to be displayed in the graph.	

Keeping results

Automatic tap control = **ON**, **Automatic result** = **ON** *(by default)*:

In this mode, taps and phases are switched automatically. *TouchControl* saves a result when it detects a value within the **Tolerance R dev** during the settling time.

Automatic tap control = **OFF, Automatic result** = **ON**:

► Select a tap and/or phase.

► Tap **Auto keep** during the measurement.
TouchControl then automatically saves a result when it detects a value within the **Tolerance R dev** during the settling time.
On DETCs *TouchControl* measures all three phases for the selected tap.

► Tap **Keep results** to manually save results during the settling time. This might be necessary in case the results will not stabilize.

8.4 Dynamic OLTC-Scan (DRM)

Dynamic resistance measurements are performed as a supplementary measurement in order to analyze the transient switching process of a resistive diverter OLTC. They investigate the switching process of the diverter switch itself. When switching the tap changer during winding resistance measurements, the DC current temporarily decreases and this behavior is recorded and analyzed.

8.4.1 Dynamic OLTC-Scan – Settings

► Adjust the settings and enter the necessary values for your test.

► Tap **Wiring** to display the wiring diagram for this test and vector group.
Refer to "Connection to the transformer" on page 28 for more information on tap changer wiring.

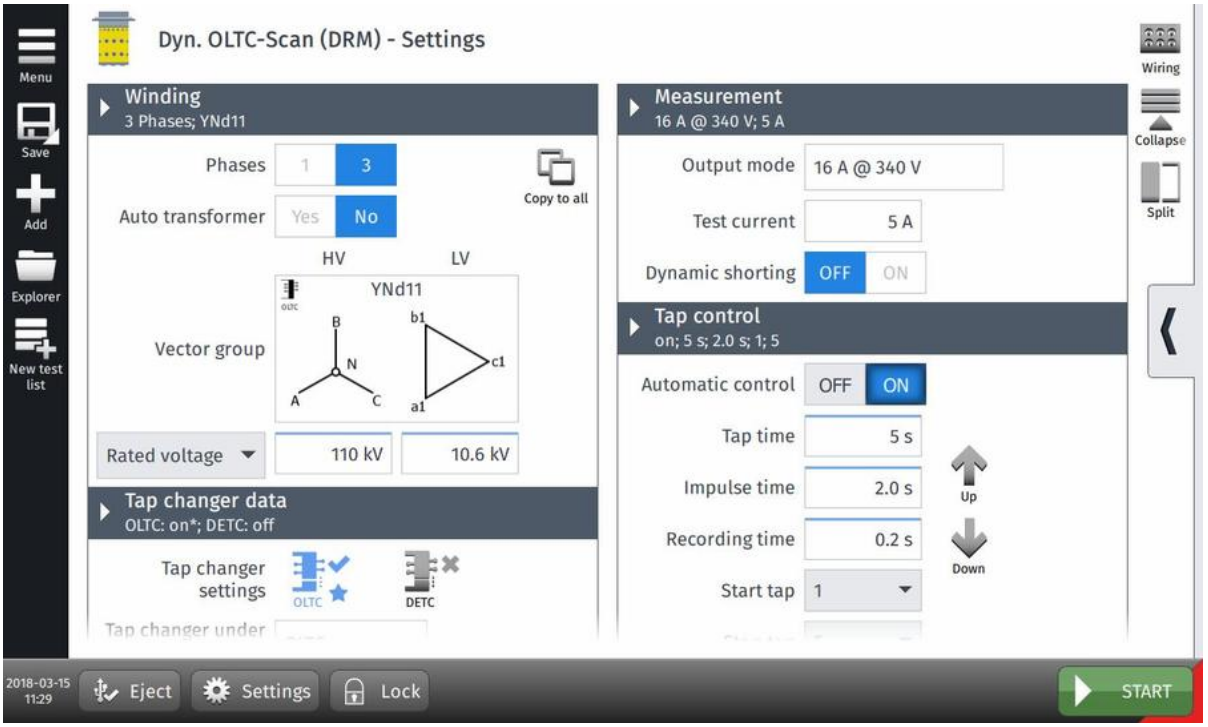


Figure 8-7: Dynamic OLTC-Scan – Settings view

Table 8-9: Dynamic OLTC-Scan – Settings

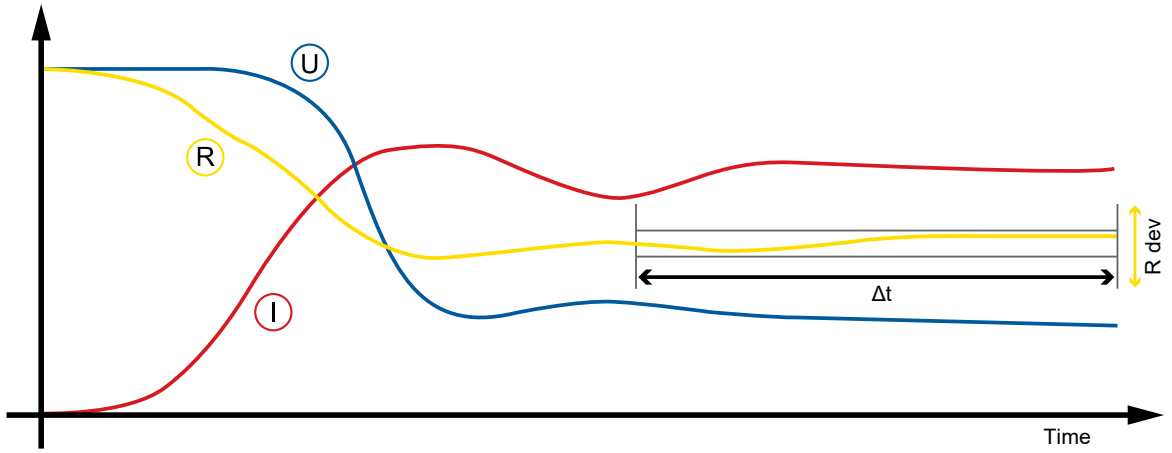
Option	Description
Winding	
Phases	► Set the number of transformer phases.
Auto transformer	► Tap **Yes** if you are testing an auto transformer.
Vector group	► Set the vector group: Tap **Select winding configuration**.
Rated voltage Rated current	► Tap the drop-down box to choose between **Rated voltage** and **Rated current** and enter the applicable value.

Table 8-9: Dynamic OLTC-Scan – Settings (continued)

Option	Description
► Tap **Copy to all** to copy the winding and tap changer configuration to all tests that have not yet been executed.	
Tap changer data	
Tap changer settings	► Adjust the tap changer settings by tapping the corresponding icon.
	No tap changer defined
	Tap changer has been defined and will be included in the measurement
Tap changer under test	► Select which tap changer to include in the measurement if both an OLTC and a DETC have been defined. The tap changer under test is marked with a star.
OLTC position	The OLTC tap position during tap switching on the DETC
DETC position	The DETC tap position during tap switching on the OLTC
Tap changer settings – Define Tap Changer	
► Refer to "Defining a tap changer" on page 41.	
Test conditions	
Temperature correction	► Tap **ON** to activate temperature correction.
Material	► Select the winding material: copper or aluminium.
Temperature	Winding temperature
Reference temperature	Reference temperature for the temperature correction
Correction factor	Temperature correction factor calculated from the values entered above
Measurement	
Output mode	16 A @ 340 V Fast magnetization with elevated voltage
	33 A @ 170 V For assets with expected low resistances
	100 A @ 56 V For assets with expectedly very low resistances
Test current	Current output during the test
Dynamic shorting	Dynamic short-circuit of low-voltage windings on single- and three-phase transformers. Only selectable for two- and three-winding transformers with an OLTC on the high-voltage winding.
Tap control	
Automatic control	► Select **ON** to activate the automatic tap control.
Tap time	Time for the change between two tap positions
Impulse time	Duration of the impulse triggering the tap change

Table 8-9: Dynamic OLTC-Scan – Settings (continued)

Option	Description
Recording time	Recording period during the switching cycle
Start tap	Start tap position of the test
Stop tap	Stop tap position of the test
Up/Down test	► Select **ON** to activate the automatic change of switching direction after the first/last tap.
Up Down	► Use the **Up** and **Down** buttons to switch between the taps and check if your wiring is correct.
Automatic result	
Automatic result	In this test, results are saved automatically, depending on **Tolerance R dev** and the **Settling time**.



Tolerance R dev	Tolerance for the deviation of measurement results within the settling time
Settling time (Δt)	If during the settling time the deviation remains below the defined **Tolerance R dev**, the result is recorded.
Motor supply	
Record	► Tap **ON** to record the current and voltage supply to the tap changer motor.
Clamp ratio	► Enter the current clamp's transformer ratio (current to voltage).

8.4.2 Dynamic OLTC-Scan – Measurement view

In the **Measurement** view, the results are displayed in the **Table** or **Plot** view.

Plot view

For an easier distinction of the different graphs, select a graph from the **Graph legend** list, then tap **Color meas.** to assign it a color.

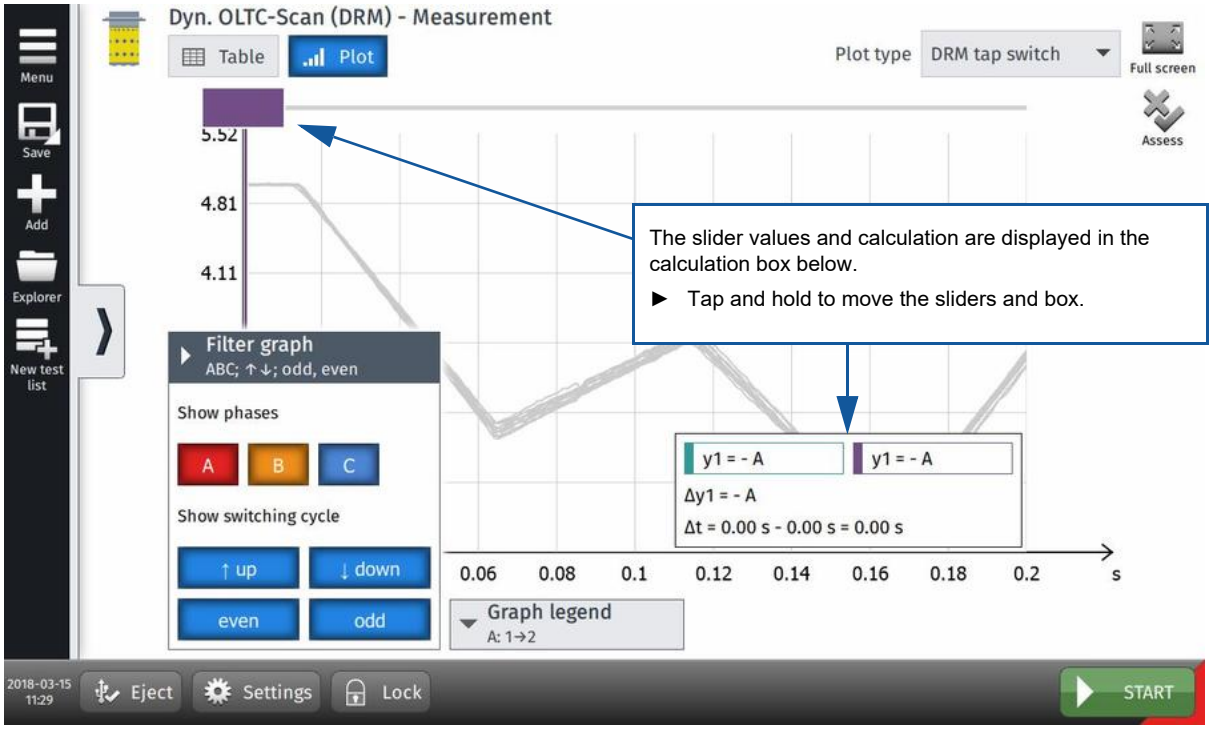


Figure 8-8: Dynamic OLTC-Scan – Measurement view

Table view

► Tap the arrows in the table head to sort the results by tap or phase number.

If **Up/down test** is **ON**, the left-most column displays the switching direction: up or down .

Table 8-10: Dynamic OLTC-Scan – Measurement, table view

Option	Description
Tap	Tap under test
Phase	Output phase
R meas	Measured resistance
R dev	Deviation of two successive measurement results at the time the test was stopped
R corr	Temperature-corrected measured resistance

Table 8-10: Dynamic OLTC-Scan – Measurement, table view (continued)

Option	Description
Ripple	Percentage deviation between highest and lowest value in the DRM curve
Time	Time until a stable condition was reached
I DC	Measured current
V DC	Measured voltage

8.5 Leakage reactance/Short-circuit impedance

Short-circuit impedance/leakage reactance measurements are sensitive methods to assess possible deformation or displacements in windings.

The frequency response of stray losses (FRSL) test is a measurement of the resistive component of the short-circuit impedances at multiple frequencies. It is an electrical method to identify short-circuits between parallel strands and local overheating due to excessive eddy current losses. The test setup and procedure of the FRSL test is the same as for the per phase short-circuit impedance/leakage reactance test and can be performed simultaneously.

Note: The name of this test depends on the standard set in the **Settings** view (see 6.4 "TouchControl settings" on page 36):

- According to the IEEE standard: Leakage Reactance
- According to IEC standard: Short-Circuit Impedance

In this chapter, the test will be referred to as short-circuit impedance.

8.5.1 Short-circuit impedance – Settings

► Adjust the settings and enter the necessary values for your test.

► Tap **Wiring** to display the wiring diagram for this test and vector group.

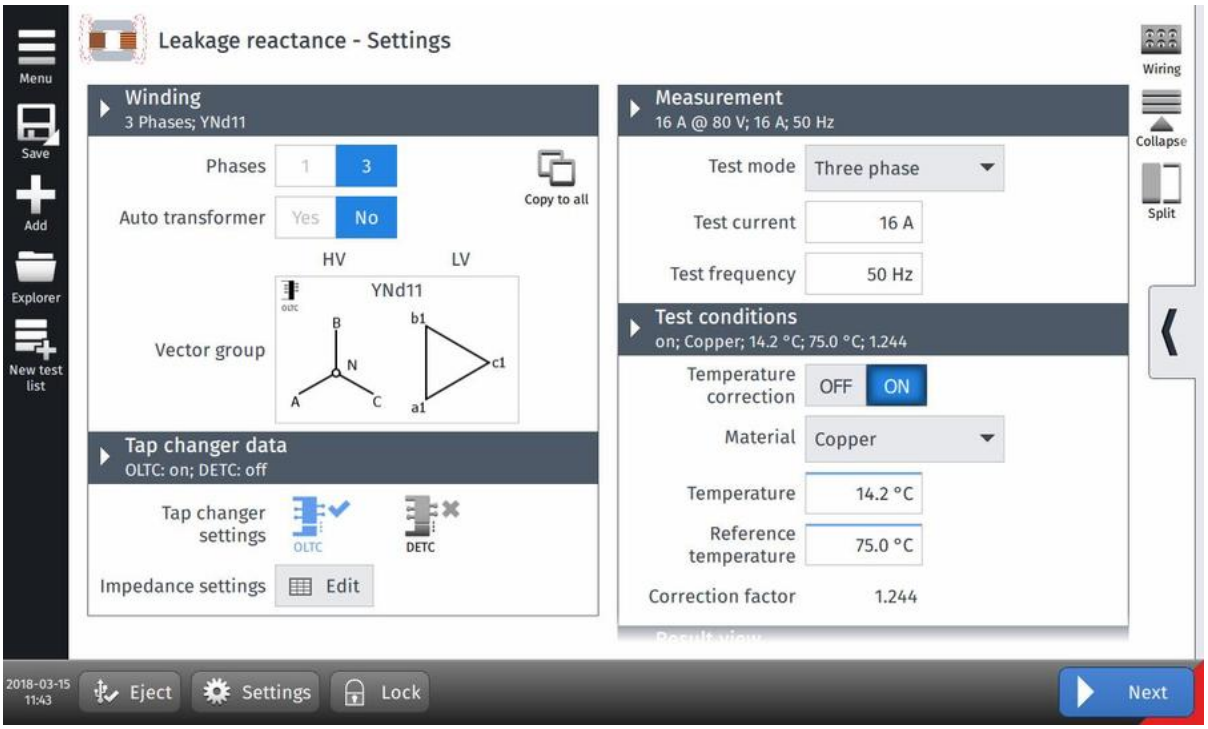


Figure 8-9: Short-circuit impedance test – Settings view

Table 8-11: Short-circuit impedance – Settings

Option	Description
Winding	
Phases	► Set the number of transformer phases.
Auto transformer	► Tap **Yes** if you are testing an auto transformer.
Vector group	► Set the vector group: Tap **Select winding configuration**.
► Tap **Copy to all** to copy the winding and tap changer configuration to all tests that have not yet been executed.	
Tap changer data	
Tap changer settings	► Adjust the tap changer settings by tapping the corresponding icon .
	No tap changer defined
	Tap changer has been defined and will be included in the measurement
Tap changer settings – Define Tap Changer	
► Refer to "Defining a tap changer" on page 41.	
Impedance settings – Define impedances	
► Define the tap settings for the short-circuit impedance test. In the **Measurement** view you will be able to filter the results for the individual entries in this list, using the **Impedance list entry** drop-down box.	
Short-circuit impedance Z/uk[1]	Short-circuit impedance of the transformer
Base power	Base power used for calculating the percent values of impedances
Base voltage	Base voltage used for calculating the percent values of impedances
OLTC position	Tap position of the OLTC corresponding to the impedance value
DETC position	Tap position of the DETC corresponding to the impedance value
Measurement	
Test mode	► Select **Three phase** for a three-phase measurement to compare the results to the nameplate data.
	► Select **Per phase** for an in-depth error analysis of the individual phases.
Selected phase	► Select the phase for the **Per phase** mode.
Test current	► Enter the maximum test current.
Test frequency	► Enter the mains frequency.
Test conditions	
Temperature correction	► Tap **ON** to activate temperature correction.
Material	► Select the winding material: copper or aluminium.
Temperature	Winding temperature

Table 8-11: Short-circuit impedance – Settings (continued)

Option	Description
Reference temperature	Reference temperature for the temperature correction
Correction factor	Temperature correction factor calculated from the values entered above
Result view	
Show FRSL results	► Tap ON to display the FRSL results in the **Per phase** table of the **Measurement** view.

1. Depending on the **Profile** selected in **Settings** – **General** (see 6.4.1 "General settings" on page 36).

8.5.2 Short-circuit impedance – Measurement view

In the **Measurement** view, the results are displayed in the **Table** or **Plot** view.

► Choose an **Impedance list entry** from the drop-down-list to show the results for one of the impedances defined in the **Settings** view (see page 65).

► Tap the arrows in the table heads to sort the results by frequency or position.

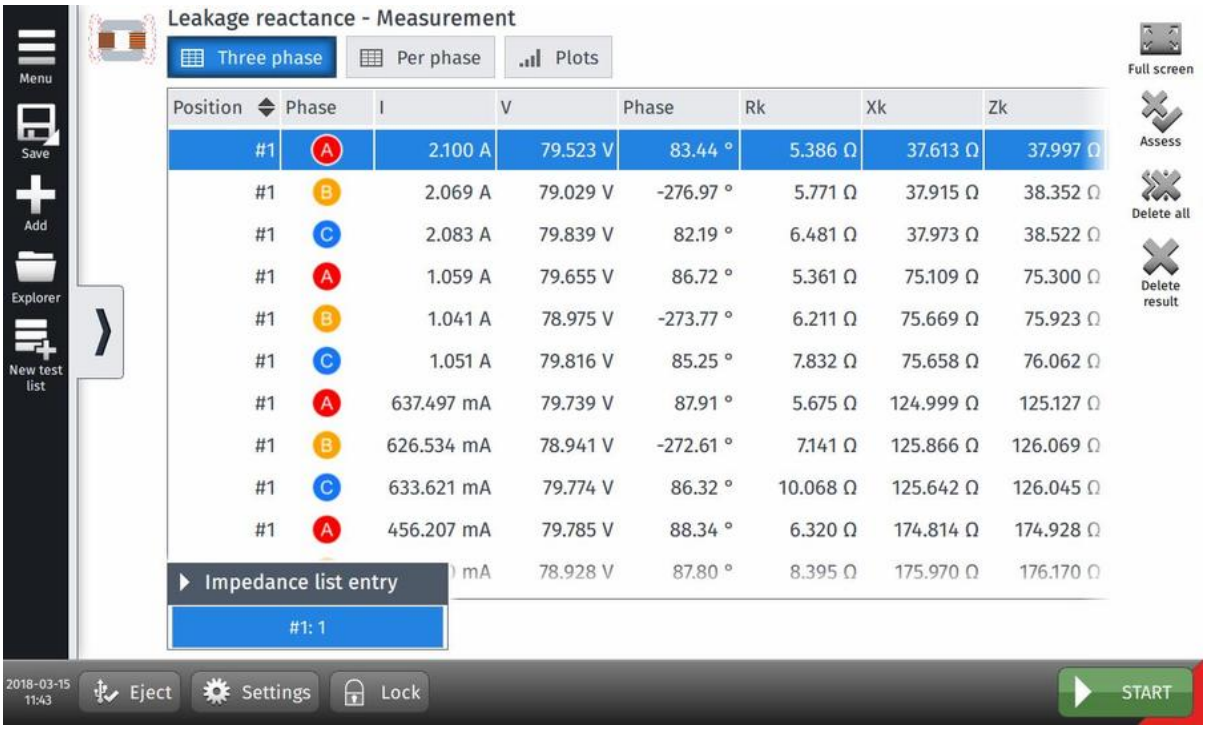


Figure 8-10: Short-circuit impedance test – Measurement view

Table 8-12: Short-circuit impedance – Measurement

Option	Description
Position	Entry selected from the impedance list
Phase	Phase under test
I	Measured current
V	Measured voltage
Phase	Phase angle between voltage and current
Rk	Real part of the measured Zk
Xk	Imaginary part of the measured Zk (short-circuit impedance)
Zk	Measured short-circuit impedance
uk/Zk calc[1]	Calculation based on the Zk value of all three phases

Table 8-12: Short-circuit impedance – Measurement (continued)

Option	Description
uk dev / Zk dev[1]	Three phase measurement: Deviation from the nameplate value entered in the **Impedance settings** list
	Per phase measurement: Deviation from **uk avg** / **Zk avg**
uk avg / Zk avg[1, 2]	Average of **Zk** across all phases
Impedance list entry	Tap settings for the short-circuit impedance test (see "Impedance settings – Define impedances" on page 65)
Selected phase[2]	► After rewiring, select the next phase and press **Start**.

1. Depending on the **Profile** selected in **Settings** – **General** (see 6.4.1 "General settings" on page 36).
2. Only for **Per phase** test

8.6 Tan Delta

Capacitance and power factor/dissipation factor measurements are performed to investigate the condition of the insulation of power transformers and bushings. Both insulation systems are essential for the reliable operation of the transformer.

Note: This test requires the *CP TD1*.

► For details on how to connect the devices and prepare a test, refer to chapter 5.2 "Preparing the test setup" on page 26.

8.6.1 Tan Delta – Settings

► Adjust the settings and enter the necessary values for your test.

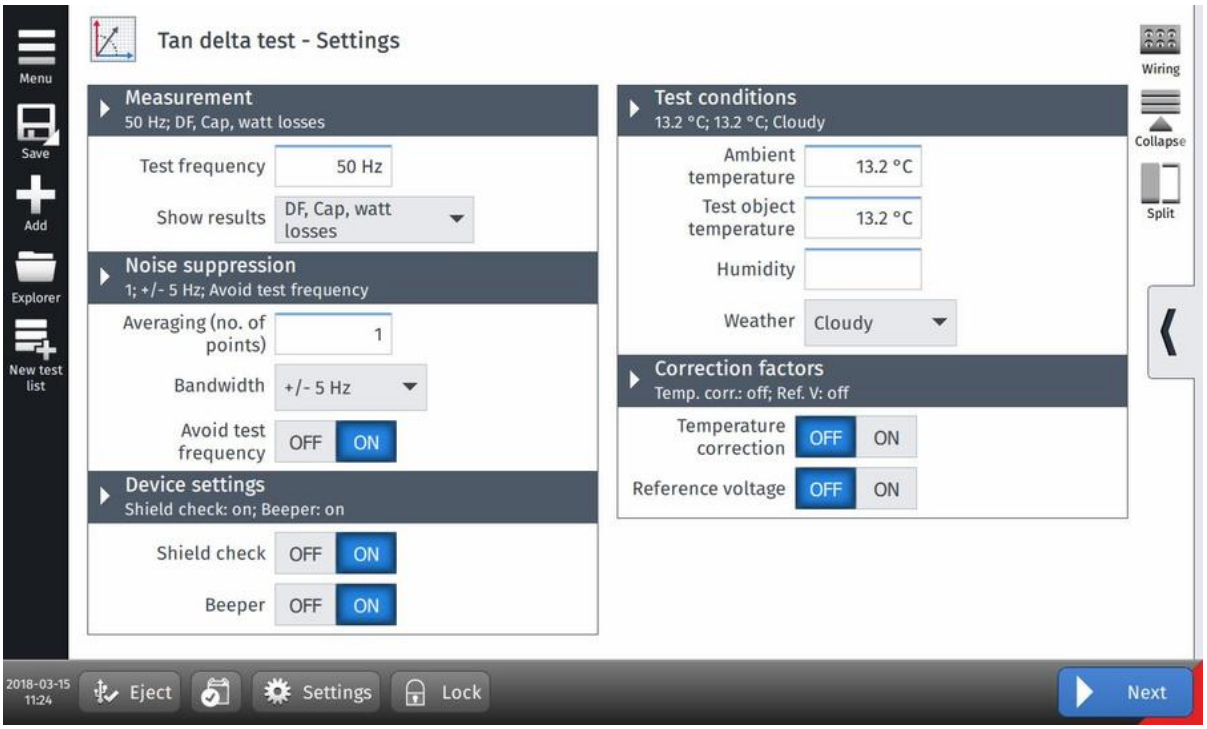


Figure 8-11: Tan delta test – Settings view

Table 8-13: Tan Delta – Settings

Option	Description
Measurement	
Test frequency	► Set the output frequency for the test/the frequency used to calculate the sweep.
Show results	► Select the type of calculation for the measured results from the drop-down list (see Table 8-14: "Tan Delta – Measurement").

Table 8-13: Tan Delta – Settings (continued)

Option	Description
Noise suppression	
Averaging (no. of points)	► Enter the number of measurement points used for averaging.
Bandwidth	► Select the *CP TD1* filter bandwidth from the drop-down list.
Avoid test frequency	If this setting is active, the measurement will *not* be performed at the **Test frequency** set in the **Measurement** section. *TouchControl* will instead measure two values at frequencies below and above the entered **Test frequency** and calculate the median of those two values. The **Avoid test frequency** setting is predefined for the selected test. ► Only change the default setting for special applications.
Device settings	
Shield check	**ON**: *TESTRANO 600* checks whether the shield of the high-voltage cable is connected.
Beeper	**ON**: The *CP TD1* beeper is on during the measurement.
Test conditions	
Ambient temperature	Ambient temperature on site
Test object temperature	Temperature of the test object
Humidity	Relative ambient humidity
Weather	Weather conditions during the test
Correction factors	
Temperature correction	► Tap **ON** to set the temperature correction factor.
Reference voltage	► Tap **ON** to set the reference voltage for the extrapolation of measurement results.

8.6.2 Tan Delta – Measurement view

► Tap **Wiring** to display the wiring diagram for this test and vector group.

In the **Measurement** view, the results are displayed in the **Table** or **Plot** view.

► Switch to the **Live** view to monitor the voltage output **V out** during measurement.

The **Overview** lists all measurements.

► Mark a list entry and tap **Go to meas.** to open the measurement.

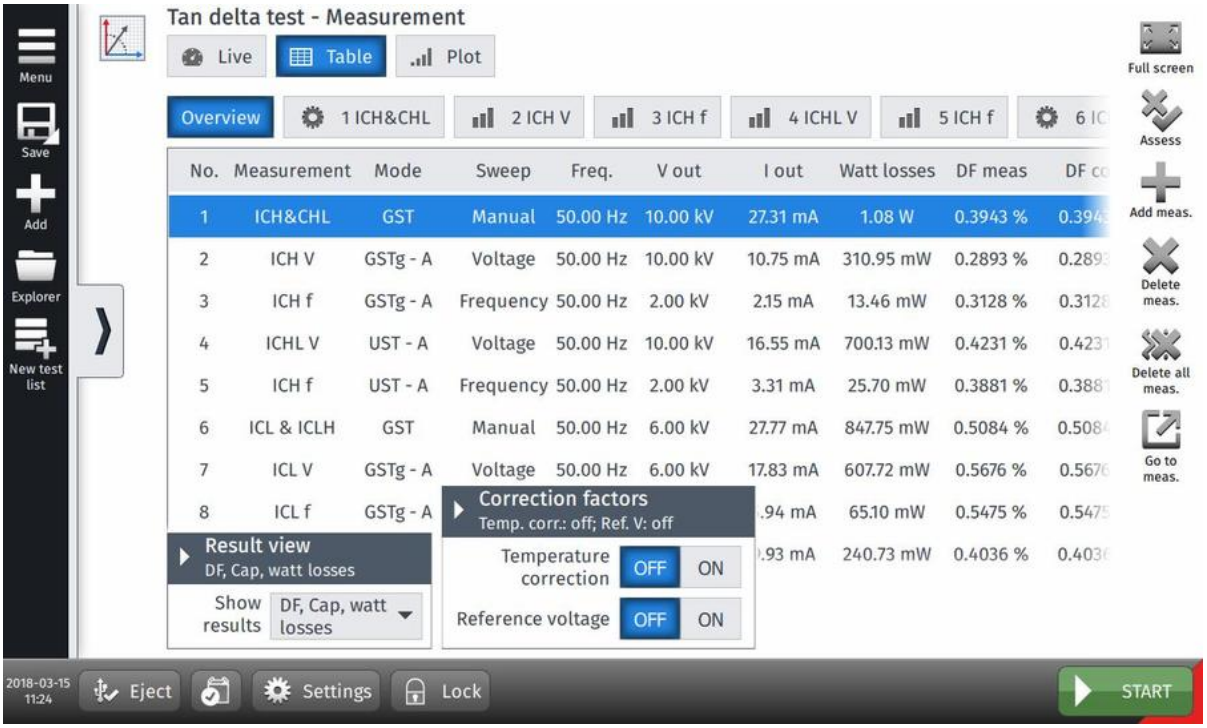


Figure 8-12: Tan delta test – Measurement view

Table 8-14: Tan Delta – Measurement

Option	Description
Table	
Mode	Measurement mode
Measurement	Text field for description or comment
V test	Test voltage
Freq.	Test frequency
V out	Measured output voltage
I out	Measured output current

Table 8-14: Tan Delta – Measurement (continued)

Option	Description
Depending on the Result view	
PF/DF[1], Cap, watt losses	Power factor/dissipation factor, capacitance and watt losses
Imp. Z	Impedance with phase angle
Q power, S power	Reactive and apparent power
Cp, Rp	Parallel capacitance and parallel resistance
Cp, quality factor	Parallel capacitance and quality factor
Ls, Rs	Serial inductance and serial resistance
Ls, quality factor	Serial inductance and quality factor
Correction factors	
Temperature correction	► Tap **ON** to activate temperature correction.
Reference voltage	Reference voltage for the extrapolation of measurement results

1. Depending on the **Profile** selected in **Settings** – **General** (see6.4.1 "General settings" on page 36).

Measurements – Sweeps

► In the **Table** view, tap **Add** to add further measurements (max. 30).

► Tap **Add point** to add a point to an existing measurement.

The following sweeps are available:

- Frequency sweep CPC template:
  Sweep frequencies specified by the *CPC 100* test templates
- Frequency sweep OMICRON expertise:
  Sweep frequencies dynamically distributed within the *CP TD1* frequency range for optimum results
- Voltage sweep OMICRON expertise:
  Sweep voltages dynamically distributed within the asset-dependent voltage range for optimum results
- Manual sweep

8.7 Exciting current test

Exciting current measurements are performed to assess the turn-to-turn insulation of the windings, the magnetic circuit of a transformer as well as the tap changer. The most valued benefit of the test is to detect turn-to-turn short-circuits in a winding. Physical movement of the core laminations or severe damage to the core can influence the reluctance and, thus, will result in a change in exciting current. Deviations may also indicate contact wear or improper wiring of the tap changer.

8.7.1 Exciting current test – Settings

► Adjust the settings and enter the necessary values for your test.

► Tap **Wiring** to display the wiring diagram for this test and vector group.

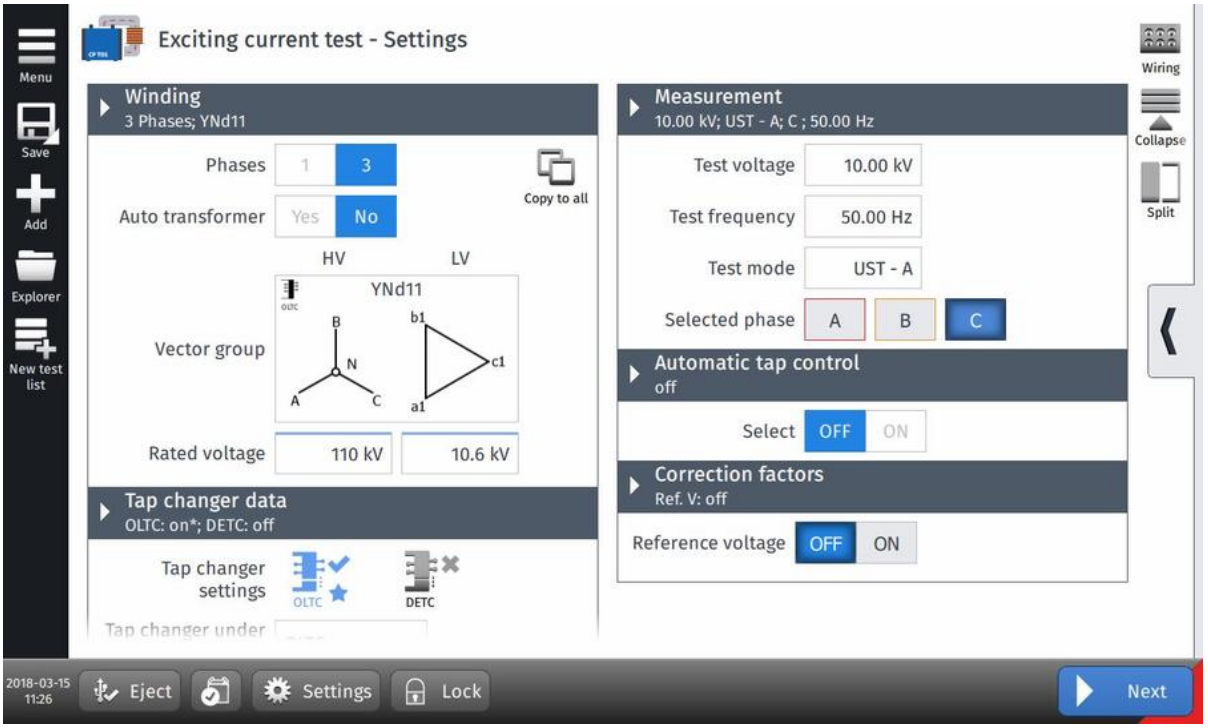


Figure 8-13: Exciting current test – Settings view

Table 8-15: Exciting current – Settings

Option	Description
Winding	
Phases	► Set the number of transformer phases.
Auto transformer	► Tap **Yes** if you are testing an auto transformer.
Vector group	► Set the vector group: Tap **Select winding configuration**.
► Tap **Copy to all** to copy the winding and tap changer configuration to all tests that have not yet been executed.	

Table 8-15: Exciting current – Settings (continued)

Option	Description
Tap changer data	
Tap changer settings	► Adjust the tap changer settings by tapping the corresponding icon .
	No tap changer defined
	Tap changer has been defined and will be included in the measurement
Tap changer settings – Define Tap Changer	
► Refer to "Defining a tap changer" on page 41.	
Noise suppression	
Averaging (no. of points)	► Enter the number of measurement points used for averaging.
Bandwidth	Select the *CP TD1* filter bandwidth from the drop-down list.
Avoid test frequency	If this setting is active, the measurement will *not* be performed at the **Test frequency** set in the **Measurement** section. *TouchControl* will instead measure two values at frequencies below and above the entered **Test frequency** and calculate the median of those two values. The **Avoid test frequency** setting is predefined for the selected test. ► Only change the default setting for special applications.
Device settings	
Shield check	**ON:** *CP TD1* checks whether the shield of the high-voltage cable is connected.
Beeper	**ON:** The *CP TD1* beeper is on during the measurement.
Measurement	
Test voltage	Output voltage
Test mode	Test mode for this test: UST-A
Selected phase	► After rewiring, select the next phase and press **Start**.
Test frequency	Output frequency: • IEEE: 60 Hz • IEC: 50 Hz
Automatic tap control	
► See "Keeping results" on page 53 for more information.	
Select	► Select **ON** to activate the automatic tap control.
Up Down	► If automatic tap control is **ON**, use the **Up** and **Down** buttons in the **Settings** view to switch between the taps and check if your wiring is correct.
Tap time	Time for the change between two tap positions
Impulse time	Duration of the impulse triggering the tap change

Table 8-15: Exciting current – Settings (continued)

Option	Description
Start tap	Start tap position of the test
Stop tap	Stop tap position of the test
Correction factors	
Reference voltage	► Tap **ON** to set the reference voltage for the extrapolation of measurement results.

8.7.2 Exciting current – Measurement view

► Tap **Wiring** to display the wiring diagram for this test and vector group.

In the **Measurement** view, the results are displayed in the **Table** or **Plot** view.

► Switch to the **Live** view to monitor the voltage output **V out** during measurement.

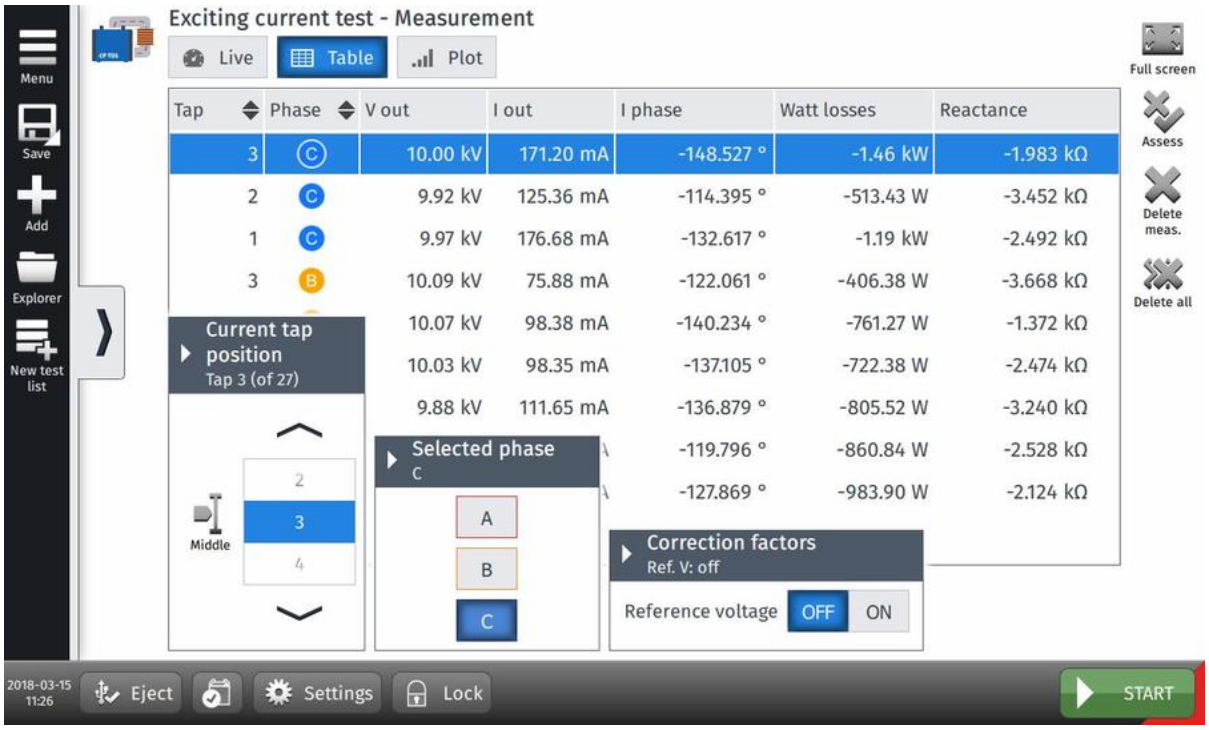


Figure 8-14: Exciting current test – Measurement view

Table 8-16: Exciting current test – Measurement

Option	Description
Tap	Tap under test
Phase	Phase under test ► Refer to the wiring diagram for correct wiring after changing the phase.
V out	Measured output voltage
I out	Measured output current
I phase	Measured primary current per phase
Watt losses	Measured losses
Reactance	Main inductance of the transformer

Table 8-17: Exciting current test – Measurement, table view

Option	Description
Tap	Tap under test
Phase	Phase under test ► Refer to the wiring diagram for correct wiring after changing the phase.
V out	Measured output voltage
I out	Measured output current
I phase	Measured primary current per phase
Watt losses	Measured losses
Reactance	Main inductance of the transformer
Selected phase	
► After rewiring, select the next phase and press **Start**.	
Current tap position	
Middle	 ► Tap to view the middle tap position.
Correction factors	
► Tap **ON** to edit the reference voltage.	

8.8 High voltage turns ratio

The turns ratio is determined during factory acceptance tests and needs to be checked routinely once the transformer is in service. By measuring the ratio and phase angle from one winding to the other, open circuits and shorted turns can be detected.

A low-voltage turns ratio test may not detect a voltage sensitive failure within the transformer. Therefore, for fault investigations, it is recommended that a high-voltage TTR test is performed to apply a higher electrical stress to the insulation system.

8.8.1 High voltage turns ratio – Settings

► Adjust the settings and enter the necessary values for your test.

► Tap **Wiring** to display the wiring diagram for this test and vector group.

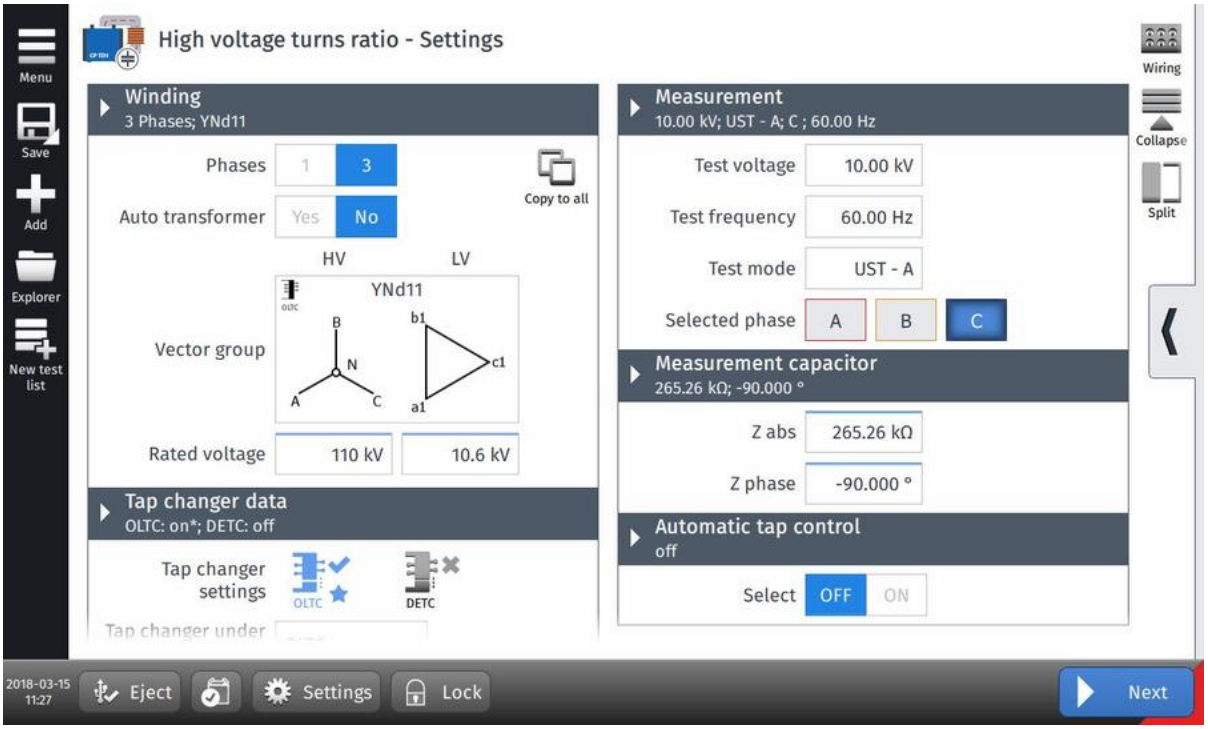


Figure 8-15: High voltage turns ratio test – Settings view

Table 8-18: High voltage turns ratio– Settings

Option	Description
Winding	
Phases	► Set the number of transformer phases.
Auto transformer	► Tap **Yes** if you are testing an auto transformer.
Vector group	► Set the vector group: Tap **Select winding configuration**.
Rated voltage	► Enter the transformer's rated voltage.

Table 8-18: High voltage turns ratio– Settings (continued)

Option	Description
► Tap **Copy to all** to copy the winding and tap changer configuration to all tests that have not yet been executed.	
Tap changer data	
Tap changer settings	► Adjust the tap changer settings by tapping the corresponding icon.
	No tap changer defined
	Tap changer has been defined and will be included in the measurement
Tap changer under test	► Select which tap changer to include in the measurement if both an OLTC and a DETC have been defined. The tap changer under test is marked with a star.
OLTC position	OLTC tap position during tap switching on the DETC
DETC position	DETC tap position during tap switching on the OLTC
Tap changer settings – Define Tap Changer	
► Refer to "Defining a tap changer" on page 41.	
Noise suppression	
Averaging (no. of points)	► Enter the number of measurement points used for averaging.
Bandwidth	► Select the *CP TD1* filter bandwidth from the drop-down list.
Avoid test frequency	If this setting is active, the measurement will *not* be performed at the **Test frequency** set in the **Measurement** section. *TouchControl* will instead measure two values at frequencies below and above the entered **Test frequency** and calculate the median of those two values. The **Avoid test frequency** setting is predefined for the selected test. ► Only change the default setting for special applications.
Device settings	
Shield check	**ON:** The *CP TD1* checks whether the shield of the high-voltage cable is connected.
Beeper	**ON:** The *CP TD1* beeper is on during the measurement.
Measurement	
Test voltage	Output voltage
Test frequency	Output frequency: • IEEE: 60 Hz • IEC: 50 Hz
Test mode	Test mode for this test: UST-A
Selected phase	► After rewiring, select the next phase and press **Start**.
Measurement capacitor	
Z abs	Absolute impedance value

Table 8-18: High voltage turns ratio– Settings (continued)

Option	Description
Z phase	Phase angle of the impedance
Automatic tap control	
► See "Keeping results" on page 53 for more information.	
Select	► Select **ON** to activate the automatic tap control.
Up Down	► If automatic tap control is **ON**, use the **Up** and **Down** buttons in the **Settings** view to switch between the taps and check if your wiring is correct.
Tap time	Time for the change between two tap positions
Impulse time	Duration of the impulse triggering the tap change
Start tap	Start tap position of the test
Stop tap	Stop tap position of the test

8.8.2 High voltage turns ratio – Measurement view

In the **Measurement** view, the results are displayed in the **Table** or **Plot** view.

► Use the **Current tap position** drop-down box to choose the correct label for the currently measured tap.

► Tap the arrows in the table head to sort the results by tap or phase number.

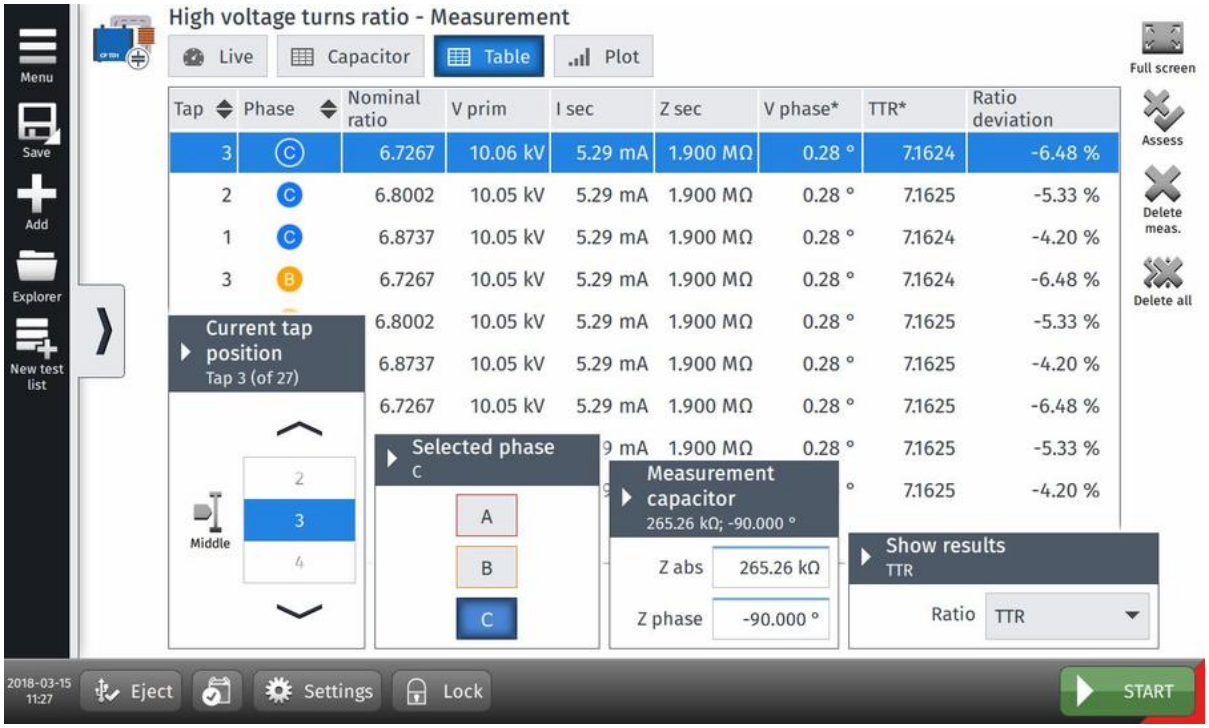


Figure 8-16: High voltage turns ratio test – Measurement view with results

Table 8-19: High voltage turns ratio – Measurement, table view

Option	Description
Tap	Tap under test
Phase	Phase under test
Nominal ratio	Nominal transformer ratio
V prim	Output voltage
I sec	Measured current on the secondary side of the transformer
Z sec	**V prim** divided by **I sec** Used to calculate the turns ratio
V phase	Phase shift between primary and secondary voltage
TTR	Measured transformer turns ratio

Table 8-19: High voltage turns ratio – Measurement, table view (continued)

Option	Description
Ratio deviation	Deviation of the measured ratio from the nominal ratio
Show results	
V phase	► Choose from the drop-down box which value to display in the table.
Ratio	► Choose between TTR (transformer turns ratio) and VTR (voltage ratio) to be displayed in the result table.

Table 8-20: High voltage turns ratio – Measurement, plot view

Option	Description
Plot type	**TTR/VTR**: Transformer/voltage ratio over tap position
	TTR deviation: Ratio deviation over tap position
Filter graph	► Select the phases to be displayed in the graph.
Show results	
V phase	► Choose from the drop-down box which value to display in the table.
Ratio	► Choose between TTR (transformer turns ratio) and VTR (voltage ratio) to be displayed in the result table.

Table 8-21: High voltage turns ratio – Capacitor table

Option	Description
V out	Output voltage
I out	Output current
Z abs	Absolute impedance value
Z phase	Phase angle of the impedance

8.9 Power losses at low voltage

The power losses at low voltage test helps detect open circuits, shorted turns or problems with the transformer core. It is performed during factory acceptance tests and for routine checks on a regular basis to comply with the GOST 3484.1 standard, in countries where it is applicable.

Note: The transformer should always be demagnetized before performing a power losses at low voltage test.
TESTRANO 600 currently only supports the power losses at low voltage test on transformers with vector groups YNd11, Yd11 and YNyn0.

8.9.1 Power losses at low voltage – Settings

► Adjust the settings and enter the necessary values for your test.

► Tap **Wiring** to display the wiring diagram for this test and vector group.

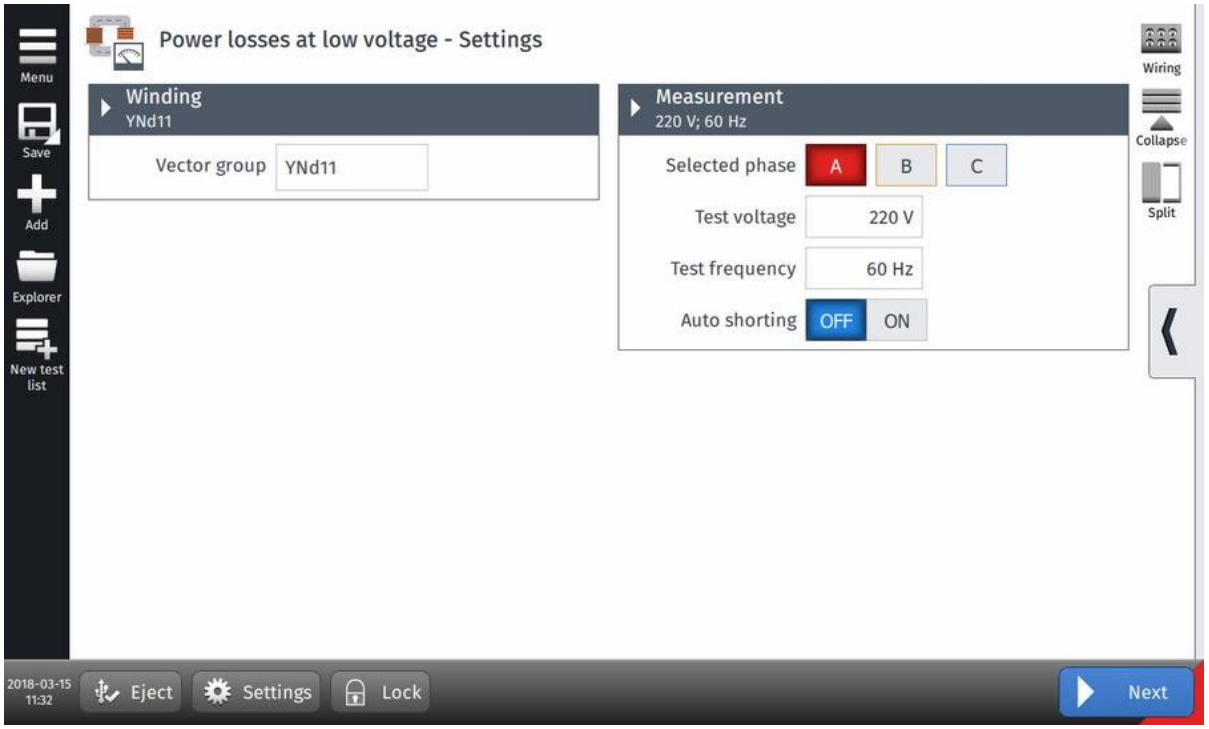


Figure 8-17: Power losses at low voltage test – Settings view

Table 8-22: Power losses at low voltage – Settings

Option	Description
Winding	
Vector group	► Select from vector groups YNd11, Yd11 and YNyn0.

Table 8-22: Power losses at low voltage – Settings (continued)

Option	Description
Measurement	
Selected phase	► After rewiring, select the next phase and press **Start**. Only available if **Auto shorting** is set to **OFF**.
Test voltage	► Enter the output voltage.
Test frequency	► Enter the mains frequency.
Auto shorting	**ON**: Automatic phase switch and short-circuiting of the phases *not* under test **OFF**: Manual phase switching via the **Phase selection** buttons and manual short-circuiting of the phases *not* under test

8.9.2 Power losses at low voltage – Measurement

In the **Measurement** view, the results are displayed in the **Table** or **Plot** view.

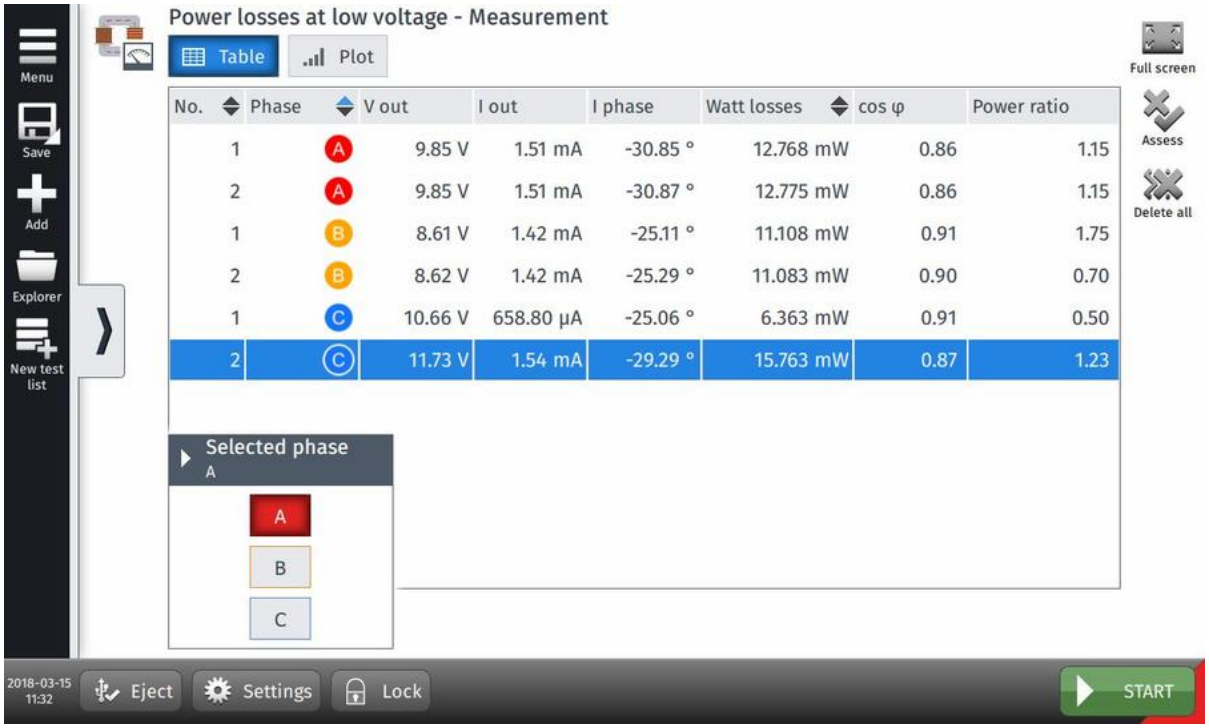


Figure 8-18: Power losses at low voltage test – Measurement view

Table 8-23: Power losses at low voltage – Measurement

Option	Description
Table	
Phase	Phase under test ► Refer to the wiring diagram for correct wiring after changing the phase.
V out	Measured output voltage
I out	Measured output current
I phase	Measured current per phase
Watt losses	Measured losses
cos φ	Power factor
Selected phase	
► After rewiring, select the next phase and press **Start**.	

8.10 Quick

Quick is the most basic mode to operate all of the *TESTRANO 600* outputs in a manual-like mode using *TouchControl*.

8.10.1 Quick – Settings

► Adjust the settings and enter the necessary values for your test.

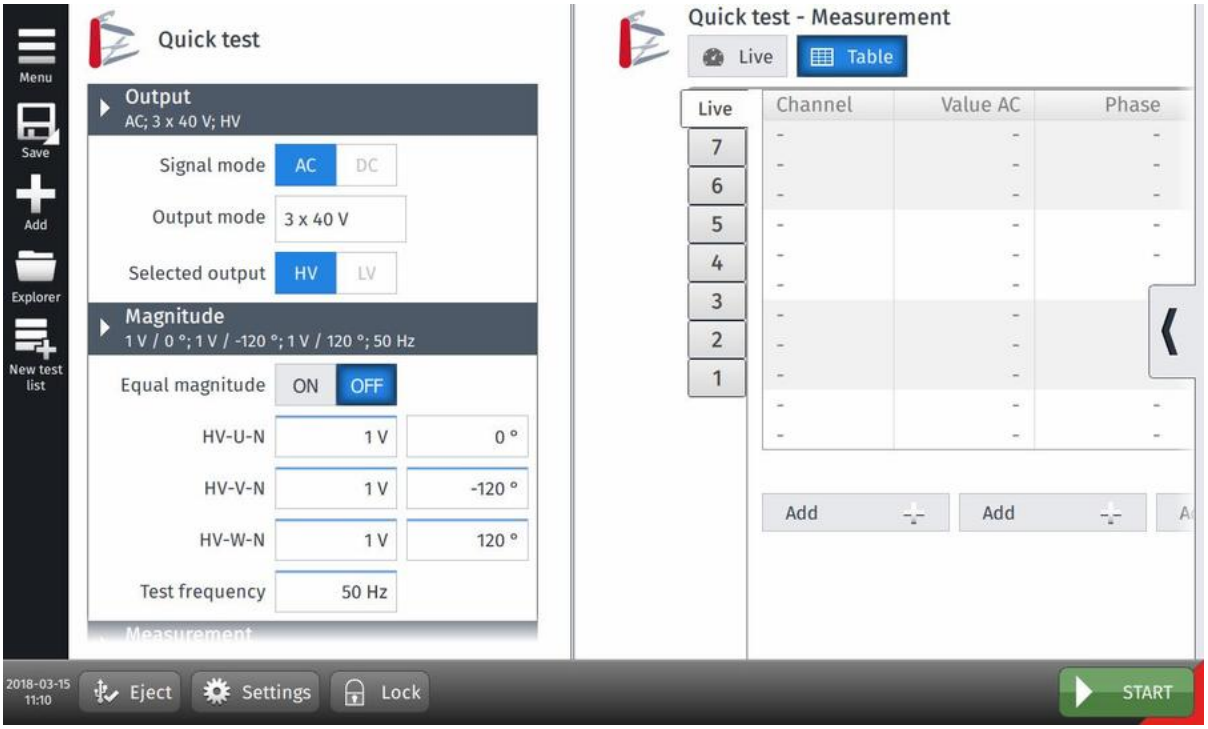


Figure 8-19: Quick test – Settings view

► Enter the **Output** and **Magnitude** data as required.

Table 8-24: Quick test – Settings

Option	Description
Output	
Signal mode	► Set AC or DC as output signal.
Output mode	► Select 1-phase or 3-phase voltage (V) or current (A) control from the drop-down list.
Selected output	► Select the *TESTRANO 600* output: HV (red) or LV (yellow) ► See 3.1.5 "TESTRANO 600 measuring cables" on page 18
Magnitude	
Equal magnitude	► Tap **ON** for magnitude distribution to all three phases (phase shift = 120°)

Table 8-24: Quick test – Settings (continued)

Option	Description
Test frequency	► Enter the mains frequency
Measurement	
Phases	Number of phases
HV/LV	► Choose the cable pair for the measurement. ► Choose between line-to-line (L-L) and line-to-neutral (L-N) voltage.
Result table view	
► Tap ON/OFF to activate/deactivate the corresponding value in the **Result table** in the **Measurement** view.	

8.10.2 Quick – Measurement

- ► Tap **Wiring** to display the wiring diagram for this test and vector group.
- ► To mark a test result for later reference, tap the result's number and press the star icon. Markers will be included in the report file.
- ► Tap **Delete result** to delete the currently open result, and **Delete all** to delete all results saved during this test.

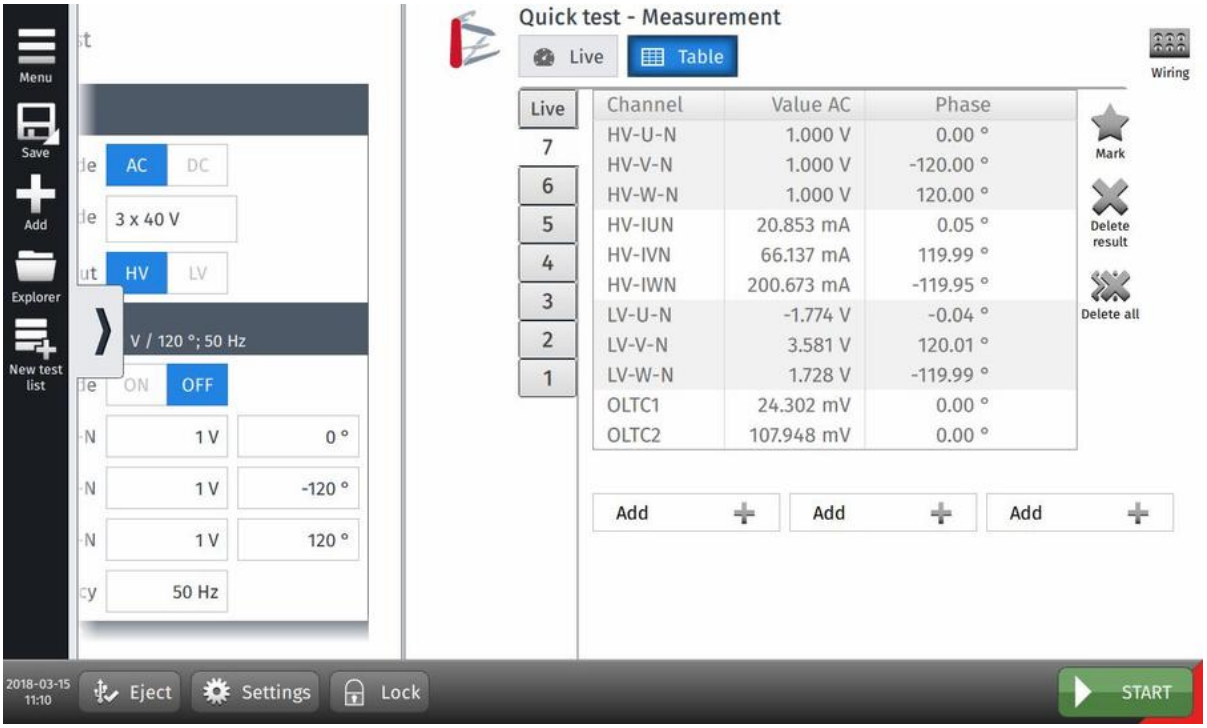


Figure 8-20: Quick test – Measurement, table view

Quick test calculation

- ► In the **Measurement** view, tap **Add** to add up to three calculations based on the measured current, voltage and frequency values.
- ► In the **Quick Test Calculation** view, choose two channels and the **Calculation type** for each calculation.
- ► Tap **Reset calculation** to delete your settings.

8.11 Vector group check

The **Vector group check** comprises a three-phase turns ratio measurement, neutral detection and a series of single-phase measurements to determine the vector group.

8.11.1 Vector group check – Settings

Table 8-25: Vector group check – Settings

Option	Description
Measurement	
Test voltage	Maximum output voltage ► Perform the vector group check using the default value. ► If there is no conclusive result, try increasing the test voltage.
Test frequency	► Enter the mains frequency

8.11.2 Vector group check – Measurement

In the **Measurement** view of the **Vector group check**, you can observe the maximum values applied during the test.

Table 8-26: Vector group check – Measurement

Option	Description
V HV	Voltage on high-voltage side
V LV	Voltage on low-voltage side
I	Measured current on the primary side of the transformer

After the check is completed, *TouchControl* displays the detected vector group(s).

► If there is no conclusive result, try increasing the test voltage.

► Tap the vector group. *TouchControl* then transfers it to the **Settings** view.

You can now determine the **Tap changer data** – see "Defining a tap changer" on page 41.

► Tap **Copy to all** to copy the winding and tap changer configuration to all tests that have not yet been executed.

9 Primary Test Manager

9.1 Introduction

Primary Test Manager is a management tool for testing primary assets such as power transformers, circuit breakers, and current transformers with the OMICRON test systems. *Primary Test Manager* provides a computer interface to the test set, controls the automated test procedures, and facilitates testing of primary assets by guiding you through the test workflow.

Primary Test Manager uses the concept of jobs. A job contains all relevant information about the location, the asset under test, and the tests. With *Primary Test Manager*, you can process jobs as separate entities.

With *Primary Test Manager*, you can create new jobs, manage locations, assets, jobs, and reports, and execute prepared jobs. For a specified job, you can make measurements on the asset under test by just pressing the **Start/Stop** button on the front panel of the *TESTRANO 600* test system. After you have performed a test, you can generate exhaustive test reports. *Primary Test Manager* runs on a computer and communicates with the test set through the Ethernet connection.

9.2 Installing Primary Test Manager

For the minimum requirements your computer needs to run the *Primary Test Manager* software, see 9.5 "Primary Test Manager system requirements" on page 93.

To install *Primary Test Manager*:

1. Connect the computer's Ethernet port to the network connector of *TESTRANO 600* using an Ethernet cable.

   Note: You can operate *Primary Test Manager* without connection to *TESTRANO 600*. The computer running *Primary Test Manager* must be connected to *TESTRANO 600* in order to run tests.
2. Switch on *TESTRANO 600*.
3. Insert the *Primary Test Manager* DVD into the DVD drive of your computer and follow the instructions on the screen.

Note: Upgrade your *TESTRANO 600* during the installation, if necessary.

9.3 Software start and device update

9.3.1 Connecting to TESTRANO 600

► Start *Primary Test Manager* via the Windows Start menu or the desktop icon.

► To connect to *TESTRANO 600*, select the device from the list in the *PTM* **Home** view.

► In *Primary Test Manager* click **Connect** after selecting the device.

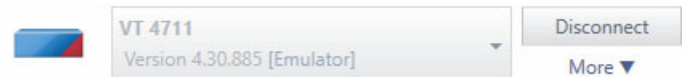


Figure 9-1: Connecting to *TESTRANO 600* via *PTM*

If you were not able to connect to your *TESTRANO 600* and the green light is permanently on, wait a few seconds, then do one of the following:

► Click **More** (under the **Connect** button), then click **Refresh** (or press F5).

If the *TESTRANO 600* device to which you want to connect is not displayed in the list of available devices, proceed as described in "Manual connection to a test system" on page 106.

Alternatively, you can manage the connection to *TESTRANO 600* in the *Primary Test Manager* status bar (see 9.6.2 "Status bar" on page 105).

9.3.2 Updating the TESTRANO 600 embedded software

The *TESTRANO 600* embedded software must be compatible with the *Primary Test Manager* software. You can update the *TESTRANO 600* embedded software by following the steps below:

1. In the *PTM* **Home** view, select the device you want to update from the list.
2. Click **More** beneath the **Connect** button, and then click **Update device software**.
3. In the **Select TESTRANO Upgrade Image** dialog box, double-click the **`embeddedImage.tar`** file.

► Alternatively, select the device you want to update from the list, and then click **Connect**. *Primary Test Manager* will prompt you to update the *TESTRANO 600* embedded software, if necessary.

9.3.3 Upgrading the TESTRANO 600 firmware

After upgrading the *TESTRANO 600* embedded software, you might also need to upgrade the firmware of *TESTRANO 600*. If a firmware upgrade is necessary, a message is displayed on top of the screen.

► To upgrade the *TESTRANO 600* firmware, click **Start firmware update**.

Manual software upgrade

If you encounter any problems when upgrading the *TESTRANO 600* embedded software in the *Primary Test Manager* home view, we recommend using the device browser.

1. Close *Primary Test Manager* if it is running.
2. Double-click the **OMICRON Devices** icon on the desktop.
3. In the **OMICRON Devices** window, right-click the *TESTRANO 600* device you want to upgrade, and then click **Upgrade device** to open the *TESTRANO 600* device website in your default web browser. Your browser will direct you to a website with the IP address of the *TESTRANO 600* device opens.

4. On the navigation bar, click the flag representing the language you want to use.
5. On the navigation bar, click **Upgrade**, and then click **Select file**.
6. In the **Choose File to Upload** window, browse to the upload file. You can find the upload file:
   - On the *Primary Test Manager* DVD at ._EmbeddedSoftware\TESTRANO600\embeddedImage.tar
   - On the hard disk of your computer at C:\Program Files (x86)\Common Files\OMICRON\UpgradeImages\CHIMERA\ embeddedImage.tar
7. On the device website, click **Start upload**.
8. After the upload has finished, *TESTRANO 600* reboots automatically.

   Note: Depending on the browser you are using you may have to wait for up to 30 seconds for a response after pressing **Start upload**. Sometimes a message may appear that the server does not respond. Ignore this message, after a while the upload will start automatically.

9.3.4 Device web interface

On the device website, you can upgrade the device embedded software, get log files, roll back software images, reboot the device and manage license files.

To open the device web interface:

1. In the home view, select the device from the list.
2. Click **More** beneath the **Connect** button, and then click **Open device web interface**.
   A website with the IP address of the device opens in the default web browser.

9.4 Primary Test Manager licensing

Table 9-1: *Primary Test Manager* licenses

License	Description
PTM Standard	Manual control mode with tests according to your *TESTRANO 600* license. Additional 30 testing days with guided workflow according to your *TESTRANO 600* license.
PTM Advanced	Unlimited testing with guided workflow and manual tests according to your *TESTRANO 600* license.

The PTM Advanced license key is on the device.

► For detailed information, contact your OMICRON local sales representative or distributor.

9.5 Primary Test Manager system requirements

Table 9-2: *Primary Test Manager* system requirements

Characteristic	Requirement (*recommended)
Operating system	**Windows 10 64-bit*** **Windows 8.1 64-bit***, **Windows 8 64-bit***, **Windows 7 SP1 64-bit*** and 32-bit
CPU	**Multicore system with 2 GHz or faster***, single-core system with 2 GHz or faster
RAM	min. 4 GB (**8 GB***)
Hard disk	min. 5 GB of available space
Storage device	DVD-ROM drive
Graphics adapter	Super VGA (1280×768) or higher-resolution video adapter and monitor[1]
Interface	Ethernet NIC[2], USB 2.0[3]
Installed software required for the optional Microsoft Office interface functions	**Microsoft Office 2016***, Office 2013, Office 2010, Office 2007

1. We recommend graphics adapter supporting Microsoft DirectX 9.0 or later.
2. For testing with *TESTRANO 600*, *CPC 100* and *CIBANO 500*. NIC = Network Interface Card. *TESTRANO 600*, *CPC 100* and *CIBANO 500* can be connected with RJ-45 connectors either directly to the computer or to the local network, for example, by using an Ethernet hub.
3. For testing with *FRANEO 800*

9.6 Home view

After starting *Primary Test Manager*, the home view opens. In the home view, you can select different user tasks designed to support you during diagnostic testing and management of test objects and test data.

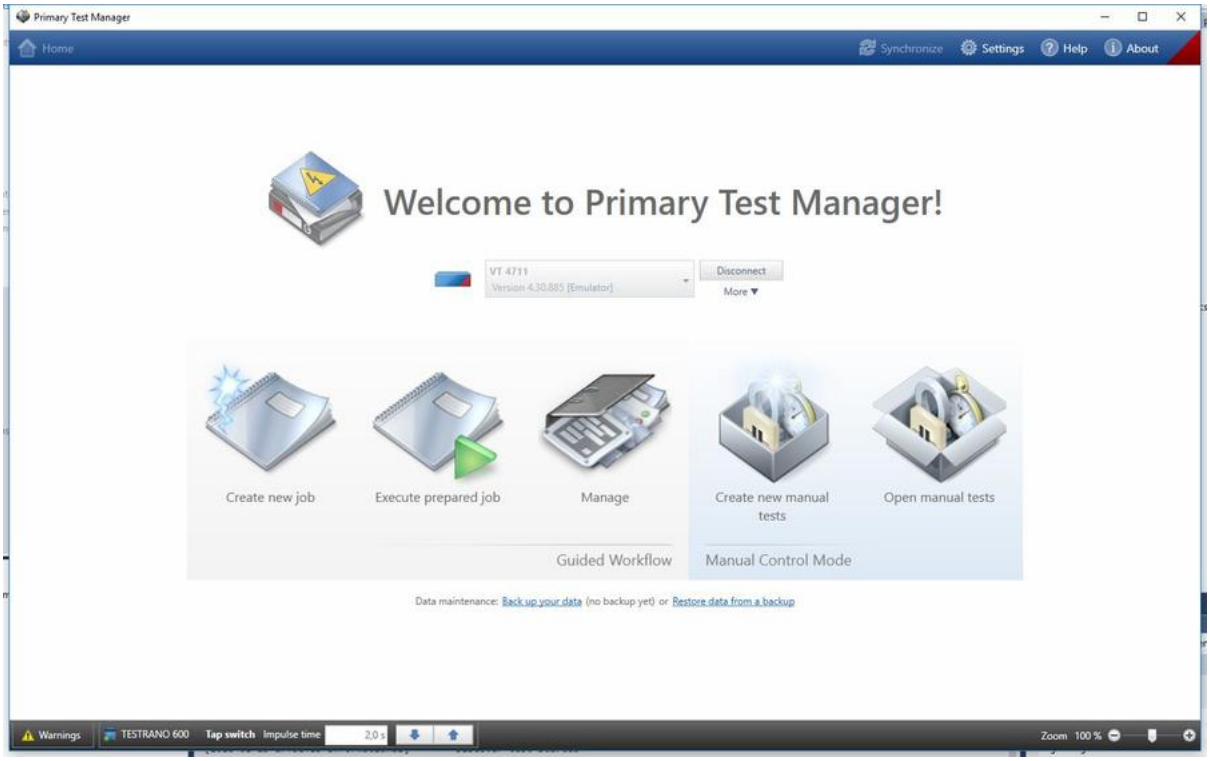


Figure 9-2: *Primary Test Manager* home view

Primary Test Manager processes data of different workflow importance. This is indicated by balloons of different categories as described in the following table.

Table 9-3: Data importance categories

Balloon	Category	Description
	Mandatory	Indicates data required for performing tests.
	Recommended	Indicates data supporting the *Primary Test Manager* workflows.
	Information	Contains descriptive information.

Primary Test Manager supports the following user tasks.

Table 9-4: Selecting the user tasks

Button	Description	Action
	Create new job	Click to start the guided test workflow (see 9.7 "Jobs" on page 110).
	Execute prepared job	Click to execute a prepared job (see 9.7.7 "Execute prepared job" on page 139).
	Manage	Click to open the **Manage** view for locations, assets, jobs, and reports (see 9.8 "Manage objects" on page 144).
	Create new manual tests	Click to create a new manual test (see 9.7.8 "Create new manual tests" on page 140)
	Open manual tests	Click to open a manual test (see 9.7.9 "Open manual tests" on page 141)

9.6.1 Title bar

Note: The title bar is displayed in any *Primary Test Manager* view.

The following table describes the title bar commands.

Table 9-5: Title bar commands

Command	Action
Home	Click **Home** to move from any view to the home view.
Synchronize[1]	Click **Synchronize** to synchronize your local database with the *Primary Test Manager* server database (see 9.6.4 "Data synchronization" on page 107).
Settings	Click **Settings** to open the **Settings** dialog box (see "Settings" later in this chapter).
Help	Click **Help** to open the *TESTRANO 600* technical documentation and send data to OMICRON support (see "Help" on page 103).
About	Click **About** to open the **About Primary Test Manager** dialog box (see "About" on page 104).

1. Only enabled with the appropriate license.

Settings

In the **Settings** dialog box, you can make a number of *Primary Test Manager* settings to match your regional conventions, manage the job templates, and set the *Primary Test Manager* server settings for data synchronization (see 9.6.4 "Data synchronization" on page 107). To open the **Settings** dialog box, click **Settings** in the title bar.

NOTICE

Equipment damage or loss of data possible

Changing the settings in the **Settings** dialog box affects all data in *Primary Test Manager*.

- ► Only change settings if you are qualified to do so.
- ► Review your changes before clicking **OK**.

Note: After changing a setting, you must restart *Primary Test Manager* for the setting to take effect.

General

The **General** tab lists the general settings of *Primary Test Manager*.

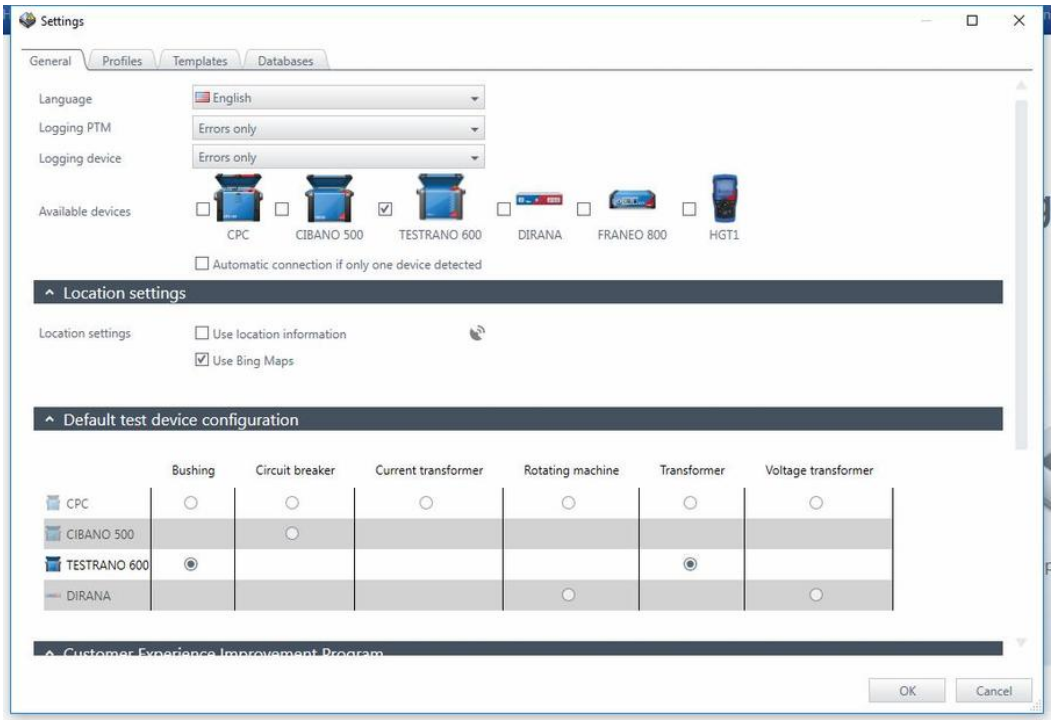


Figure 9-3: **General** tab

► To set the *Primary Test Manager* language, select your preferred language from the **Language** list.

► To set the logging level, select your preferred level from the **Logging PTM** and **Logging Device** lists. The logging function provides information to help find the cause for an error in cooperation with an OMICRON support engineer. **Logging PTM** collects information on PTM while **Logging Device** focuses on your device.

Note: Log files do not contain any information about users or devices.

Table 9-6: Logging levels

Logging level	Description
Disabled	Logging is disabled.
Errors only	Only errors are logged. Recommended setting
Info	Errors and some additional information are logged.
Full	All software-related activities are logged. **Note:** Full logging will slow down software performance.

► To set the types of available devices, select the respective check boxes.

Location settings

In this section you can activate the **Use location information** check box for **Grounding system** tests.

Default test device configuration

In this section *Primary Test Manager* displays the default devices for testing different assets. If more than one device is available for an asset, you can set your preferred test system as default device for that asset.

Note: If no device is connected, *Primary Test Manager* will automatically compile the test list (see section 9.7.5 "Test view" on page 125) for the selected default test set.

Customer Experience Improvement Program

The **CEIP** collects information about how you use *Primary Test Manager* without interrupting you. This helps OMICRON identify which features to improve. No information collected is used to identify or contact you. We encourage you to join the program to help improve *Primary Test Manager*.

Remote control

Certain features of *Primary Test Manager* can be controlled via the *PTMate* app. Complete the steps below to establish the connection between your smartphone and your computer.

1. Activate the **Allow remote control via HTTP** check box in the **Remote control** section of the *PTM* **Settings**. *Primary Test Manager* will establish a Wi-Fi access point.
   - ► If both your smartphone and your computer are already connected to the same Wi-Fi network, proceed to step 2 below.
   - ► If you are *not* connected to a Wi-Fi network, press the **Start Wi-Fi access point** button. *PTM* will attempt to create a Wi-Fi access point and refresh the displayed QR code.

   Note: If your computer does not support ad hoc Wi-Fi access point creation, you can use an external Wi-Fi device supporting this functionality or create a hotspot on your smartphone. Be aware that using a smartphone hotspot can lead to additional costs.
2. Open the *PTMate* app on your smartphone, go to **Settings** and scan the QR code displayed in the **Remote control** section in *PTM*.

Primary Test Manager displays status icons in the bottom bar:

 Number of active remote connections

 Active Wi-Fi access point

 Active remote control

Profiles

In the **Profiles** tab, you can set your profile, the default rated frequency, the loss index, the units of your own profiles, and make the test system settings.

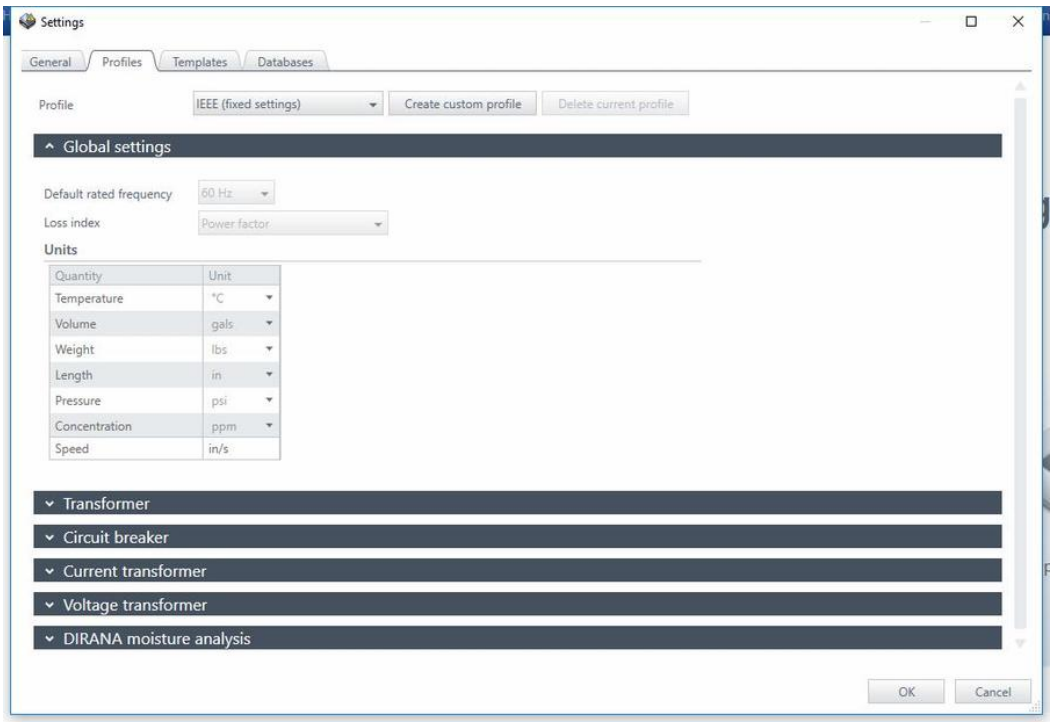


Figure 9-4: **Profiles** tab

With *Primary Test Manager*, you can use predefined profiles and create your own profiles for naming conventions.

Note: *Primary Test Manager* sets the default profile according to the regional settings of your computer.

► To set a profile, select the profile you want to use from the **Profiles** list.

To create your own profile:

1. Click **Create custom profile**.
2. In the **Create custom profile** dialog box, type the profile name, and then click **Create**.
3. Under **Global settings**, set the default rated frequency, the loss index, and your preferred units.

Profiles: Transformer

4. Under **Transformer**, set the transformer terminal name schemes and preferences such as the names of some tests, the oil measure, and the short-circuit impedance abbreviation.

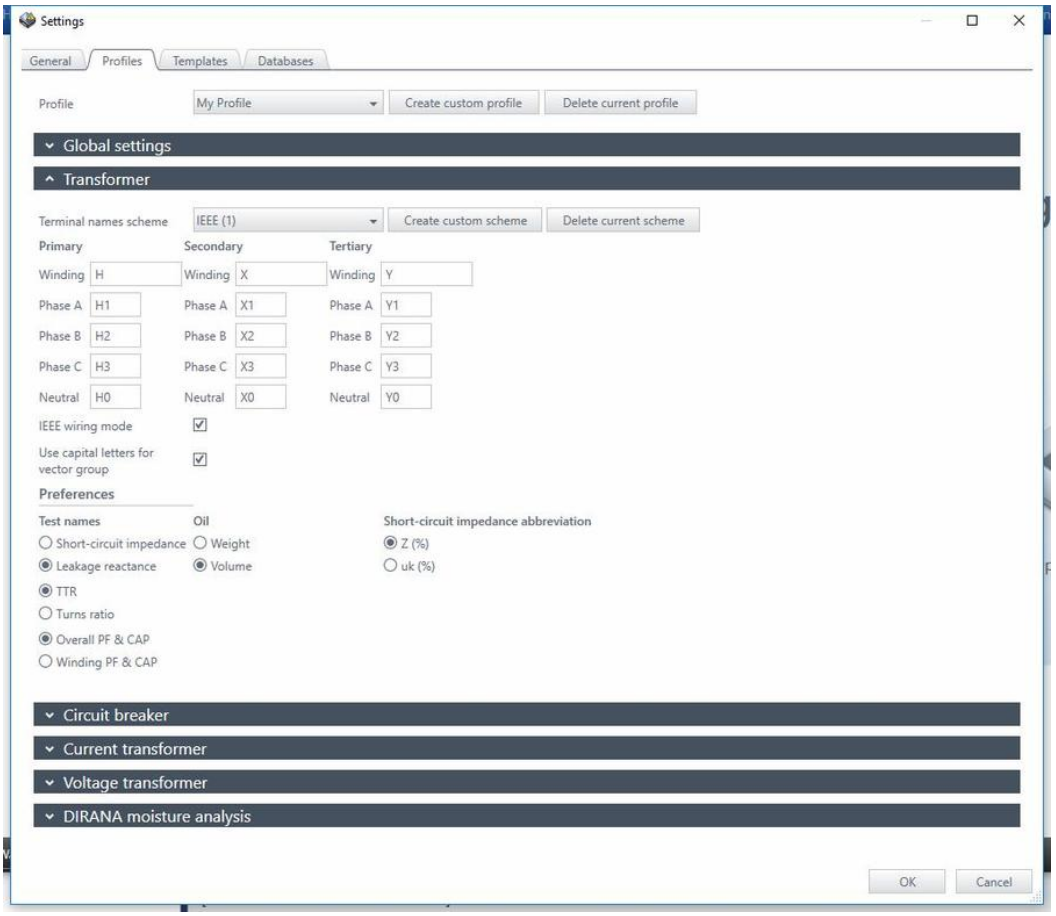


Figure 9-5: **Profiles** tab: **Transformer**

With *Primary Test Manager*, you can use predefined transformer naming conventions according to the established standards and create your own terminal name schemes.

► To set a terminal names scheme, select the scheme you want to use from the **Terminal names scheme** list.

To create your own terminal names scheme:

1. Click **Create custom scheme**.
2. In the **Enter scheme name** dialog box, type the scheme name.
3. Set the transformer terminal names, scheme options, and preferences.

► To delete your own terminal name scheme, select the scheme from the **Terminal names scheme** list, and then click **Delete current scheme**.

Templates

In the **Templates** tab, you can edit, import and export job templates for transformers.

► For information on how to process the templates, see "Processing templates" on page 133.

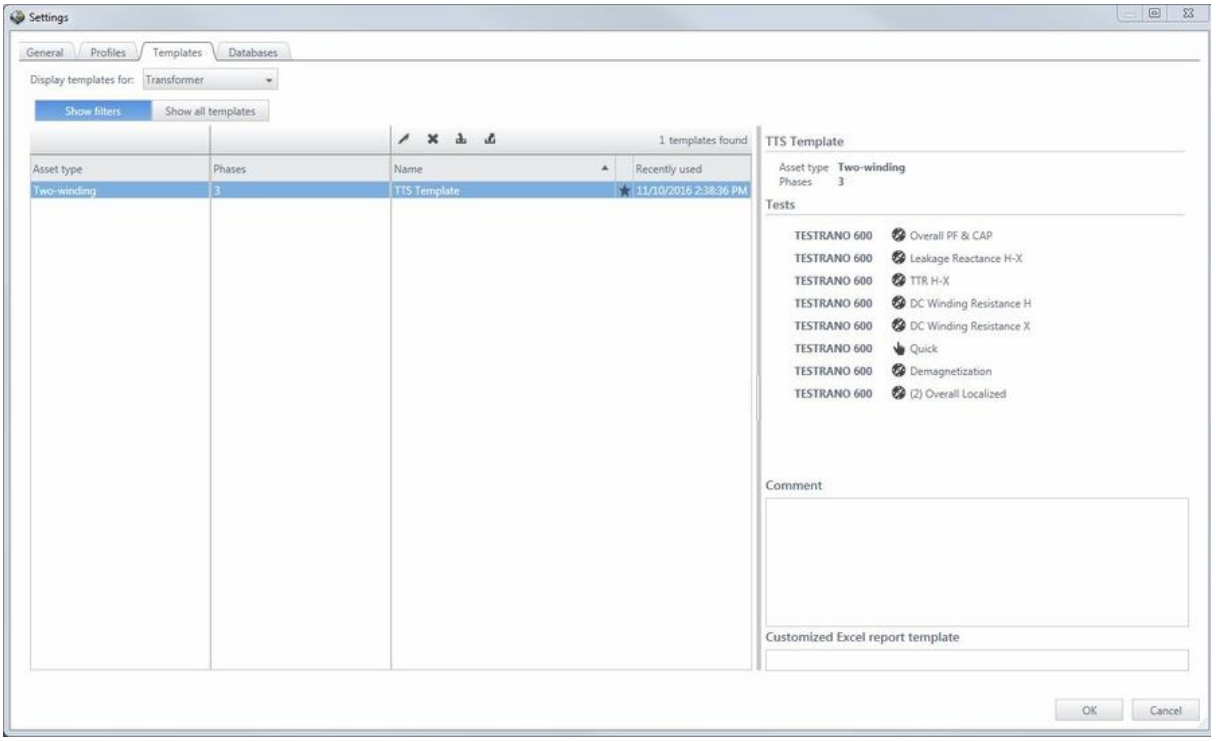


Figure 9-6: **Templates** tab

The right pane of the template workspace displays the template preview.

To manage the job templates, select **Transformer** from the **Display templates for** list, and then do one of the following:

► To assign a template to a different asset type or a phase group, or to edit template properties (name, comment), click the respective **Edit** button.

► Press the **Delete** button to delete templates from the **Asset type** or **Phases** list.

► To export a template, select the template, and click the **Export** button.

► To import a template, click the **Import** button, then browse to the template you want to import.

► To set a template as favorite, click the star icon .

Note: All future test lists with the same asset and number of phases will by default be loaded with the tests defined in this favorite template.

Databases

In the **Databases** tab you can create, manage and switch between different databases for *Primary Test Manager*. Under **Properties**, you can adjust the server settings for *DataSync*. For more information, see "Server settings" on page 108.

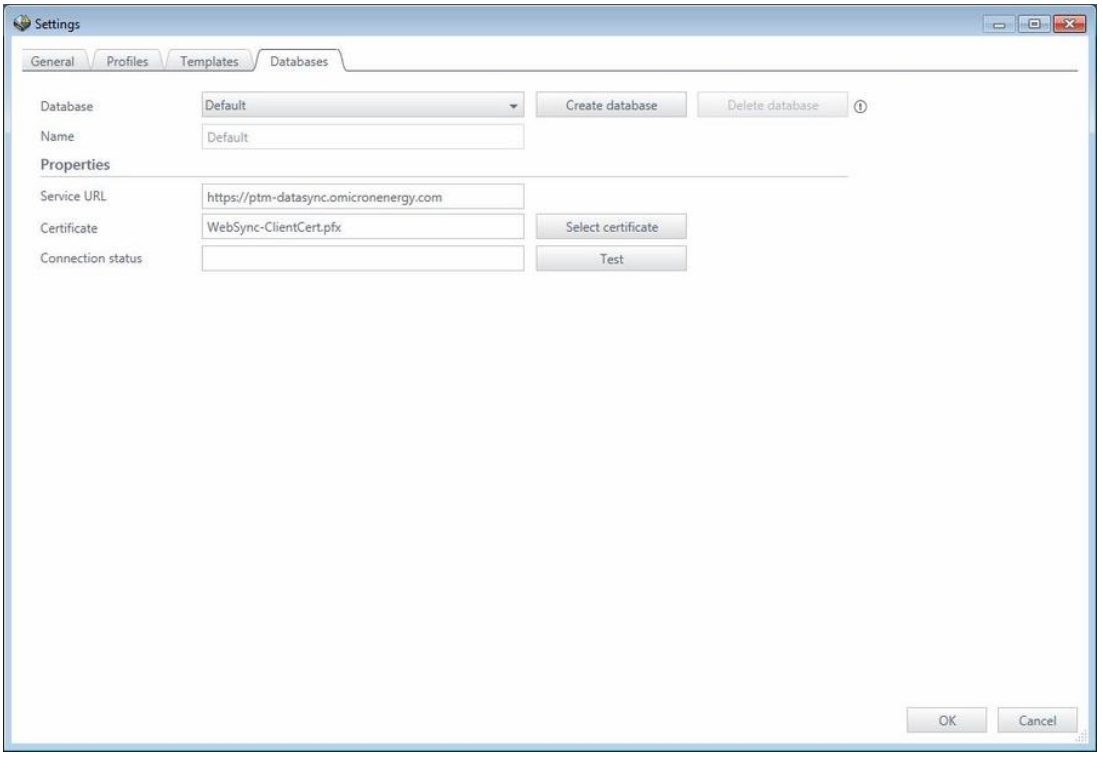


Figure 9-7: **Databases** tab

Help

In the **Help** dialog box, you can get the relevant information about *TESTRANO 600* and data synchronization, and send data to OMICRON technical support. To open the **Help** dialog box, click **Help** in the title bar.

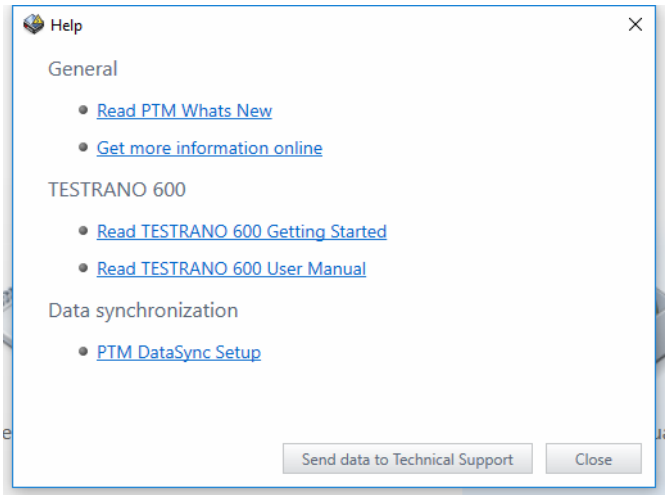


Figure 9-8: **Help** dialog box

About

In the **About Primary Test Manager** dialog box, you can enter license keys to upgrade your *Primary Test Manager* and enhance its functionality by installing additional features. To open the **About Primary Test Manager** dialog box, click **About** in the title bar.

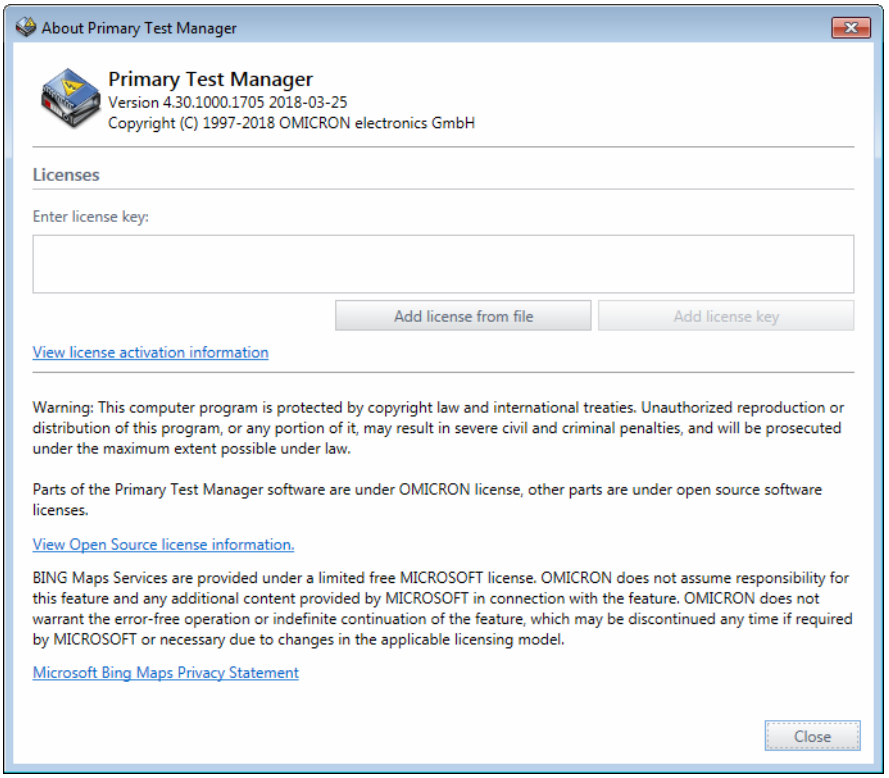


Figure 9-9: **About Primary Test Manager** dialog box

To activate a license:

1. Enter the license key in the **About Primary Test Manager** dialog box, and then click **Add license key**.
   The **About Primary Test Manager** dialog box displays the available licenses and a new **Enter license key** box.
2. Repeat step 1 for all license keys you want to enter.

Alternatively, you can enter license keys from files. To a enter a license key from a file, click **Add license from file**, and then browse to the file containing the license you want to add.

For detailed information about the *Primary Test Manager* licensing, contact your OMICRON local sales representative or distributor.

9.6.2 Status bar

Note: The status bar is displayed in any *Primary Test Manager* view.

The status bar displays information about the status of the test system and provides access to the zoom function.

Table 9-7: Test system icons

Icon	Connected device
	*TESTRANO 600*
	*CP TD1*

In the status bar, you can connect to and disconnect from a test system, and show and refresh the test set information.

Connecting to a test system

To connect to a test system:

1. Right-click the *TESTRANO 600* icon in the status bar, and then click **Connect**.

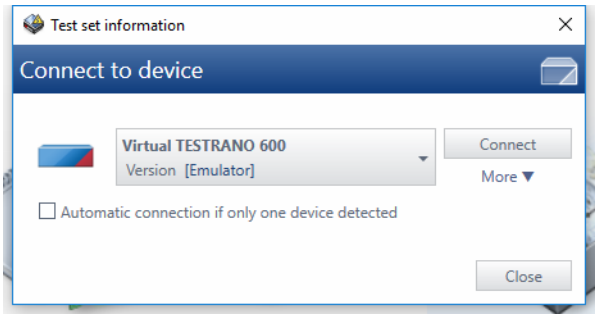


Figure 9-10: **Connect to device** dialog box

2. In the **Connect to device** dialog box, select the test system from the list, and then click **Connect**.

If you could not connect to your *TESTRANO 600* device and the green light is permanently on, wait a few seconds, and then proceed as follows:

1. Click **More** beneath the **Connect** button.
2. Click **Refresh**.
3. In the **Connect to device** dialog box, select the test system from the list, and then click **Connect**.

After you have connected to the test system, the following dialog box appears.

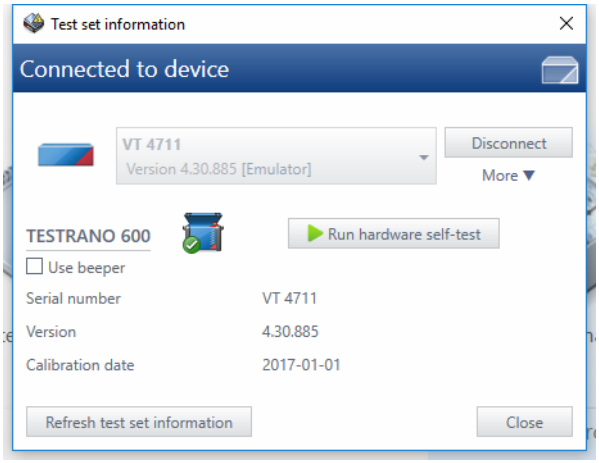


Figure 9-11: **Connected to device** dialog box

After you have connected to a test system, right-click the *TESTRANO 600* icon in the status bar, then do one of the following:

► To disconnect from a test system, click **Disconnect**.

► To display information about the connected test system, click **Show test set information**.

► To update the test set information, click **Refresh test set information**.

Note: You can open the **Connect to device** and the **Connected to device** dialog boxes also by double-clicking the *TESTRANO 600* icon.

Device self-test

If *Primary Test Manager* repeatedly displays a hardware error message, we recommend performing a device self-test. The self-test checks functionality of the *TESTRANO 600* hardware components.

► If the self-test passes but the error messages persist, check the wiring.

Note: During the self-test, the **Emergency Stop** button must be released.

Manual connection to a test system

If you encounter any problems when connecting to *TESTRANO 600* we recommend turning off any wireless adapter and VPN software on your computer.

If the *TESTRANO 600* device to which you want to connect is not displayed in the list of available devices, proceed as follows:

1. Click the **Start OMICRON Device Browser** button .
2. In the **OMICRON Device Browser** window, look for the device you want to connect to and read its IP address.
3. In the home view, click **More** beneath the **Connect** button, then click **Add device manually**.
4. In the **Add Device Manually** dialog box, type the IP address of the device you want to connect to.
5. Click **Connect**.

If you assigned a static IP address to the device, you can try to connect as follows:

1. In the **Add Device Manually** dialog box, select the **Direct connection** check box.

2. In the **Host or IP** box, type *tts://a.b.c.d*, where *a.b.c.d* is the static IP address of the device.

9.6.3 Data backup and restoring

We strongly recommend backing up your data in the *Primary Test Manager* database on a regular basis. *Primary Test Manager* reminds you to back up the data periodically by prompting you to save the data in your preferred location. The *Primary Test Manager* data is backed up in DBPTM format.

To back up the data without the *Primary Test Manager* prompt:

1. In the home view, click **Back up your data**.

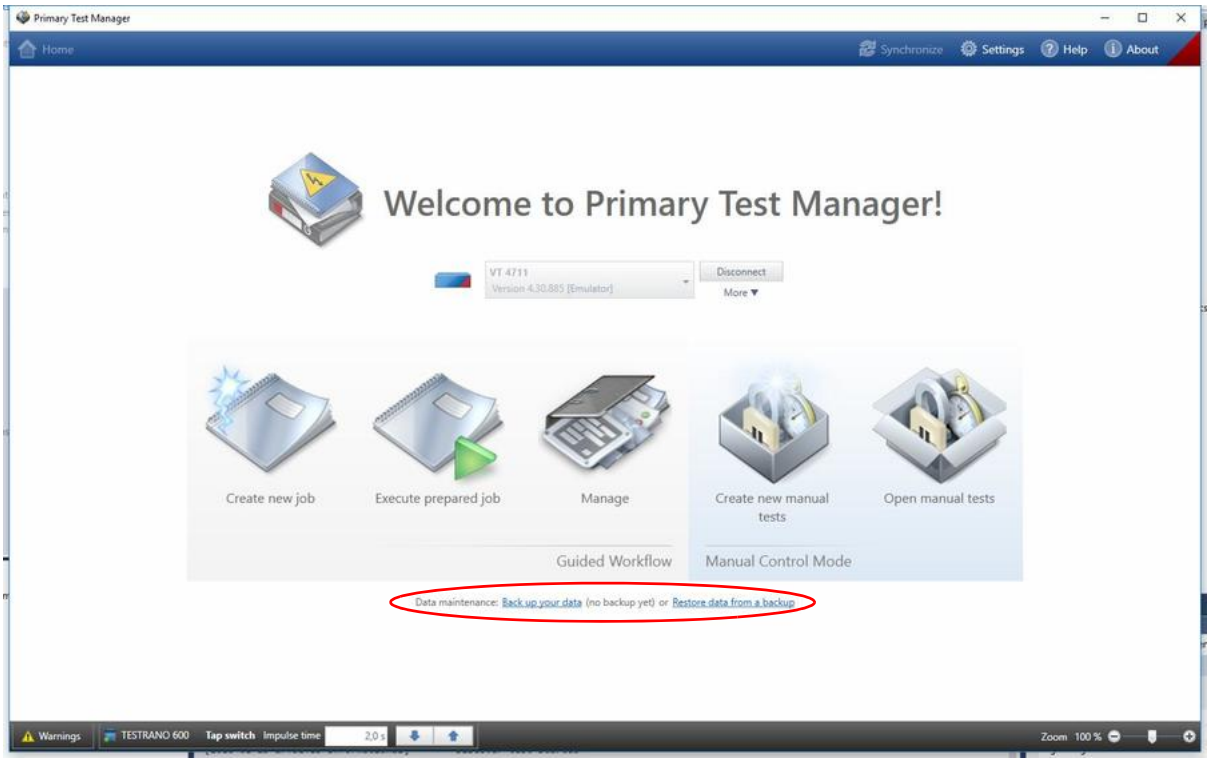


Figure 9-12: *Primary Test Manager* home view

2. Save the data in your preferred location.

To restore the data:

1. In the home view, click **Restore data from a backup**.
2. Browse to the file you want to restore.

9.6.4 Data synchronization

Primary Test Manager comes with the client/server architecture. With this feature, you can synchronize your local database with the *Primary Test Manager* server database.

Note: To synchronize your data, you need a license. To get the license, contact your regional OMICRON Service Center or sales partner. You can find our Service Center or sales partner closest to you at www.omicronenergy.com.

The data synchronization is partial data replication based on subscriptions, that is, all local data is synchronized with the server database and selected data on the server is synchronized with the local database.

Server settings

Before synchronizing the *Primary Test Manager* databases for the first time, you need to set the server settings.

1. In the title bar, click **Settings** and select the **Databases** tab.
   The next step depends on the data synchronization method you use: *DataSync* via web server or *DataSync* on premises.

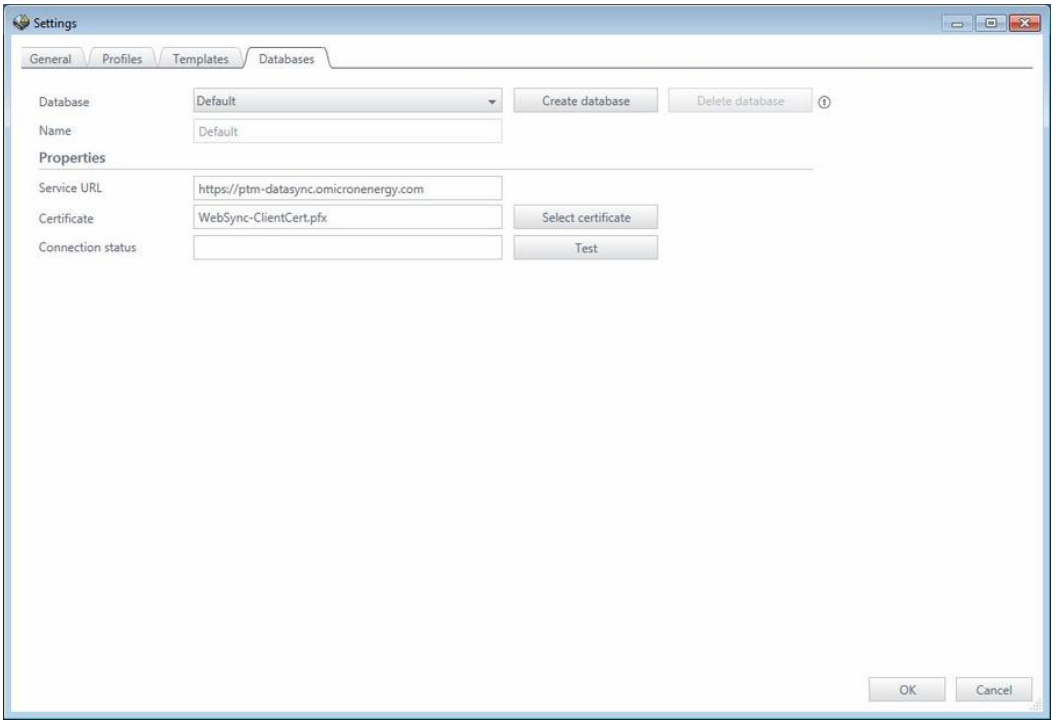


Figure 9-13: Server settings for *DataSync*

Server settings profiles

You can create server settings profiles in order to use different data bases for testing and switch between them.

► Use the corresponding buttons next to the **Profile** drop-down box to create, edit or delete a profile.

► To switch to a different profile, select one from the drop-down list and click **Set as active**.

Managing subscriptions

You can select data on the server which you want to synchronize with your local data by managing subscriptions. To manage subscriptions:

1. In the home view (see Figure 9-2: "Primary Test Manager home view" on page 94), click the **Manage** button .

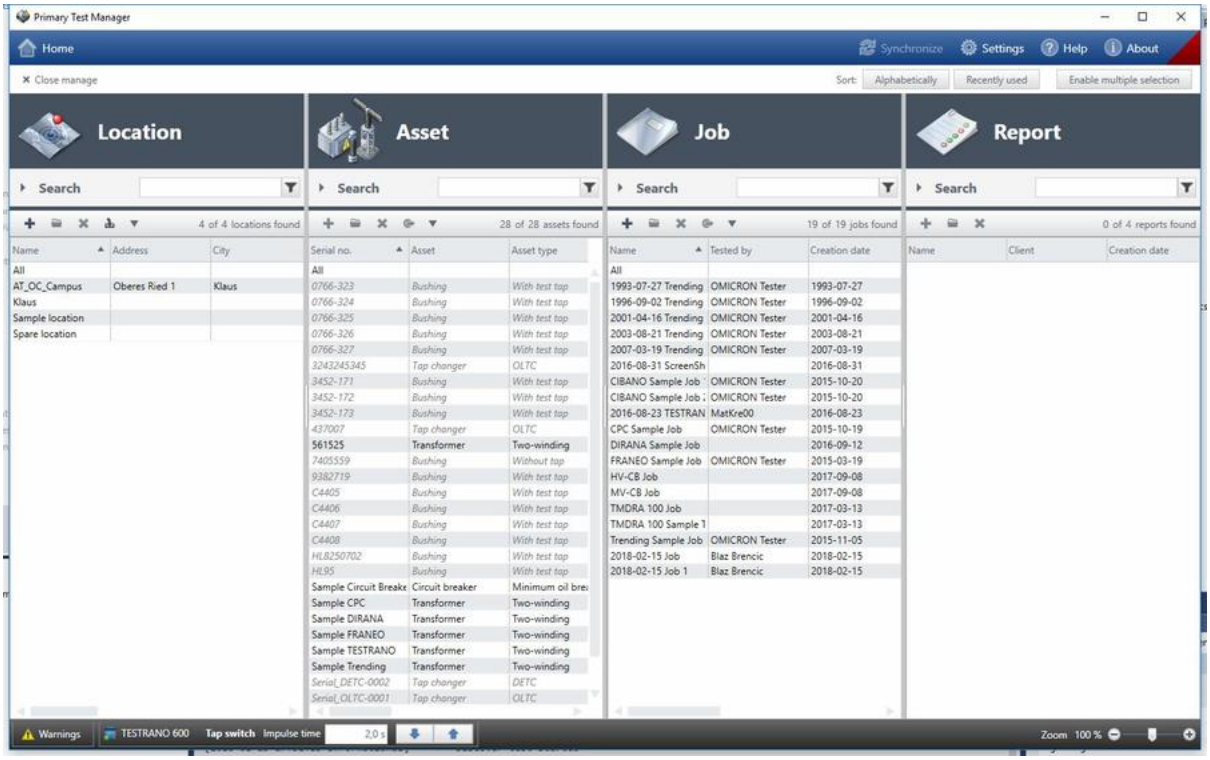


Figure 9-14: Manage view

2. In the manage view, click **Manage subscriptions** on the top of the workspace.
3. In the **Subscriptions** dialog box, select the data on the server you want to synchronize with your local data.

You can synchronize the data anytime.

► To synchronize the data, click **Synchronize** in the title bar.
After that, *Primary Test Manager* shows the synchronization progress.

Database synchronization

► To synchronize the local *Primary Test Manager* database with the server database, click **Synchronize** in the title bar of the **Manage** view.
Primary Test Manager then displays the synchronization progress.

Note: You can synchronize databases at any time, as long as a connection to the server database is available.

When the database synchronization is complete, the locations, assets, and jobs (objects) newly added to the local database are marked with blue dots in the manage view. You can sort the objects by this column. As soon as you open an object, its blue dot is removed. All blue dots are removed when you perform another database synchronization.

9.7 Jobs

When creating a new job, *Primary Test Manager* leads you through the guided test workflow.

► To open the create new job view, click the **Create new job** button  in the home view.

A job contains all relevant information about the location, the asset under test, and the tests. With *Primary Test Manager*, you can process jobs as separate entities. During the guided test workflow, the job status displayed in the left pane of the create new job view changes. The following table describes the job statuses.

Table 9-8: Job statuses

Status	Description
New	Location has been defined.
Prepared	Asset has been defined.
Partially executed	At least one measurement has been executed.
Executed	All tests of the job have been executed.
Approved	Job has been approved.

9.7.1 Guided test workflow

The guided test workflow leads you through the following steps:

1. Enter the job data (see 9.7.2 "Job overview" on page 112).
2. Specify the location (see 9.7.3 "Location view" on page 114).
3. Specify the asset (see 9.7.4 "Asset view" on page 116).
4. Specify and perform the tests (see 9.7.5 "Test view" on page 125).
5. Generate the test reports (see 9.7.10 "Test reports" on page 142).

To navigate through the test workflow, click the navigation buttons in the left pane of the create new job view.

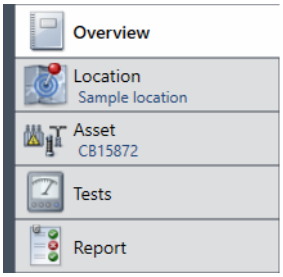


Figure 9-15: Navigation buttons

Note: You can interrupt the test workflow and return to any view at any time by clicking the corresponding navigation button.

By using the commands on the menu bar, you can process jobs. The following table describes the available operations.

Table 9-9: Operations on the jobs

Command	Action
Close	Closes a job displayed in the create new job view and leads you back to home or manage view respectively.
Save job	Saves the job displayed in the create new job view.
Copy test	Adds another test of the same kind and with the same settings to the test list. Results are not copied.
Take screenshot	Takes screenshot of the selected area of the *Primary Test Manager* workspace. The screenshot appears as attachment in the General area and can be attached to the test report (see 9.7.10 "Test reports" on page 142).

For more information about operations on the jobs, see 9.8 "Manage objects" on page 144.

9.7.2 Job overview

In the job overview of the create new job view, you can enter the job data (see Table 9-10: "Job data" on page 112). In the course of the guided test workflow, *Primary Test Manager* sets also some basic location, asset, and test data. To open the job overview, click the **Create new job** button in the home view.

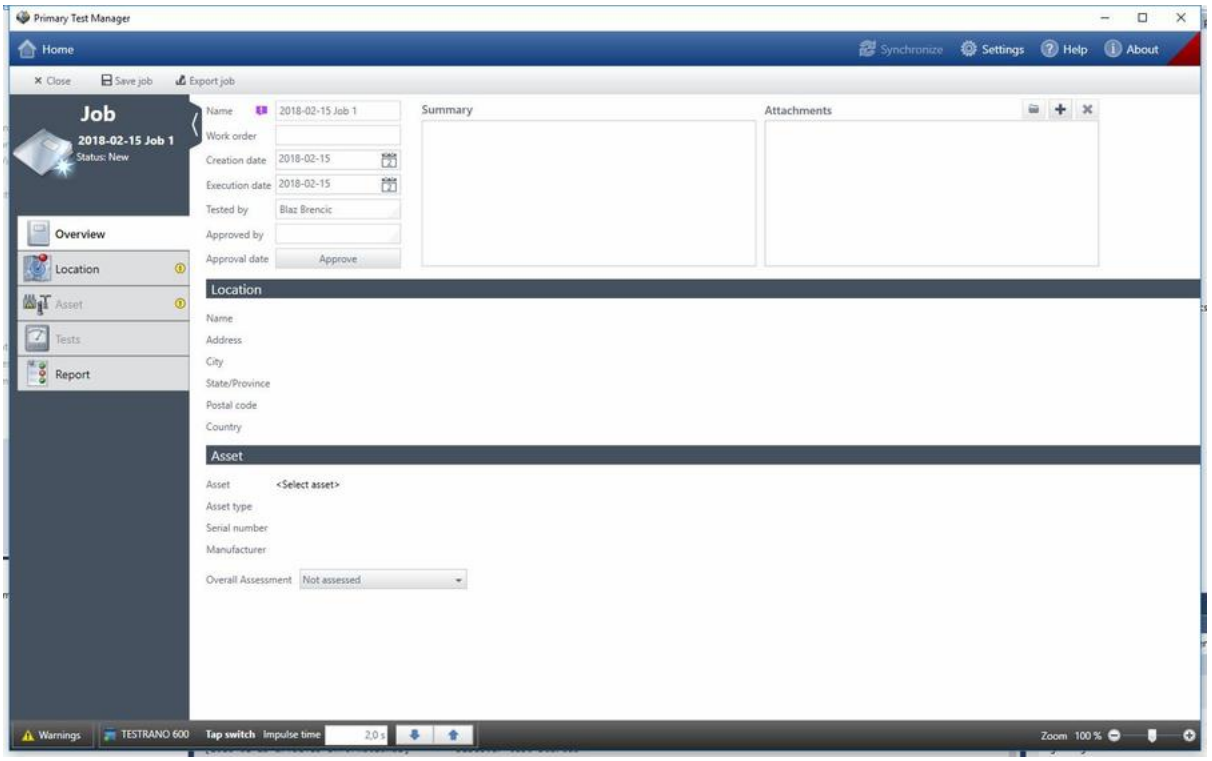


Figure 9-16: Job overview

Job data

The following table describes the job data.

Table 9-10: Job data

Data	Description
Name/WO[1]	Name of the job or work order (by default generated by *Primary Test Manager*)
Creation date	Date the job was created
Execution date	Date the job was executed
Tested by	Person who performed the test
Approved by	Person who approved the test
Approval date	Date the job was approved (see "Approving jobs" later in this section)

1. Mandatory data

Approving jobs

If the job data displayed in the job overview has been approved, you can set the approval date of the job. To set the job approval date, click **Approve**.

Note: After approving a job, some settings cannot be edited anymore.

Assessment summary

In the Tests area of the job overview, the **Result state** and **Assessment** status of test results are displayed.

► Use the **Overall Assessment** combo box to manually characterize the asset's condition for reporting purposes.

Table 9-11: Assessment statuses in the job overview

Status	Description
Fail	The status was automatically set to *Fail* by *Primary Test Manager*.
Manual fail	The status was manually set to *Fail*.
Investigate	The status was automatically set to *Investigate* by *Primary Test Manager*.
Manual investigate	The status was manually set to *Investigate*.
Pass	The status was automatically set to *Pass* by *Primary Test Manager*.
Partial pass	Some measurements have not been assessed.
Manual pass	The status was manually set to *Pass*.
Manual partial pass	Some measurements have not been assessed and at least one assessment status was changed manually.
Not assessed	The measurement has not been assessed.
Not rated	The status was automatically set to *Not Rated* by *Primary Test Manager*.

Managing attachments

Under **Attachments**, you can manage attachments to the job overview.

To add an attachment to the job overview:

1. Click the **Add** button ➕.
2. In the **Select Files** dialog box, browse to the file you want to attach to the job overview.

To open an attachment, do one of the following:

► Select the attachment, and then click the **Open** button 🗀.

► Double click the attachment.

To delete an attachment from the job overview:

1. Select the attachment you want to delete.
2. Click the **Remove** button ✖.

9.7.3 Location view

In the location view of the create new job view, you can specify locations. To open the location view, click the **Location** navigation button  .

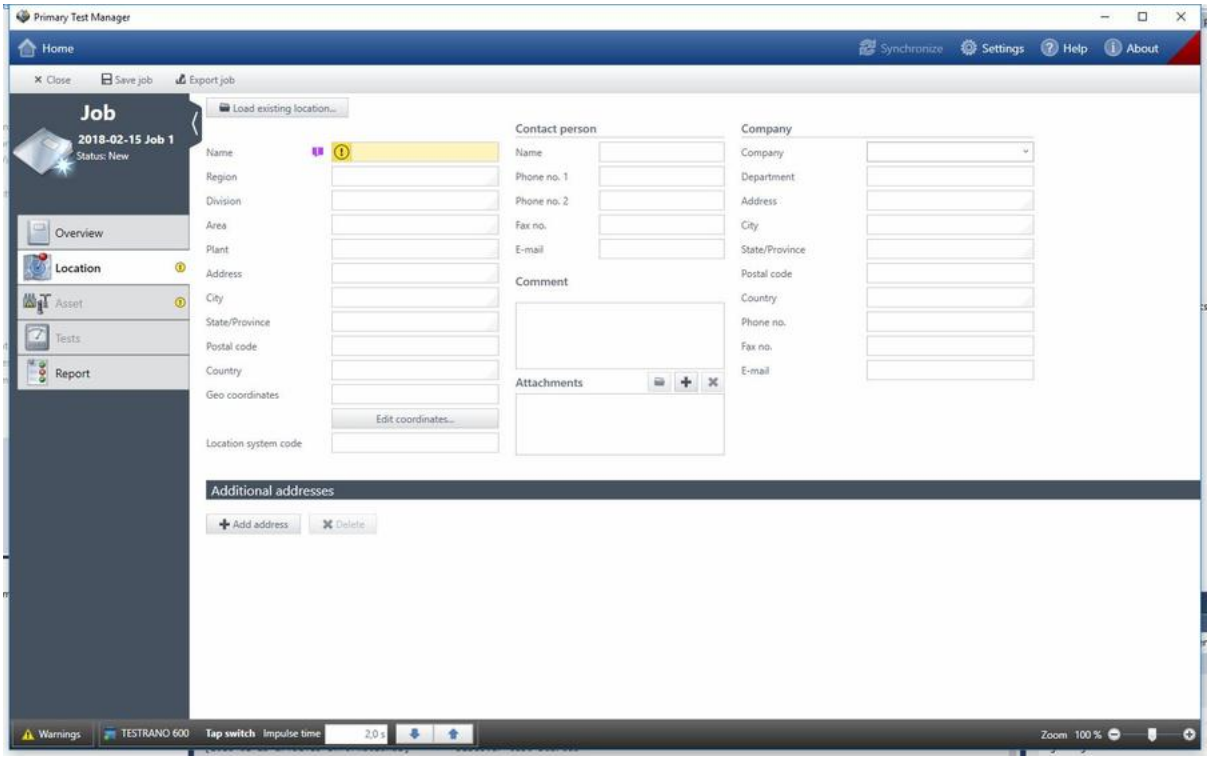


Figure 9-17: Location view

To specify a location, do one of the following:

► Enter the location data.

Note: If you enter location or asset data for a prepared job that differ from those of the master location or master asset, a notification bar will be displayed. In this case, choose between the following options:

- ► To import the previously defined location or asset data to this job, click **Import from master location** or **Import from master asset** in the notification bar.
- ► To update the previously defined location or asset data with the data you have entered for this job, click **Update master location** or **Update master asset** in the notification bar.
- ► For more information on operations on the jobs, see 9.8 "Manage objects" on page 144.

► To load the location data available in *Primary Test Manager*, click **Load existing location**, and then select the location you want to load in the **Select Location** dialog box.

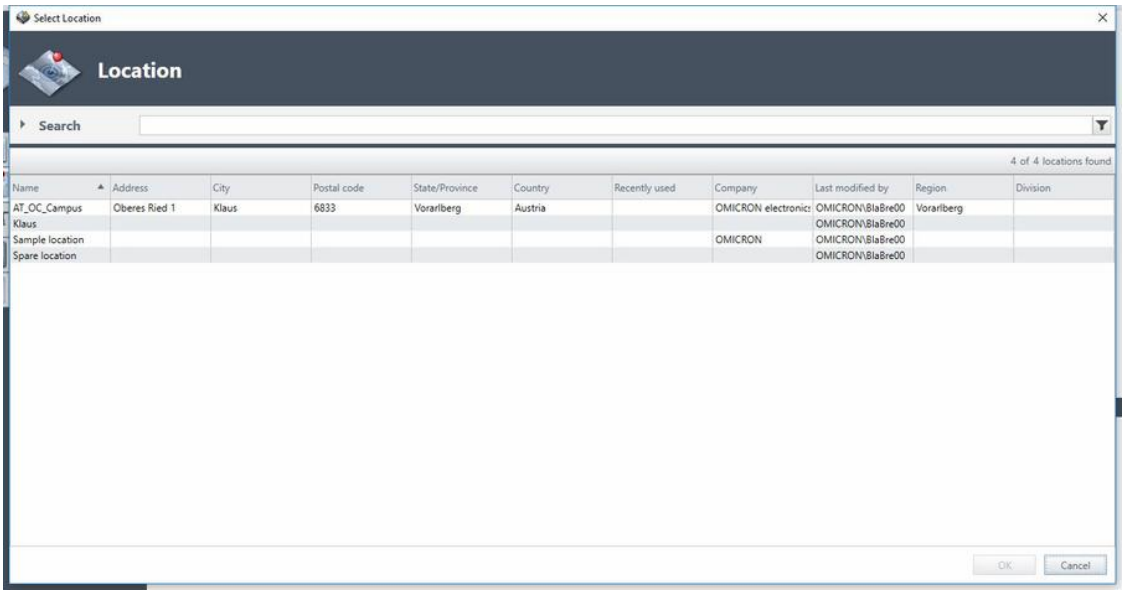


Figure 9-18: **Select Location** dialog box

In the **Select Location** dialog box, you can search for locations (see "Search for objects" on page 145).

In the location view, you can enter addresses of, for example, a client, owner or utility.

► To enter additional addresses, click **Add address** under **Additional addresses**.

Setting the geo coordinates

To set the geo coordinates of a location:

1. In the location view, click **Edit coordinates**.

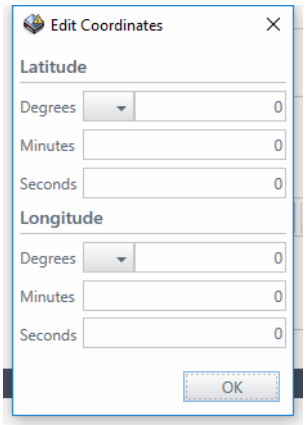


Figure 9-19: **Edit Coordinates** dialog box

2. In the **Edit Coordinates** dialog box, enter the latitude and longitude of the location.

Managing attachments

Under **Attachments**, you can manage attachments to locations.

To add an attachment to a location:

1. Click the **Add** button ➕.
2. In the **Select Files** dialog box, browse to the file you want to attach to the location.

To open an attachment, do one of the following:

► Select the attachment, and then click the **Open** button 🗁.

► Double click the attachment.

To delete an attachment from a location:

1. Select the attachment you want to delete.
2. Click the **Remove** button ✖.

9.7.4 Asset view

In the asset view of the create new job view, you can specify assets. To open the asset view, click the **Asset** navigation button .

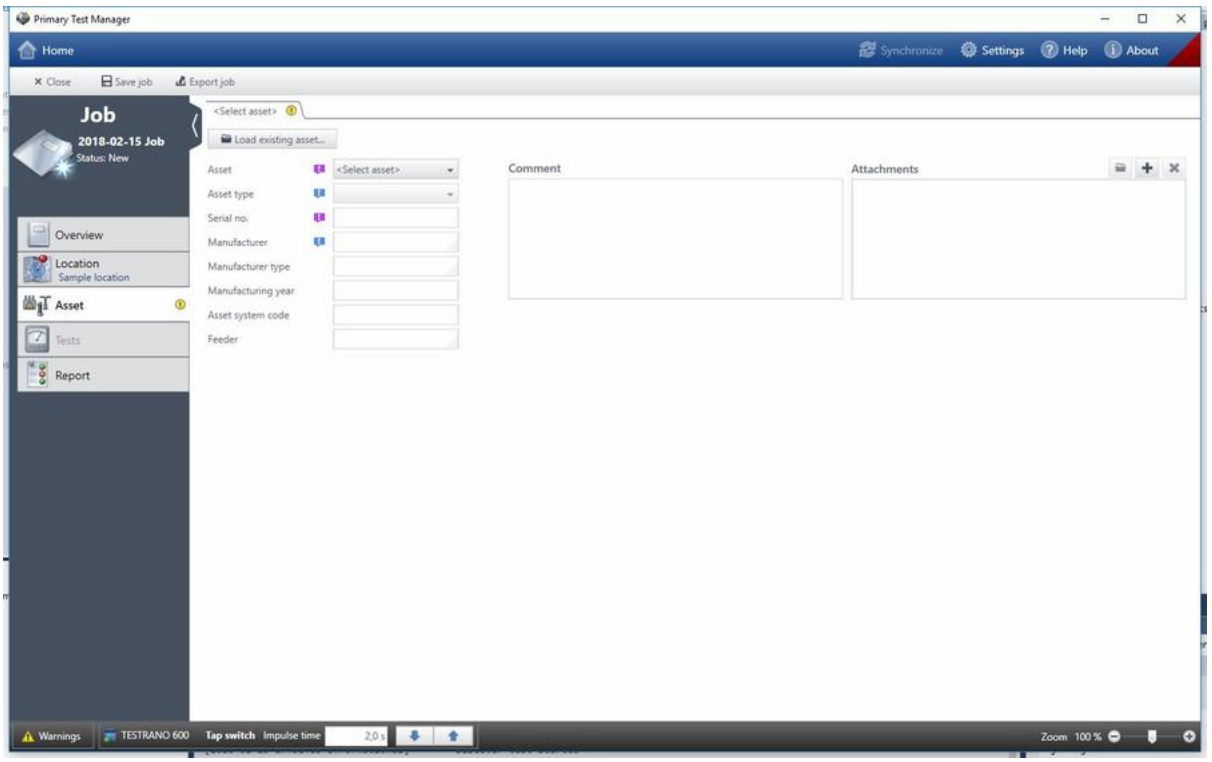


Figure 9-20: Asset view

The asset view depends on the asset you want to specify with *Primary Test Manager*. To specify an asset, do one of the following:

► Enter the asset data. The asset data includes the general asset data common to all assets (see "General asset data" on page 118 and the asset-specific data described in chapter 11 "PTM Asset data" on page 152).

Note: If you enter location or asset data for a prepared job that differ from those of the master location or master asset, a notification bar will be displayed. In this case, choose between the following options:

► To import the previously defined location or asset data to this job, click **Import from master location** or **Import from master asset** in the notification bar.

► To update the previously defined location or asset data with the data you have entered for this job, click **Update master location** or **Update master asset** in the notification bar.

► For more information on operations on the jobs, see 9.8 "Manage objects" on page 144.

► To load the asset data available in *Primary Test Manager*, click **Load existing asset**, and then select the asset you want to load in the **Select Asset** dialog box.

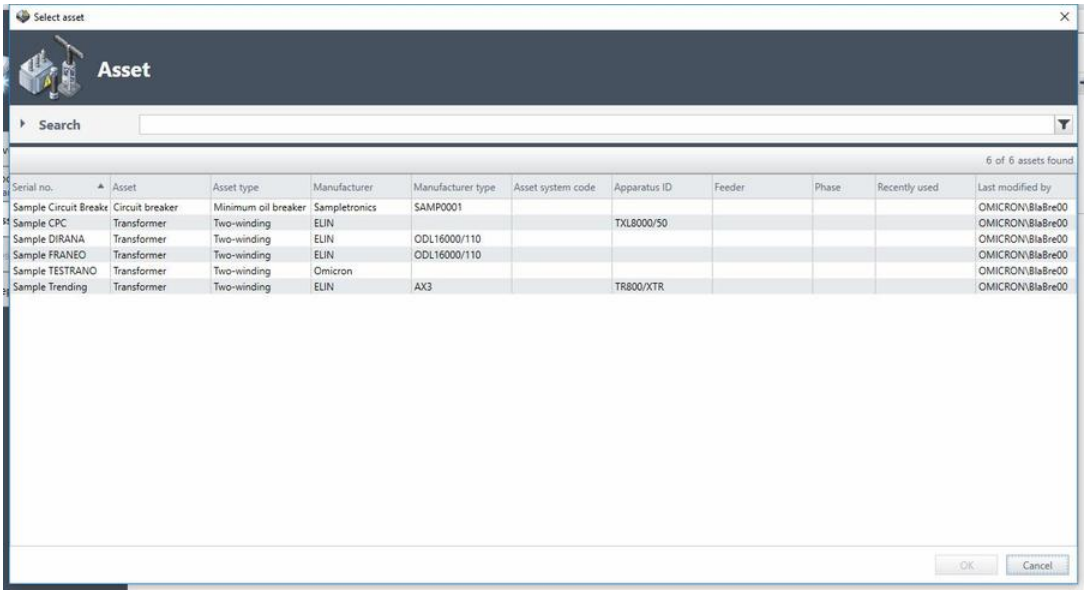


Figure 9-21: **Select Asset** dialog box

In the **Select Asset** dialog box, you can search for assets (see "Search for objects" on page 145) and sort them alphabetically or in the chronological order.

General asset data

The following table describes the general asset data.

Table 9-12: General asset data

Data	Description
Asset[1]	Asset under test
Asset type	Type of the asset
Serial no.[1]	Serial number of the asset
Manufacturer	Manufacturer of the asset
Manufacturer type	Type of the asset according to the manufacturer
Manufacturing year	Year of the asset's manufacturing
Asset system code	Code of the asset used by the maintenance planning systems
Apparatus ID	Identifier of the asset
Feeder	Feeder the asset is connected to
Phase[2]	Phase the asset is connected to

1. Mandatory data
2. Only available for current transformers, voltage transformers and miscellaneous assets.

Managing attachments

Under **Attachments**, you can manage attachments to assets.

To add an attachment to an asset:

1. Click the **Add** button ➕.
2. In the **Select Files** dialog box, browse to the file you want to attach to the asset.

To open an attachment, do one of the following:

► Select the attachment, and then click the **Open** button 🗀.

► Double click the attachment.

To delete an attachment from an asset:

1. Select the attachment you want to delete.
2. Click the **Remove** button ✖.

Transformer view

In the transformer view, you can specify transformers and assets associated with the transformer such as bushings, tap changers, and surge arresters.

Specifying a transformer

1. From the **Asset** list, select **Transformer**.
2. From the **Asset type** list, select the type of the transformer.

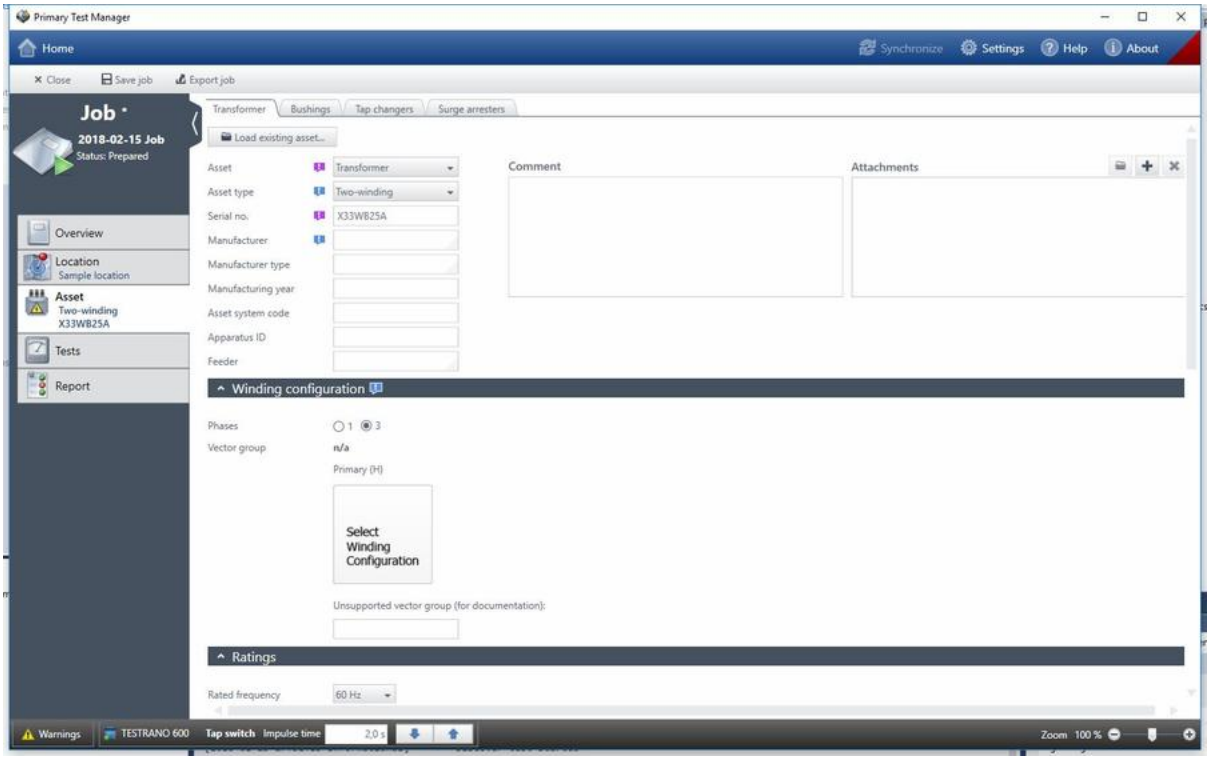


Figure 9-22: Transformer view

3. In the transformer view, enter the general asset data.
   ► See Table 9-12: "General asset data" on page 118.
4. Under **Winding configuration**, set the transformer's vector group.
   ► See "Setting the vector group of a transformer" on page 120.
5. Under **Ratings**, **Impedances** and **Others**, enter the transformer data.
   ► See 11.1 "Transformer data" on page 152.
6. Optionally, specify the bushing mounted on the transformer.
   ► See "Bushings tab (Transformer)" on page 121.
7. Optionally, specify the tap changers of the transformer.
   ► See "Tap changers tab" on page 122.
8. Optionally, specify the surge arresters mounted on the transformer.
   ► See "Surge arresters tab" on page 123.

Setting the vector group of a transformer

You can set the vector group manually or use the **Vector group check** to determine it.

► See 12.9 "Vector Group Check" on page 180 and 12.19 "Manual Vector Group Check" on page 204 for more information.

To manually set the vector group in the transformer view:

1. Select the number of transformer's phases.
2. Do one of the following:
   - ► Select the configuration of the transformer's windings from the respective lists.
   - ► Click **Select Winding Configuration** and in the **Edit vector group** dialog box, set the transformer's vector group.

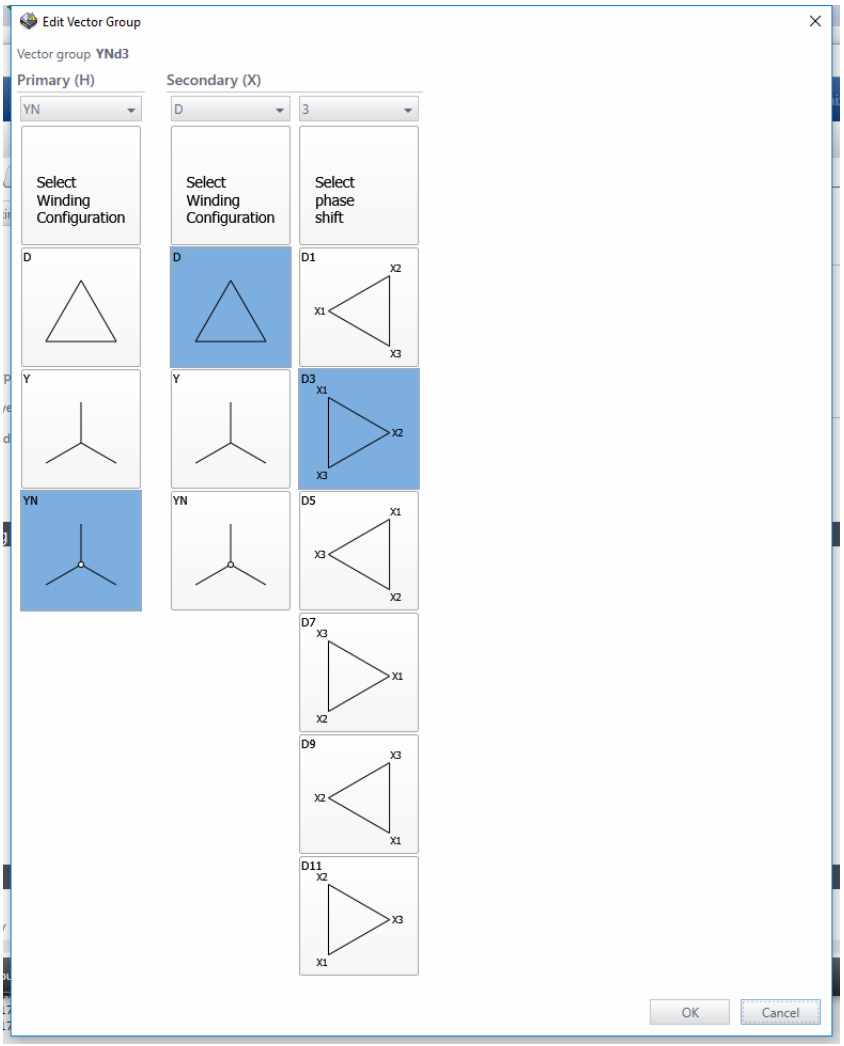


Figure 9-23: **Edit vector group** dialog box

Note: *Primary Test Manager* sets the vector group of an autotransformer without tertiary winding automatically.

Bushings tab (Transformer)

On the **Bushings** tab, you can specify the bushings mounted on the transformer.

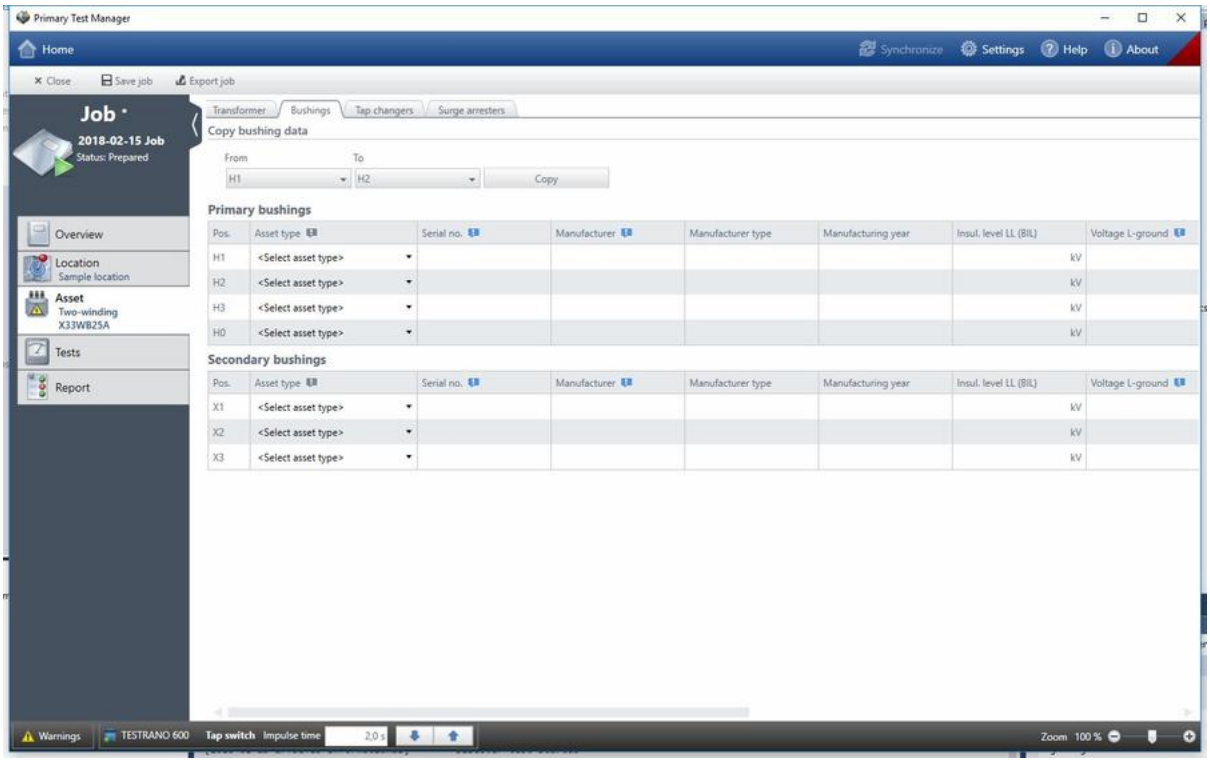


Figure 9-24: Transformer view: **Bushings** tab

Specifying a bushing

1. From the **Asset type** list, select the type of the bushing.
2. Enter the bushing data (see 11.2 "Spare bushing data" on page 155).

Under **Copy bushing data**, you can copy data of a bushing to other bushings. To copy the bushing data, select the respective bushings from the **From** and **To** lists, and then click **Copy**.

Tap changers tab

On the **Tap changers** tab, you can specify the tap changers of the transformer.

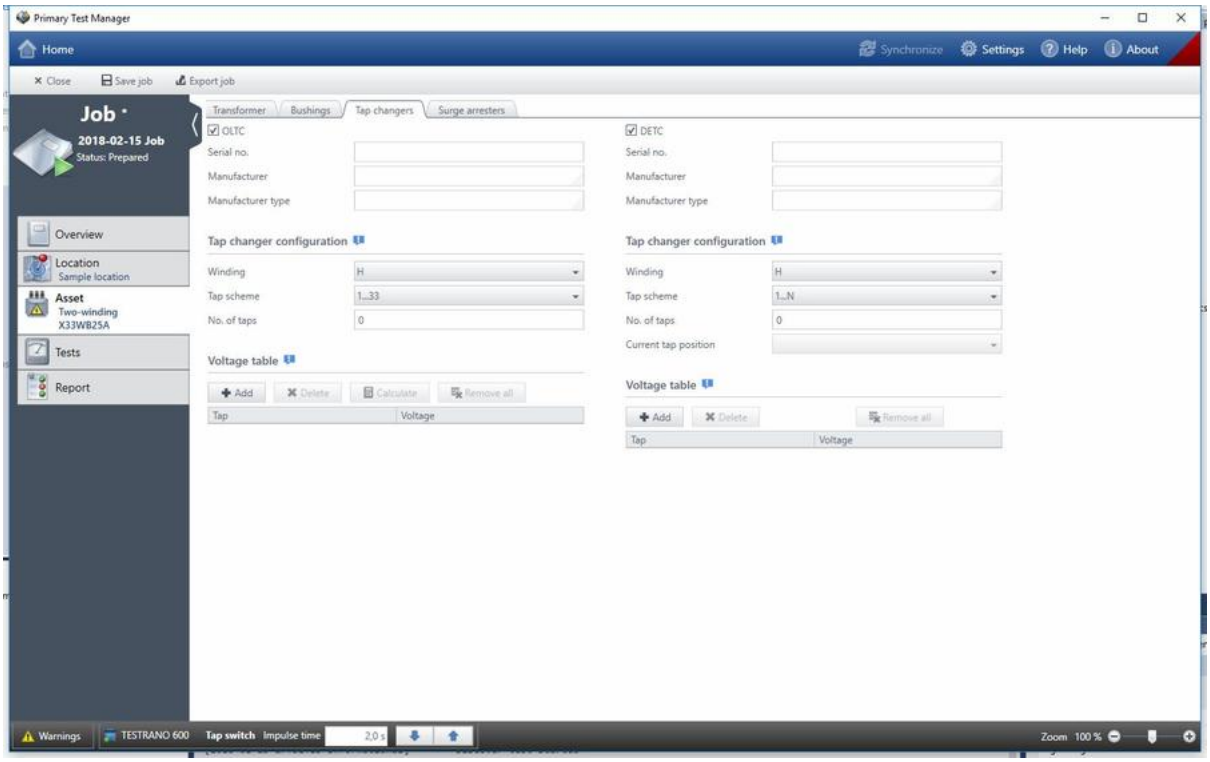


Figure 9-25: Transformer view: **Tap changers** tab

Specifying an on-load tap changer (OLTC)

1. Select the **OLTC** check box.
2. Enter the OLTC data (see 11.1.2 "Tap changer data" on page 154).
3. Under **Tap changer configuration**, set the tap changer's winding, the tap scheme, and the number of taps.
4. In the **Voltage table** you can either enter each value manually or have them calculated.
   Click **Calculate** for the voltage table calculation and use one of the three methods:
   - **First and second**: Calculation based on the voltages of the first and second tap
   - **Middle**: Calculation based on the middle tap (rated voltage) and the entered deviation value
     In the guided workflow, the rated voltage is automatically transferred from the **Voltage ratings** table under **Asset** data – **Transformer**.
   - **First/middle/last**: Calculation based on the voltages of the first, middle and last tap

   Note: Middle and **First/middle/last** are only available for odd tap numbers.

   ► After calculation, compare the calculated values with the nominal values on the nameplate.

Specifying a de-energized tap changer (DETC)

1. Select the **DETC** check box.
2. Enter the DETC data (see 11.1.2 "Tap changer data" on page 154).
3. Under **Tap changer configuration**, set the tap changer's winding, the tap scheme, the number of taps, and the current tap position.
4. Type the voltage of all taps.

To add a tap, select the tap below which you want to add a tap, and then click **Add**.

Note: The added taps match no tap scheme.

► To delete a tap, select the tap you want to delete, and then click **Delete**.

► To delete all taps, click **Remove all**.

Surge arresters tab

On the **Surge arresters** tab, you can specify the surge arresters mounted on the transformer.

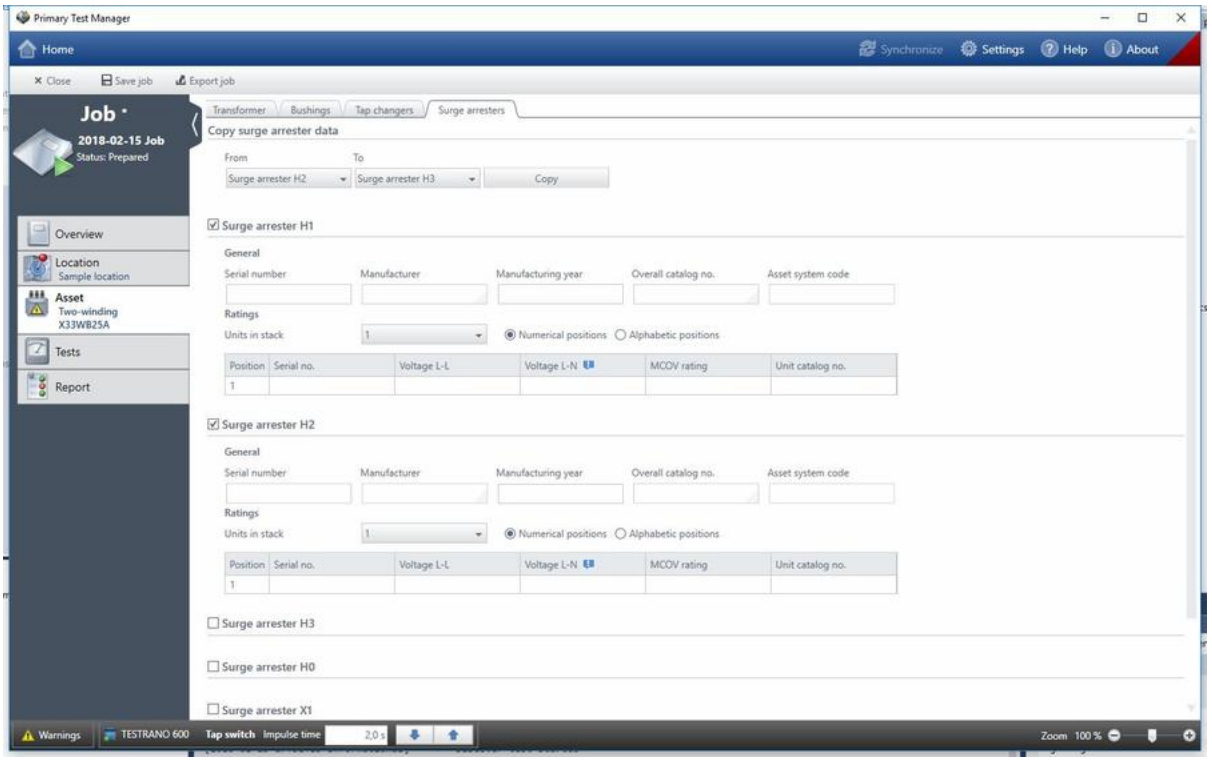


Figure 9-26: Transformer view: **Surge arresters** tab

Specifying a surge arrester

1. Select the respective **Surge arrester** check box.
2. Enter the surge arrester data (see 11.1.3 "Surge arrester" on page 154).

Under **Copy surge arrester data**, you can copy data of a surge arrester to other surge arresters. To copy the surge arrester data, select the respective surge arresters from the **From** and **To** lists, and then click **Copy**.

DGA Trending

DGA Trending is a licensed feature that visualizes a transformer's historic **Oil analysis** data in various charts and offers a comparison of data recorded at different points in time.

Refer to 14.1 "Oil Analysis" on page 210 for more detailed information on the **Oil analysis** test.

Spare bushing view

In the spare bushing view, you can specify bushings.

To specify a spare bushing:

1. From the **Asset** list, select **Bushing**.
2. From the **Asset type** list, select the type of the spare bushing.

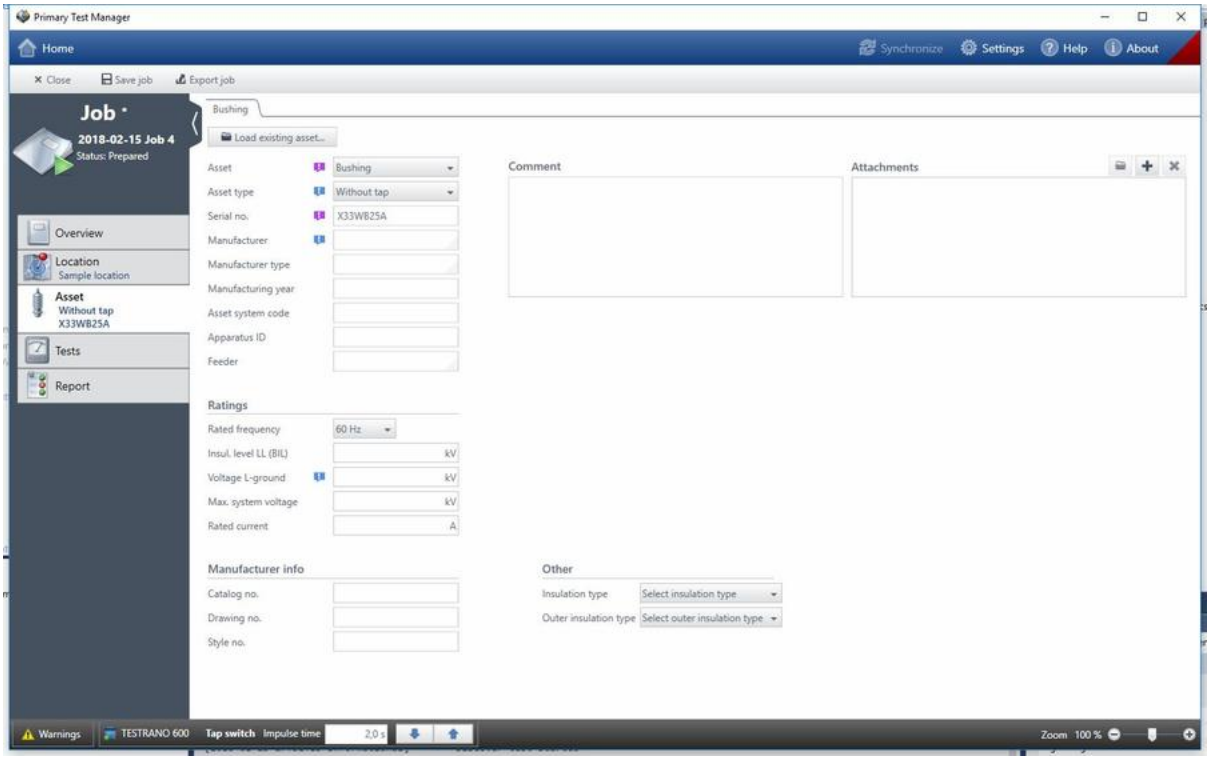


Figure 9-27: Spare bushing view

3. In the spare bushing view, enter the general asset data (see Table 9-12: "General asset data" on page 118).
4. Enter the spare bushing data (see 11.2 "Spare bushing data" on page 155).

9.7.5 Test view

In the test view, you can select, import and perform tests. To open the test view, click the **Tests** navigation button .

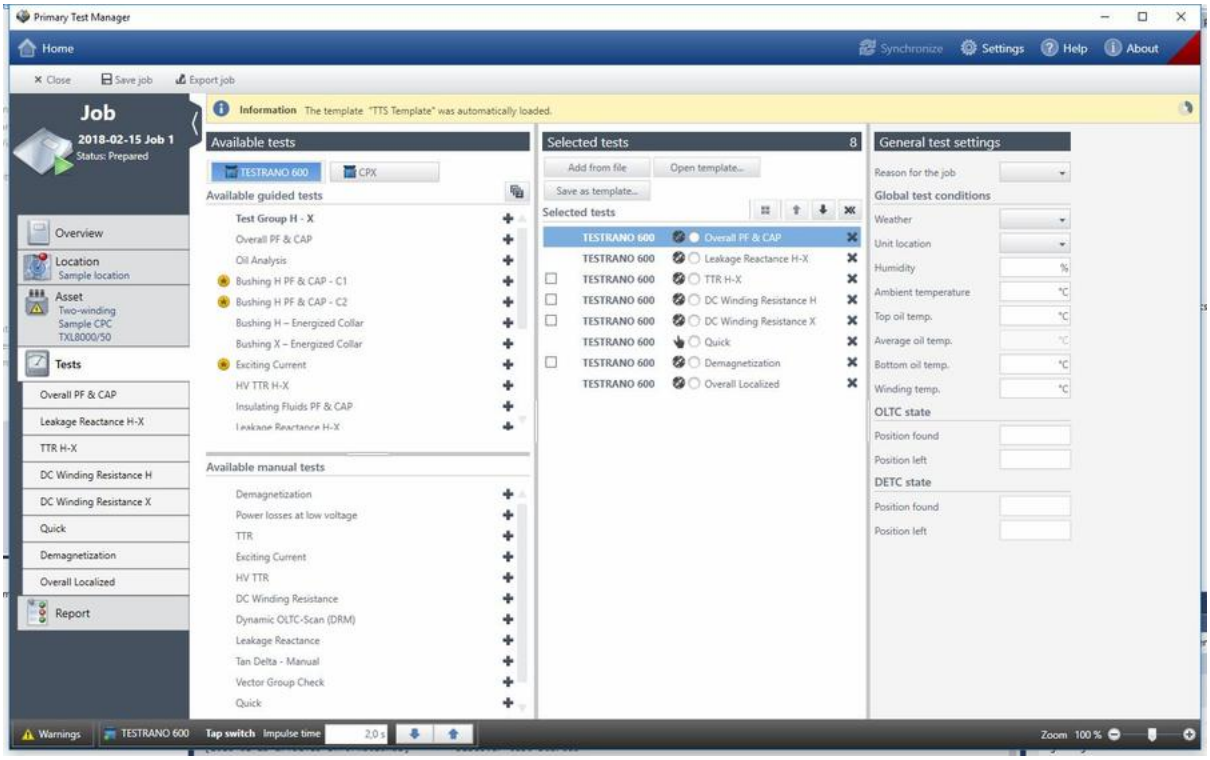


Figure 9-28: Test view

Selecting tests

The test view is divided into the **Available tests** area, the **Selected tests** area, and the **General test settings** area.

Click the button labeled with the test system with which you want to perform the test on the top of the Available tests area. Then *Primary Test Manager* displays the available guided tests and optional manual tests supported for the selected test system and the asset under test.

► To display the guided tests grouped in categories, click the **Show test categories** button .

You can select tests for different test systems supported by *Primary Test Manager* within the same job.

The symbol indicates the tests not available for the connected test system to signal to you that you need to connect another test system before proceeding to execute the job.

The optional manual tests are asset-independent. You can perform the tests for any asset described in this User Manual, but *Primary Test Manager* does not guide you through the tests and provides no test settings data.

► For more information about the manual tests, see 9.7.8 "Create new manual tests" on page 140.

The Selected tests area displays the tests you want to perform. By default, *Primary Test Manager* displays the tests recommended by OMICRON. To add a test into the Selected tests area, click the symbol next to the test name in the Available tests area. To add all tests of a category into the Selected tests area, click the symbol. The Selected tests area displays the test to be performed in the recommended order. You can change the order of the tests by dragging them or by using the and buttons. To remove a test from the Selected tests area, click the symbol next to the test name.

The General test settings area displays the reason of the job, the global test conditions, and some asset specific data.

Grouping tests

You can group tests from the **Selected tests** column in the **Tests** view of a job.

1. In the **Selected tests** area, select the check boxes next to the tests you want to group. Only groupable tests are displayed with a check box.
2. Click the **Group tests** button .

The test groups are then displayed under **Tests** in the left pane of the test view.

► To rename the test group, double-click the test group name.

► To remove a test from the test group, click the **Ungroup** button next to the test name.

► To remove a test group from the **Selected tests** area and from the left pane, click **Remove the selected test** next to the test group name.

► To open a test group, click the test group name in the left pane of the test view.
The test group view lists **Settings and conditions** that are common for all tests in this group.

► In the group's **Test control** section, press **Start all** to start the listed tests in sequence. You can stop measurements and then press **Start** to start individual measurements or **Resume all** to resume the grouped tests in sequence.

Importing tests

In the test view, you can import tests performed with *TESTRANO 600 and* even with the test systems not currently supported by *Primary Test Manager*. *Primary Test Manager* supports import of tests of the following formats.

Table 9-13: Supported test formats

File Name Extension	Description
.xml	*TESTRANO 600* files (jobs)
.xmt	*TESTRANO 600* template files (job templates)
.ptma	*Primary Test Manager* manual test
.drax	*DIRANA* native format

You can also import tests in JPG, PDF and any Microsoft Office file format.

To import test data:

1. In the Selected tests area, click **Add from file**.
2. In the **Open** dialog box, browse to the file you want the import.
3. In the left pane of the test view, click the imported test.

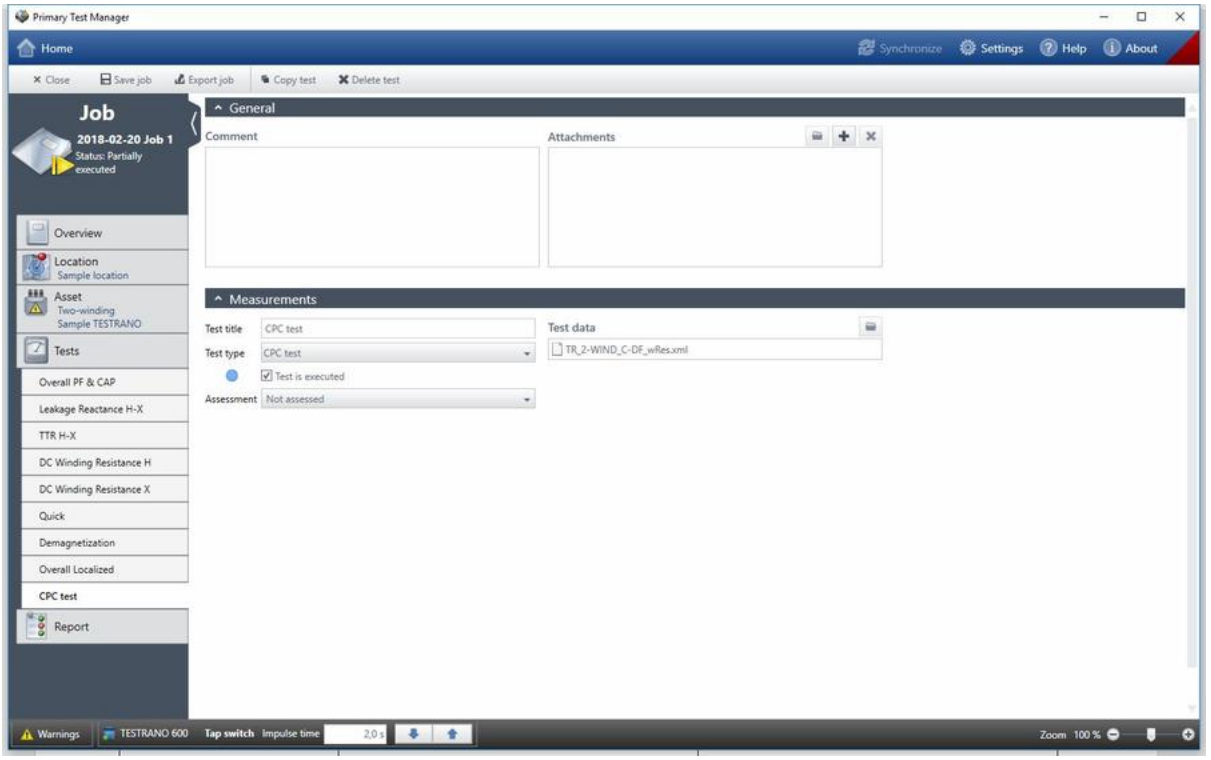


Figure 9-29: Test view after a test has been imported

4. In the workspace of the test view, you can change the test title and the test type.
5. To open the test, click the **Open** button under **Test data**.

   Note: To open a test, you must have installed the associated application software on your computer.
6. You can attach files as described earlier in this chapter and add comments to the test.

For information about importing and exporting jobs, see "Import and export jobs" on page 149.

Performing tests

To perform a test:

1. Add the tests you want to perform into the selected tests area (see "Selecting tests" on page 125).
2. In the left pane of the test view, click the test you want to perform.
   The test view is then split into the General pane, the Settings and conditions pane, the Measurements pane and, if automatic assessment is available for the test, the Assessment pane. You can expand and collapse the panes by clicking the arrows on the split bars.
3. In the Settings and conditions pane, enter the test settings (see the chapter on the asset tests later in this manual).

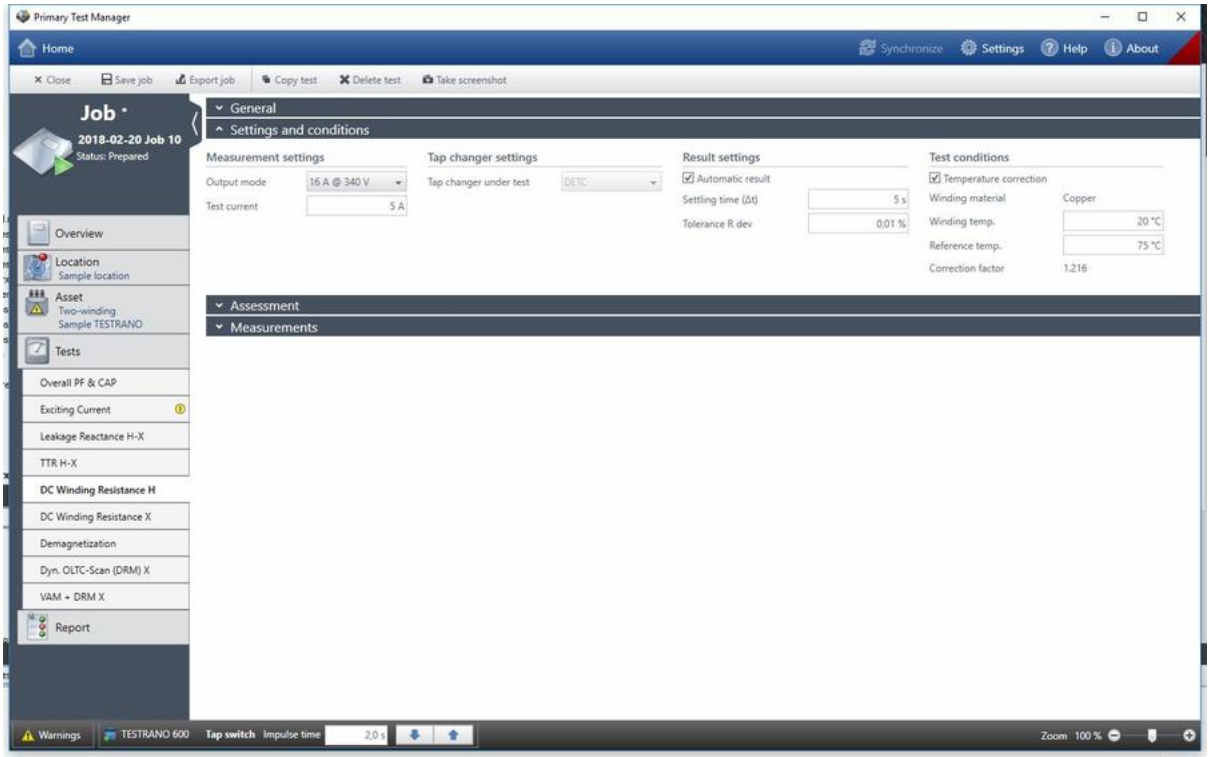


Figure 9-30: Test view: Settings and conditions pane

4. In the Assessment pane, enter the automatic assessment parameters and limits, if applicable.

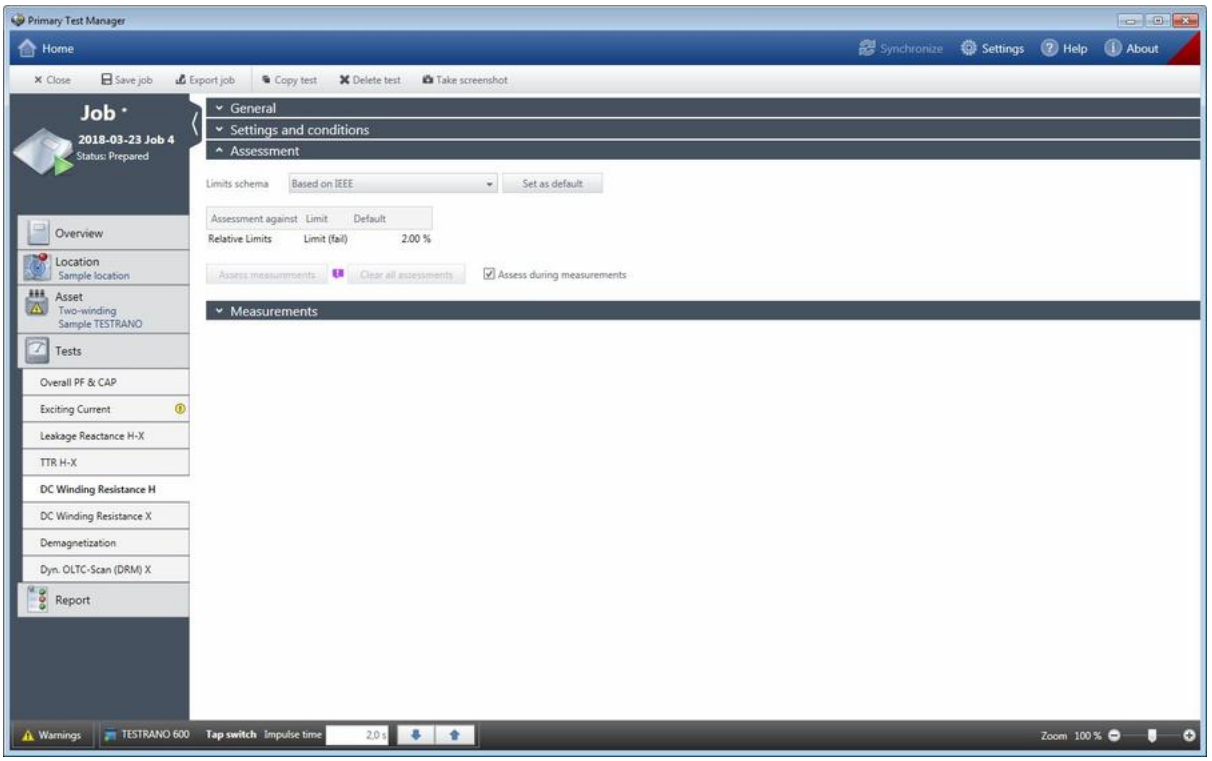


Figure 9-31: Test view: Assessment pane

5. Connect the test setup to the asset under test according to the wiring diagram displayed in the General pane. For information about connecting the test setup to the asset under test, see chapter 5 "Application" on page 25.

As soon as you connect *TESTRANO 600* to *PTM*, the tap switch command in the bottom bar is available. You can use the arrow buttons to switch a connected OLTC when no measurement is running.

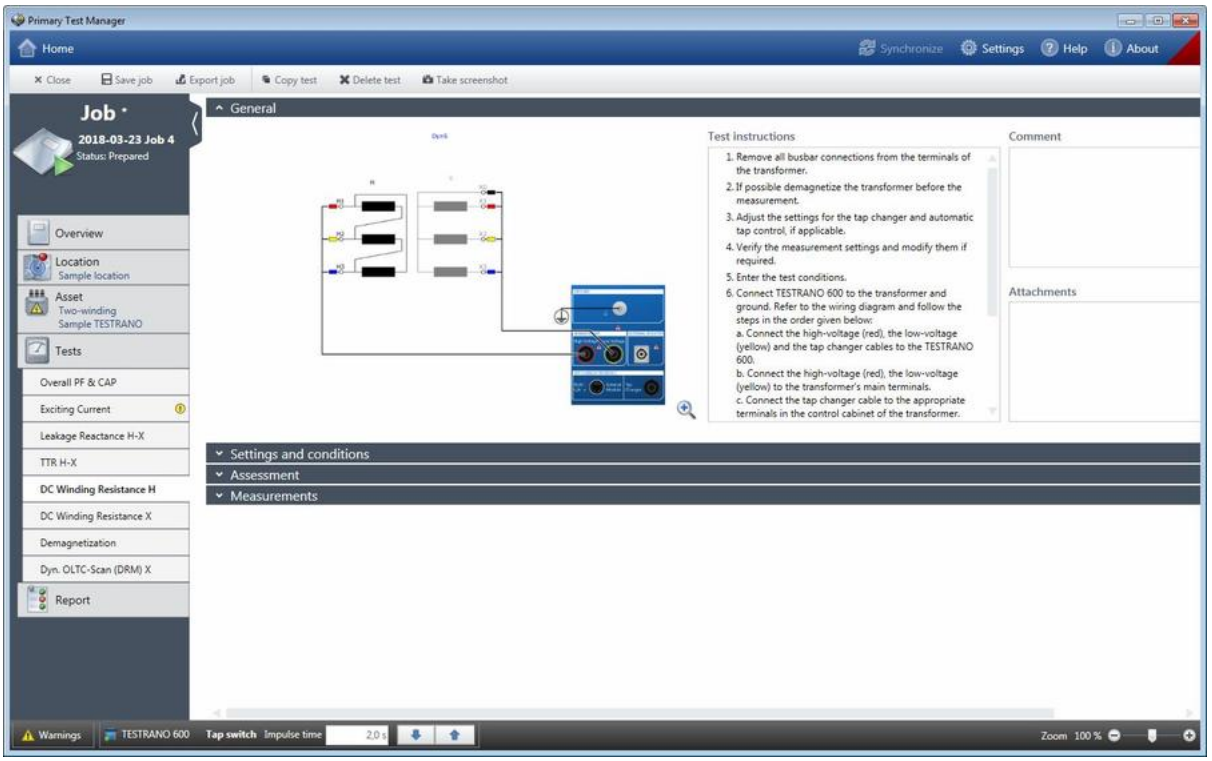


Figure 9-32: Test view: General pane

6. In the Measurements pane, click **Start** to start the selected measurement.

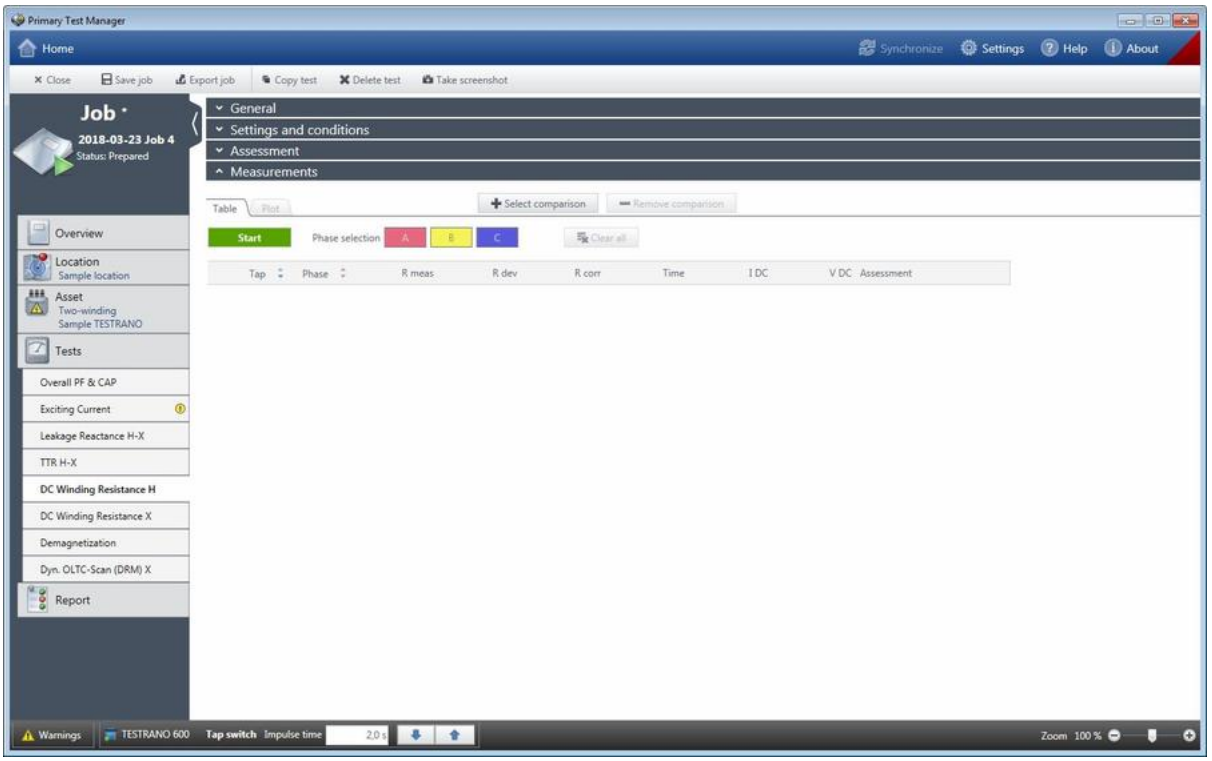


Figure 9-33: Test view: Measurements pane

DANGER

Death or severe injury caused by high voltage or current

The flashing lightning symbol in the *Primary Test Manager* test view indicates that an output of *TESTRANO 600* is active.

- ► Do not touch any outputs or cables while the lightning symbol is displayed.
- ► If in doubt, press the **Emergency Stop** button.

7. Press the **Start/Stop** button on the front panel of *TESTRANO 600*.

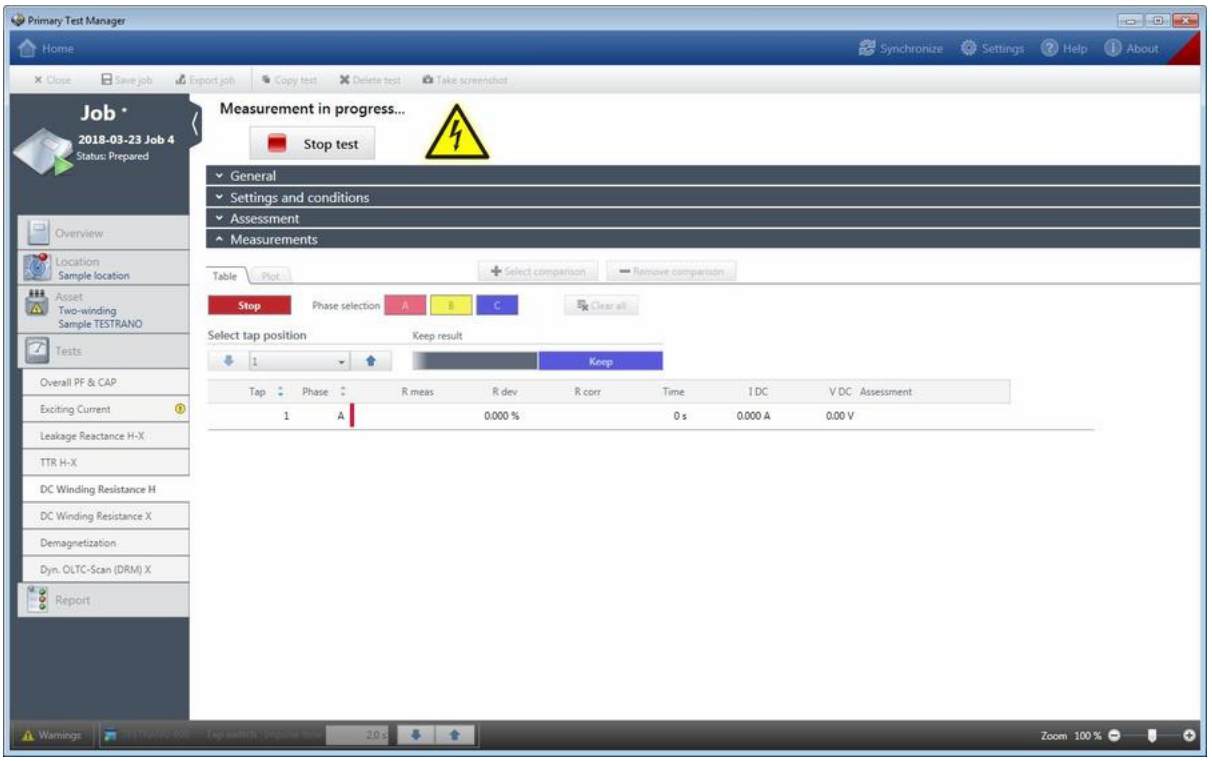


Figure 9-34: Test view during a measurement

After the measurement has been finished, *Primary Test Manager* displays the numeric measurement data and the automatic assessment, if available, in the Measurements pane. To view graphical diagrams of the measurement results, click the **Plot** tab.

8. Repeat steps 6 and 7 for all test measurements.

Note: Some tests support starting all measurements at once by clicking the **Start all** button.

Note: After the test has been performed some asset data relevant for the test configuration cannot be edited anymore.

Processing templates

In the guided test workflow, you can save jobs as templates and open the saved templates. With the help of templates, you can configure jobs according to your needs (for example, for repeated routines), and then repeatedly perform tests you only have to define once.

When you create a new job, the favorite template for the corresponding asset type and number of phases is loaded automatically, if available.

To save a job as template:

1. In the guided test workflow, configure a job.
2. In the **Selected tests** area of the test view, click **Save as template**.

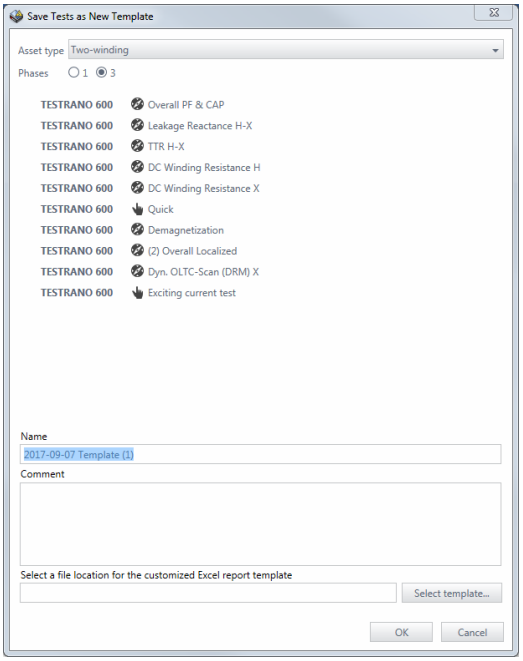


Figure 9-35: **Save Tests as New Template** dialog box

3. In the **Save Tests as New Template** dialog box:
   - ► Select the **Asset type** and number of **Phases**.
   - ► Enter a **Name** for the template.
4. Optionally, you can add a customized Microsoft Excel report template (see 9.7.10 "Test reports" on page 142) to the job template. To add a Microsoft Excel report template:
   - ► Click **Select template**.
   - ► In the **Select** dialog box, browse to the report template you want to add.

To open a template:

1. In the Selected tests area of the test view, click **Open template**.

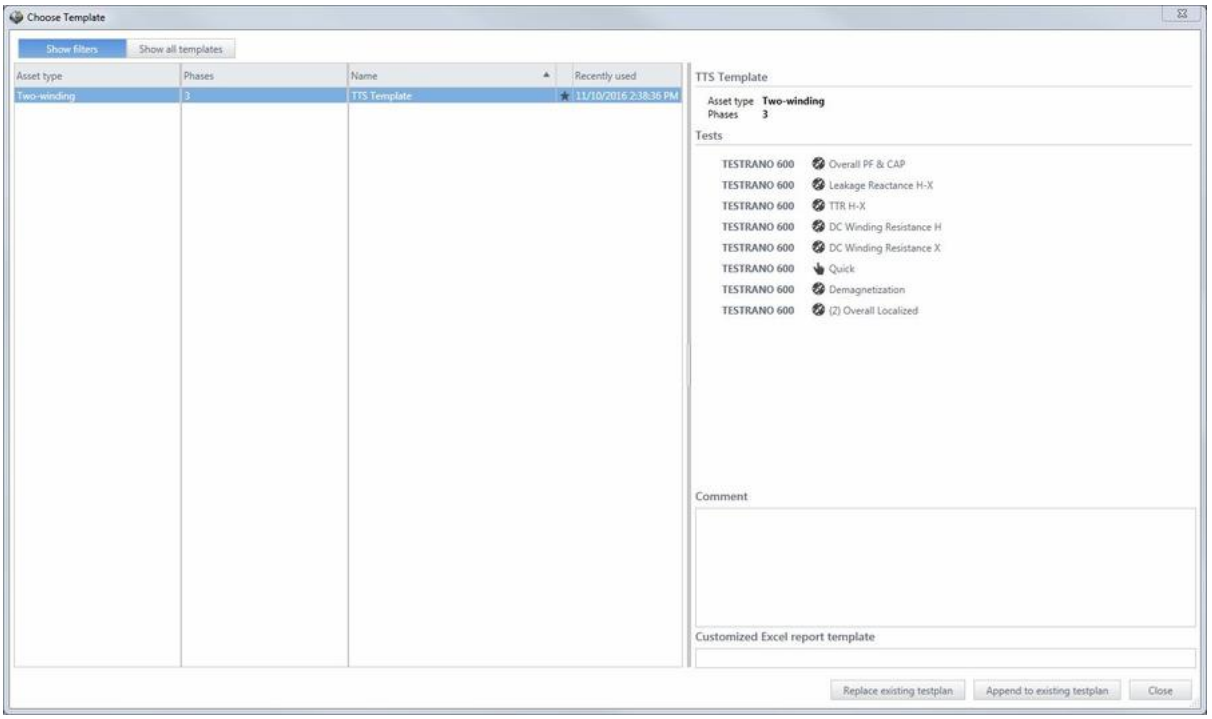


Figure 9-36: **Choose Template** dialog box

2. In the **Choose Template** dialog box, select the asset type, the number of phases and the template you want to open.

   Note: If you added a Microsoft Excel report template to the job template, its location is displayed under **Customized Excel report template**.

3. Press **Replace existing testplan** to replace the tests already listed in the test list.
   Press **Append to existing testplan** to add the tests listed in the template to the end of the existing testplan.

   Note: If you click **Append to existing testplan**, the Microsoft Excel report template will not be added the selected job template to the currently opened job.

9.7.6 Handling results

Trending tab

The **Trending** tab displays measurement data from PF/DF/Tanδ tests performed at rated frequency at different points in time.

For the collection of data, the serial number and manufacturer are taken into account. Therefore, all measurements of the bushing in question are displayed, regardless of its location (for example spare bushing, bushing mounted on different transformers, etc.).

In the chart, measurements performed with 10 kV at rated frequency are displayed as circles ◯. All other data are displayed as triangles ▽.

Note: If several tests are performed on one day, the most recent test of that day is connected to the curve in the **Trending** chart. The others are displayed in the same chart but are not connected.

Assessing measurement results

► Use the Assessment column in the Measurements area of a test to assess the measurement results or to change the automatic assessment provided by *Primary Test Manager*.

Table 9-14: Assessment statuses in the Test view

Status	Description
Fail	The status was automatically set to *Fail* by *Primary Test Manager*.
Manual fail	The status was manually set to *Fail*.
Investigate	The status was automatically set to *Investigate* by *Primary Test Manager*.
Manual investigate	The status was manually set to *Investigate*.
Pass	The status was automatically set to *Pass* by *Primary Test Manager*.
Manual pass	The status was manually set to *Pass*.
Not assessed	The measurement has not been assessed.
Not rated	The status was automatically set to *Not Rated* by *Primary Test Manager*.

Comparing results

Some tests support comparison of the graphical diagrams of measurement results. The comparison data is an integral part of the tests. You can compare tests for different assets but we recommend to perform only comparisons of tests for the same assets or assets of the same design type. *Primary Test Manager* offers you only tests of the same type for which the comparison is possible.

To compare a test with a test available in the database:

1. In the **Measurements** pane of a test, click the **+ Select comparison** button, if available.
2. In the **Select a test** window, select the test you want to compare with the current test.

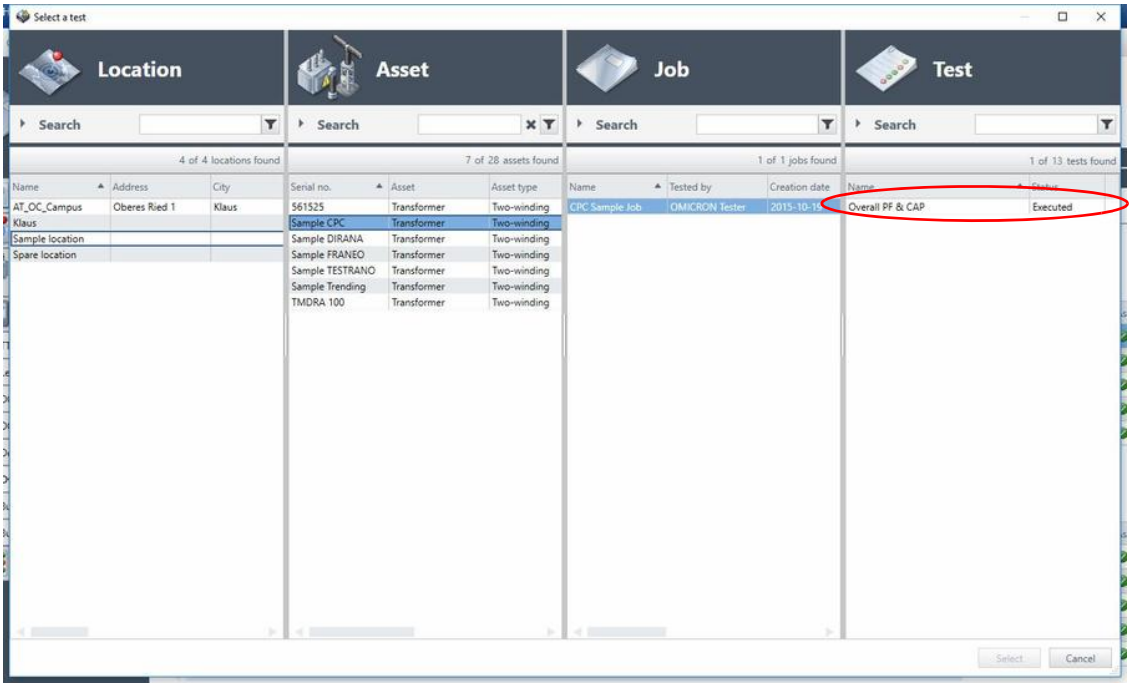


Figure 9-37: **Select a test** window

3. The Measurements pane displays the measurement results of the selected test.

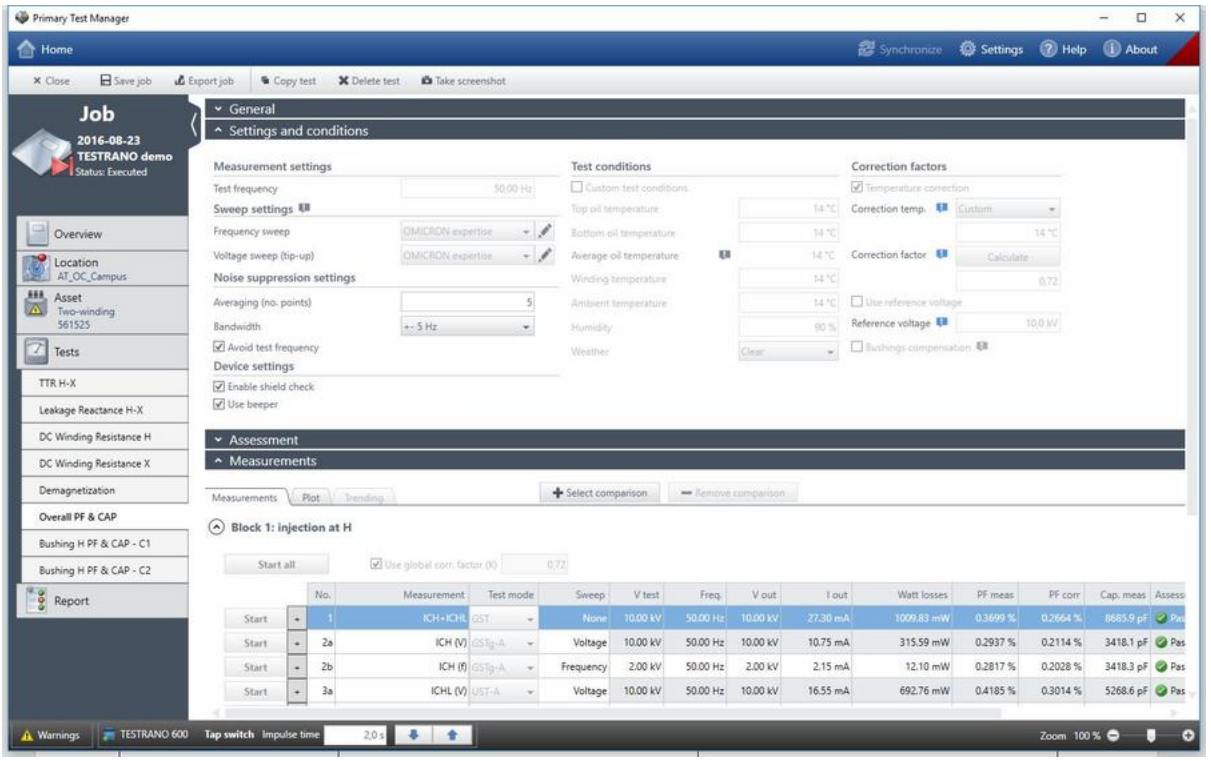


Figure 9-38: Test comparison: Measurement results of the first test

4. Start the test (see "Performing tests" on page 128).
5. Click the **Plot** tab.

6. *Primary Test Manager* displays the measurement results of both tests in real time.

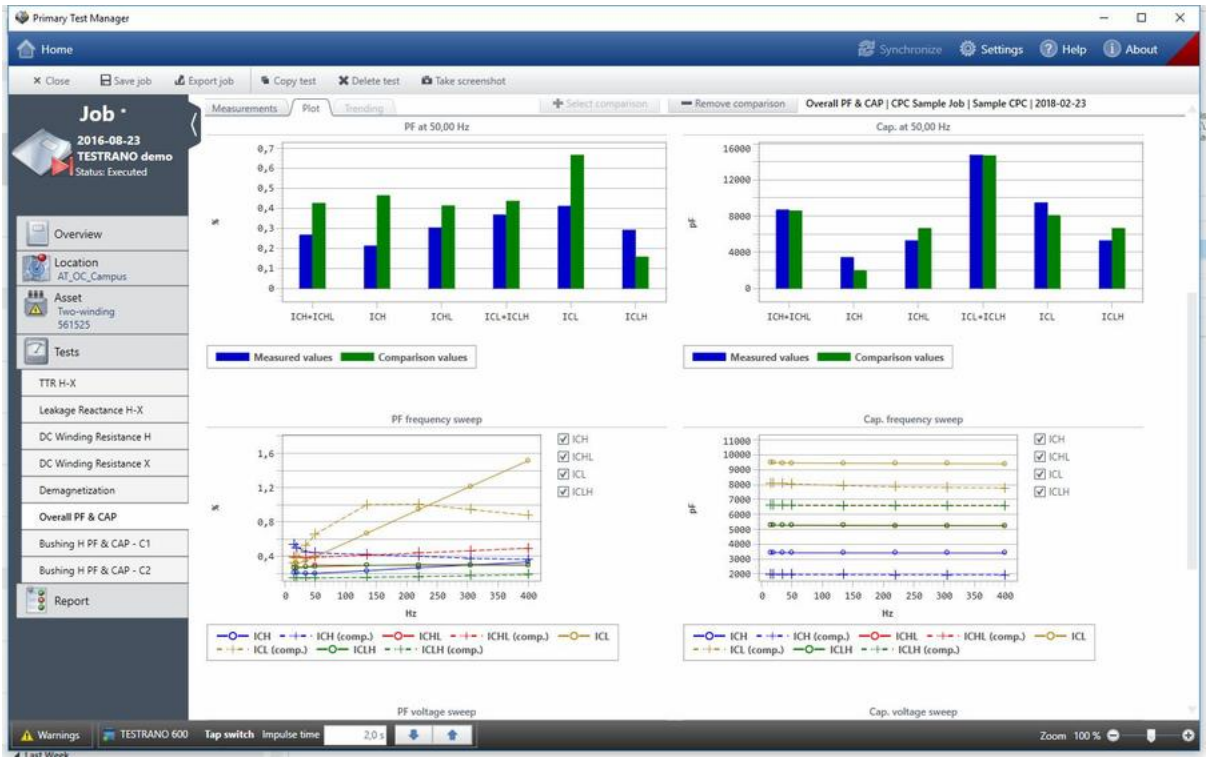


Figure 9-39: Test comparison: Measurement results of both tests

To remove the comparison diagram, click **Remove comparison**.

Alternatively, you can compare two tests available in the database:

1. In the Manage view (see 9.8 "Manage objects" on page 144), select the job including the first test for comparison.
2. In the left pane of the job overview, click the first test for comparison.
3. In the Measurements pane, click the **+ Select comparison** button, if available.
4. In the **Select a test** window, select the second test for comparison.
5. *Primary Test Manager* displays the measurement results of both tests.

9.7.7 Execute prepared job

To facilitate the field tests, you can configure a job in the office, save it in *Primary Test Manager*, and execute it later in the field. With the **Execute prepared job** user task, you can execute prepared jobs saved in a file and jobs available in *Primary Test Manager*.

To execute a prepared job saved in a file:

1. In the home view, click the **Execute prepared job** button .

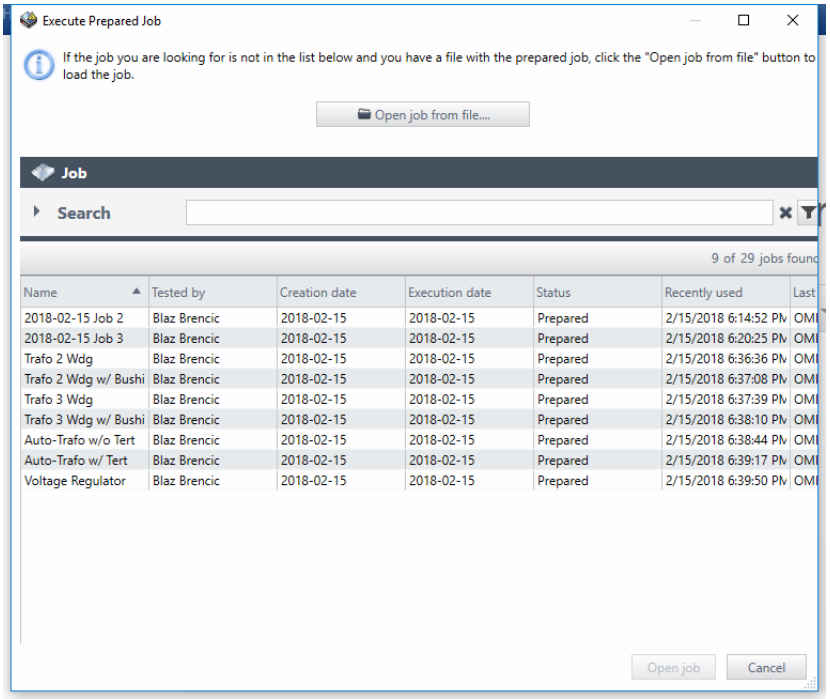


Figure 9-40: Execute prepared job view

2. In the **Execute prepared job** view, click **Open job from file**.
3. In the **Open** dialog box, browse to the .ptm file you want to import.
4. Import the job, and then go through the guided test workflow.
   ► See 9.7.1 "Guided test workflow" on page 110.

To execute a prepared job available in *Primary Test Manager*:

1. In the home view, click the **Execute prepared job** button .
2. In the **Execute prepared job** view, search for the job you want to execute.
   ► See "Search for objects" on page 145.
3. Open the job, and then go through the guided test workflow.
   ► See 9.7.1 "Guided test workflow" on page 110.

9.7.8 Create new manual tests

► To open the create new manual tests view, click the **Create new manual tests** button in the home view.

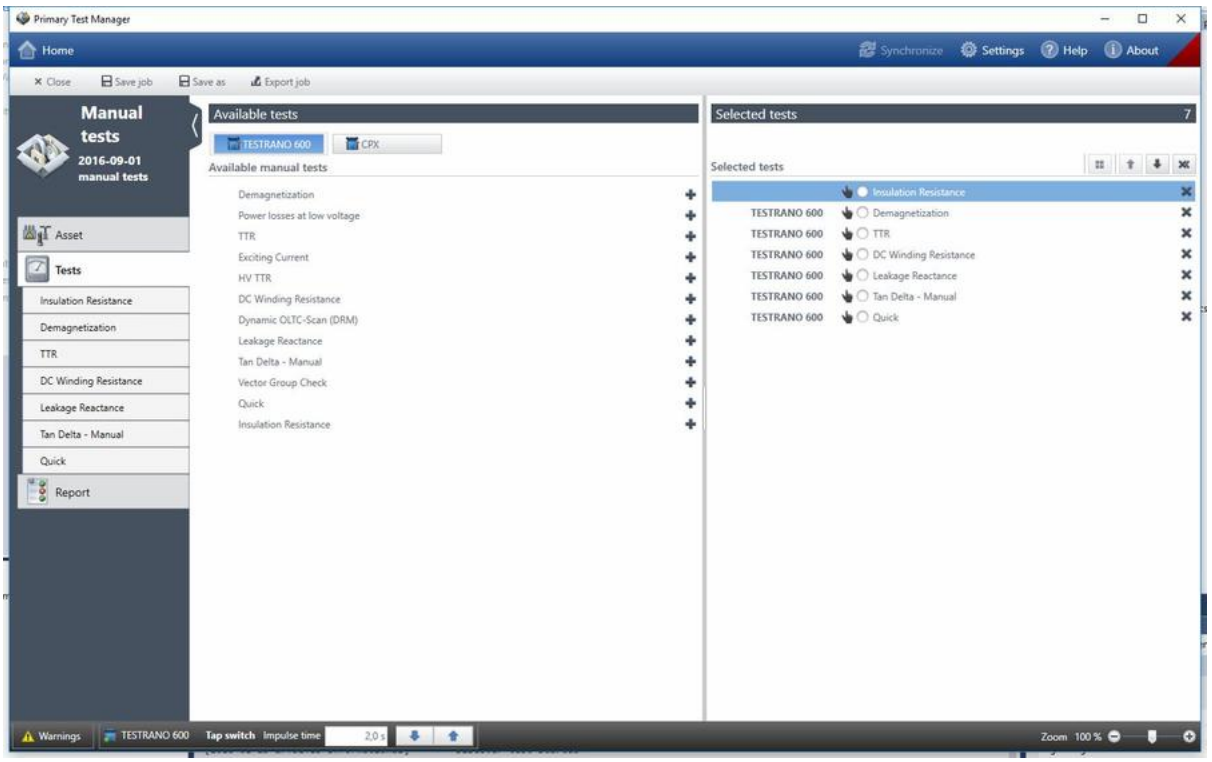


Figure 9-41: Create new manual tests view

The workspace of the create new manual tests view depends on the selected button in the left pane (see Figure 9-42: "Left-pane buttons" on page 141). Initially, the workspace is divided into the **Available tests** area and the **Selected tests** areas.

On top of the **Available tests** area you can select the test system you want to use for measurement. *Primary Test Manager* displays all available manual tests supported for the selected test system.

Add tests to a job

► On the top of the **Available tests** area, click the button labeled with the test system with which you want to perform the test.
Primary Test Manager then displays all available manual tests supported for the selected test system.

► To add a test to a job, click the ➕ symbol next to the test name or double-click the test in the **Available tests** area.

The tests added to a job are displayed in the **Selected tests** area and a button with the test name appears in the left pane.

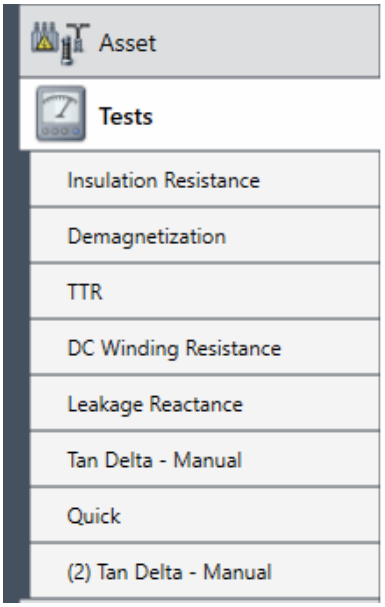


Figure 9-42: Left-pane buttons

Note: You can change the default test names. To rename a test, click the corresponding button in the left pane, and then click the test name.

9.7.9 Open manual tests

With *Primary Test Manager*, you can open existing manual tests. To open manual tests:

1. Click the **Open manual tests** button in the home view (see Figure 9-2: "Primary Test Manager home view" on page 94).
2. In the **Open** dialog box, browse to the file you want to open.

The open manual tests view displays the tests in the left pane. To view the test results, click the corresponding test button. You can add new tests and generate test reports as described in 9.7.8 "Create new manual tests" on page 140.

9.7.10 Test reports

In the report view, you can configure and generate test reports. To open the report view, click the **Report** button  in the left pane.

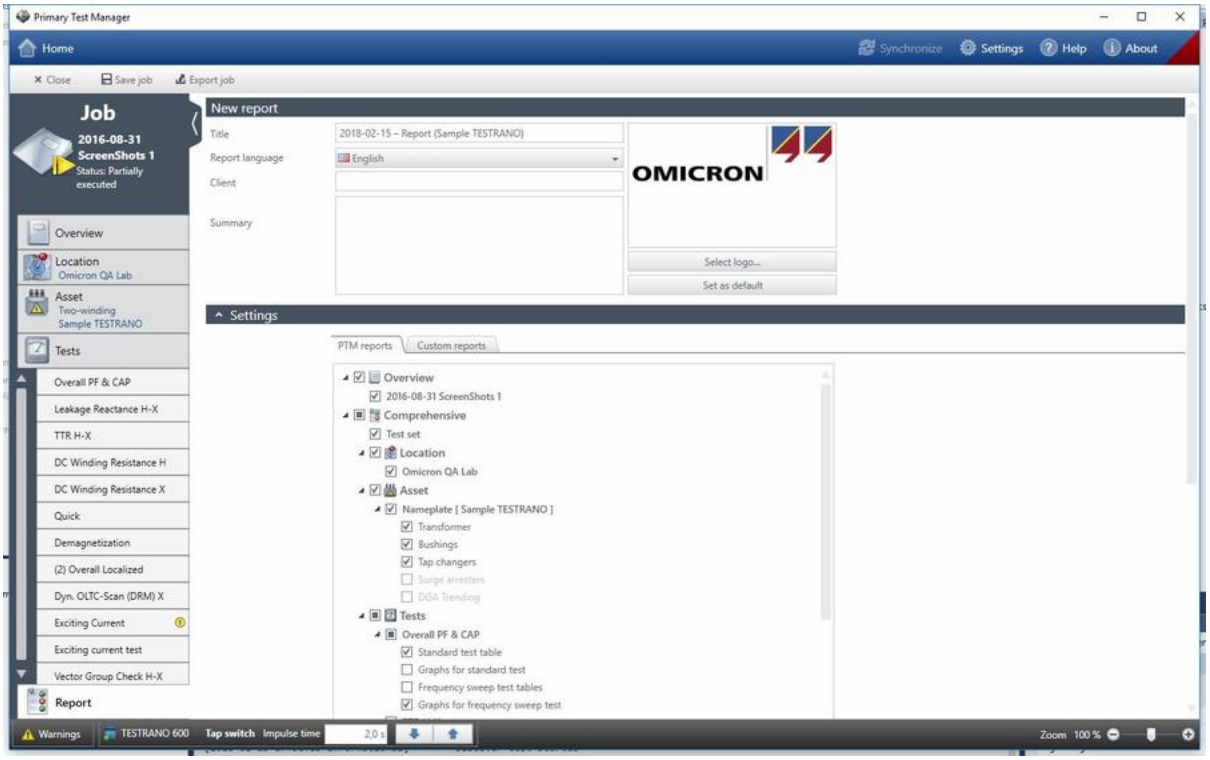


Figure 9-43: Report view

The report view is divided into the **New report** area, the **Settings** area and the **Existing reports** area. In the **New report** area, you can set the report data. The following table describes the report data.

Table 9-15: Report data

Data	Description
Title	Title of the report. Appears as the report header.
Report language	Language the report is created in
Report ID[1]	Identifier of the report
Client	Customer for which the report is designated
Logo	Logo to appear in the report (see "Setting the logo" later in this chapter)
Summary	Text field to summarize the content of the test report in own words.

1. By default generated by *Primary Test Manager*.

Setting the logo

To insert your own logo:

1. In the **New report** area, click **Select image**.
2. In the **Open Image File** dialog box, browse to the file you want to insert.

► To set your own logo as default, click **Set as default**.

Configuring test reports

In the **Settings** area, you can configure test reports by selecting the respective check boxes. You can generate test reports as Microsoft Word or in PDF format.

► To generate a test report in your preferred format, click **Report to Word** or **Report as PDF**.

You can use customized Microsoft Excel templates provided by OMICRON to tailor test reports to your needs. For information about the test report templates, contact your OMICRON local sales representative or distributor.

To open a test report template:

1. In the **Settings** area, click the **Custom reports** tab.
2. Click **Select template**.
3. In the **Select** dialog box, browse to the template you want to use.

► To set the customized test report template as default, click **Set as default**.

The **Existing reports** area displays the test reports available for the job. In addition to the test reports generated by *Primary Test Manager*, you can add other reports to jobs. To add a report to a job:

1. In the **Existing reports** area, click **Add report from file**.
2. In the **Add** dialog box, browse to the report you want to add to the job.

9.8 Manage objects

In the manage view, you can manage locations, assets, jobs, and reports available in *Primary Test Manager*. After you have opened a job, *Primary Test Manager* leads you through the guided test workflow (see 9.7.1 "Guided test workflow" on page 110).

► To open the manage view, click the **Manage** button in the home view.

Note: In this chapter, the locations, assets, jobs, and reports are collectively called objects.

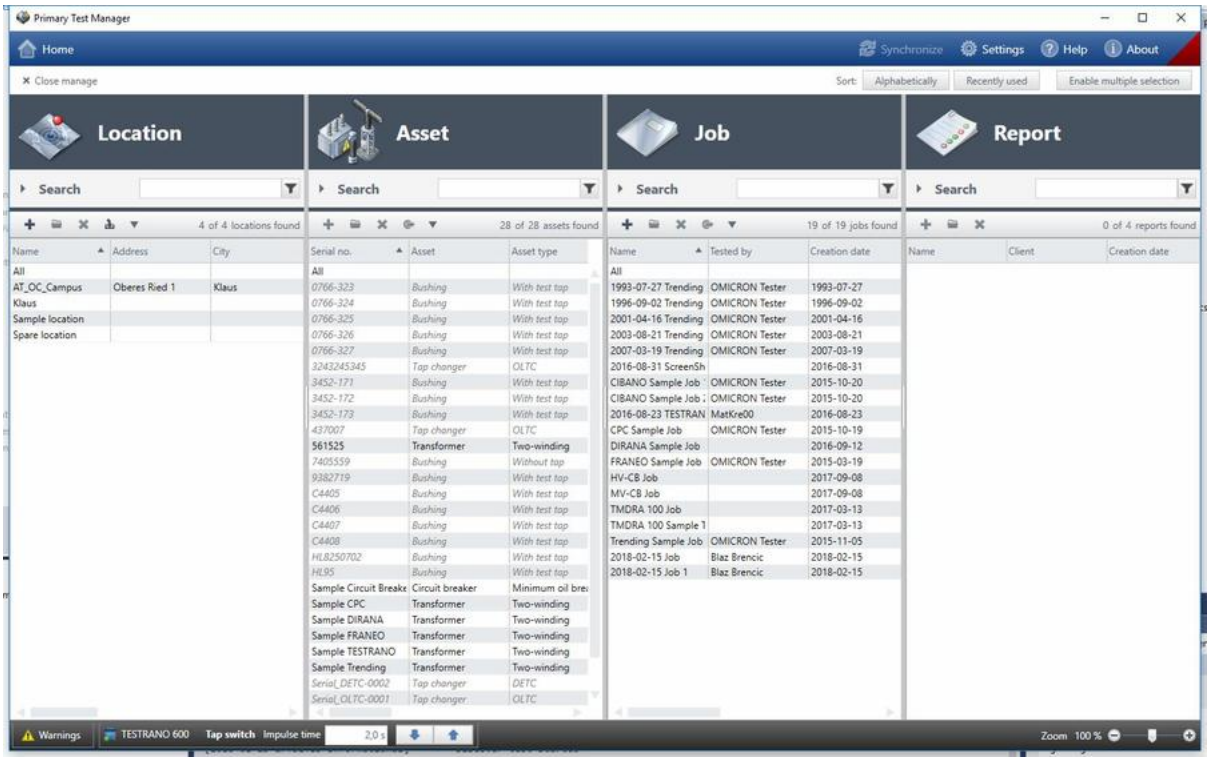


Figure 9-44: Manage view

Note: The mounted assets are displayed in italics. To hide them, expand the Search area under **Asset**, and then select the **Hide mounted assets** check box.

The manage view displays the objects in a hierarchical structure as follows:

- If you select a location, the manage view displays the assets, jobs, and reports associated with the selected location.
- If you select an asset, the manage view displays the jobs and reports associated with the selected asset.
- If you select a job, the manage view displays the reports associated with the selected job.

You can sort the objects alphabetically or in the chronological order.

► Drag and drop the column headers to rearrange the columns.

In the manage view, you can:

- Search for objects (see "Search for objects" on page 145)
- Perform operations on objects ("Perform operations on objects" on page 146)
- Relocate assets (see "Relocate assets" on page 148)
- Import and export jobs ("Import and export jobs" on page 149)

Search for objects

In the manage view, you can search for the objects available in *Primary Test Manager*:

- By searching for keywords in all object data
- By searching for keywords in particular object data

To search for keywords in all object data, type the keyword you search for in the respective **Search** box.

To search for keywords in particular object data:

3. Expand the Search area by clicking the arrow next to **Search**.
4. Type the keyword(s) you search for in the respective object data box(es).

The following table describes the asset search data.

Table 9-16: Asset search data

Data	Description
Asset	Asset under test
Asset type	Type of the asset
Serial no.	Serial number of the asset
Manufacturer	Manufacturer of the asset
Manufacturer type	Type of the asset according to the manufacturer
Asset system code	Code of the asset used by the maintenance planning systems
Apparatus ID	Identifier of the asset

The following table describes the job search data.

Table 9-17: Job search data

Data	Description
Name/WO	Name of the job or work order
Tested by	Person who performed the test
Executed between	Time period between the job was executed
Status	Status of the job

The following table describes the report search data.

Table 9-18: Report search data

Data	Description
Name	Name of the report
Client	Customer for which the report is designated
Created between	Time period between the report was created

Perform operations on objects

To perform operations on objects, select an object from the respective list, and then do one of the following:

- ► Click the **Create new *object*** button ➕ to add a new object of the same category.
- ► Click the **Open selected *object*** button 🗀 to display the data of the selected object.
- ► Click the **Delete selected *object*** button ✖ to delete the selected object.

Additionally, you can copy jobs with the associated location, asset and test data. The test results and reports are not copied. To copy a job:

1. Select the job you want to copy.
2. Click the **Copy selected job** button 🗐.

To perform operations on multiple objects, click **Enable multiple selection** in the menu bar, and then do one of the following:

- ► To delete multiple locations, assets, jobs, and test reports, select the check boxes next to the objects you want to delete, and then click the **Delete selected *object*** button ✖.
- ► To export multiple jobs, select the check boxes next to the jobs you want to export, and then click the **Export** button 🡕.

Master locations and assets

Primary Test Manager supports master locations and assets to help you keep your data consistent. When you create a job, the location and asset associated with that job – called master location and master asset, respectively – are copied to the job.

Consequently, whenever you try to change the location or the asset of an existing job, a notification bar at the top of the *Primary Test Manager* workspace prompts you to do one of the following:

- ► Click **Import from master location** or **Import from master asset** to import the location or asset originally associated with the job (master location/asset) to the current job.
- ► Click **Update master location** or **Update master asset** to update the location or asset originally associated with the job (master location/asset) with the data of the current job.

Duplicate assets

In the manage view, you can duplicate assets available in *Primary Test Manager*. To duplicate an asset:

1. From the asset list, select the asset you want to duplicate.
2. Click the **Duplicate** button .
3. In the asset view, type the serial number(s) of the new asset.

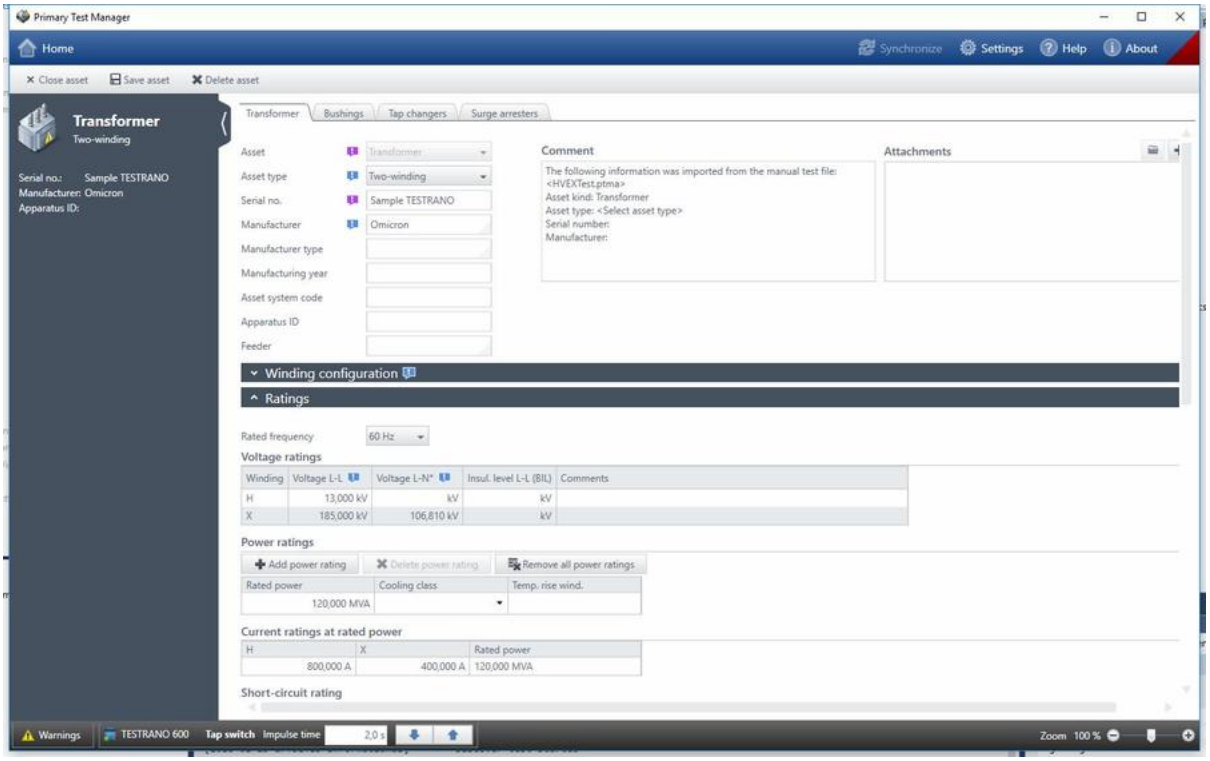


Figure 9-45: Asset view

4. In the asset view, click **Save asset**.

Note: By default, the duplicated asset are linked to location of the original asset. For relocating the asset to a different location, see "Relocate assets" later in this chapter.

Relocate assets

In the manage view, you can relocate assets available in *Primary Test Manager*. To relocate an asset:

1. From the asset list, select the asset you want to relocate.
2. Click the **Relocate** button .

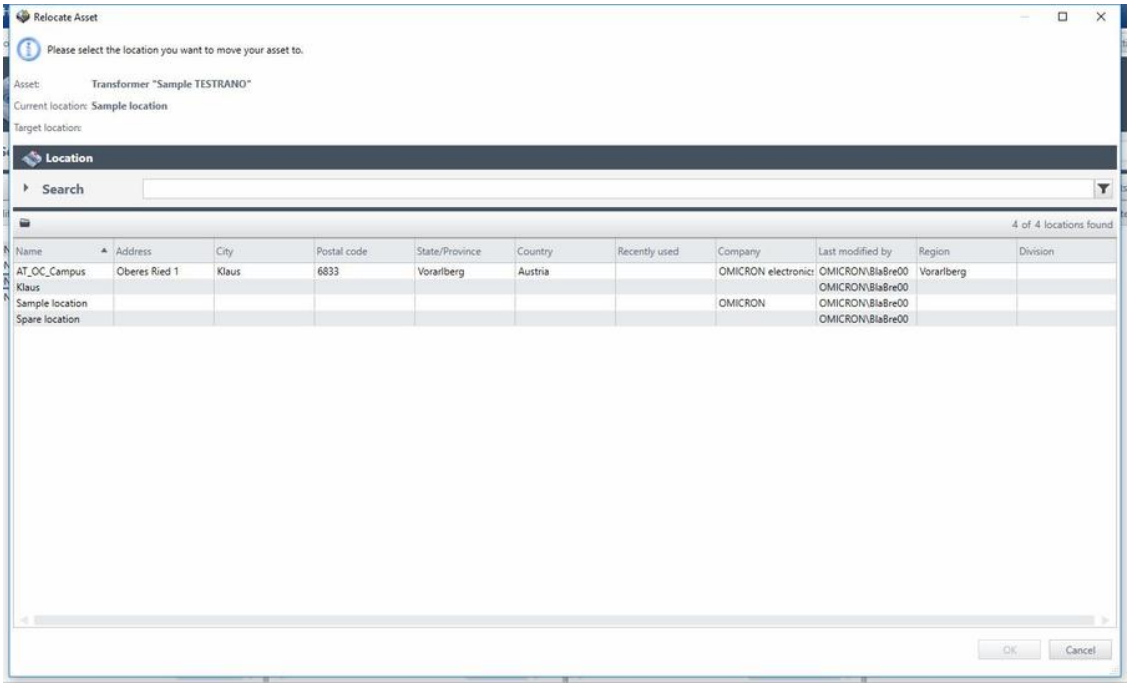


Figure 9-46: **Relocate Asset** dialog box

3. In the **Relocate Asset** dialog box, select the location you want to move the asset to.
4. If the asset you want to relocate is mountable, select an asset where the moved asset is to be mounted.

Note: You can filter the locations and assets by searching for keywords (see "Search for objects" on page 145).

Import and export jobs

Primary Test Manager supports data exchange between different test systems.

You can export jobs in the *Primary Test Manager* native PTM format. To export a job:

1. From the job list, select the job you want to export.
2. Click the **Export** button .
3. In the **Save As** dialog box, browse to the folder where you want to save the file.

You can import *Primary Test Manager* jobs in PTM format, test data in CSV format, and XML and SFRA Doble files.

Note: During the import, the Doble XML data is mapped to the *Primary Test Manager* jobs.

To import a job:

1. Under **Jobs**, click the **Import** button .
2. In the **Open** dialog box, select the data format of the file you want to import.
3. Browse to the file you want to import.

10 Testing with Primary Test Manager

10.1 Getting started

The following table lists the basic steps necessary to complete a measurement using *TESTRANO 600* and the *Primary Test Manager* guided workflow.

► For more information refer to the user manual chapters listed on the right.

Step		User manual chapter
	**1. SAFETY**	Safety instructions Hardware overview Safety and warning indicators Emergency Stop button Application
	**2. Connection to *TESTRANO 600***	Preparing the test setup
	**3. Start device and software**	TESTRANO 600 side panel Software start and device update
	**4. Location and asset**	Location view Asset view
	**5. Jobs**	Jobs
	**6. Tests**	Test view PTM Transformer tests PTM Bushing tests Device-independent PTM tests
	**7. Connection to device under test**	Safety instructions TESTRANO 600 measuring cables Application Connecting to the transformer
	**8. Test settings** **9. Test assessment**	Performing tests Assessing measurement results
	**10. Measurement**	Measurement

10.2 Measurement

► Refer to chapter 1 "Safety instructions" on page 8 for detailed information about safe testing.
► If in doubt, contact OMICRON support (see "Support" on page 231).

DANGER

Death or severe injury caused by high voltage or current

► Do not unplug any cables while the measurement is running.
► Only remove cables when **all** of the following apply to *TESTRANO 600*:
  • The red warning light on the front panel is **off**.
  • The warning lights on the side panel are **off**.
  • The green light on the front panel is **on**.

If all lights on *TESTRANO 600* are off, the device is defective or not supplied by mains.

WARNING

Death or severe injury caused by high voltage or current possible

► Do not enter the high-voltage area during the test.
► Do not touch any part of the transformer before grounding and short-circuiting its terminals.

1. Press **Start** in *Primary Test Manager*.

2. The blue ring on the **Start/Stop** button lights up.
3. Press the **Start/Stop** button to start the test.

4. The blue ring and the red warning light are now flashing for approx. 3 seconds.
   ► To suspend the test, press the **Start/Stop** button on the *TESTRANO 600* front panel.
   ► In an emergency, press the **Emergency Stop** button to stop the test.

5. After the measurement is completed or stopped, the green warning light switches on and *Primary Test Manager* displays the results in the **Measurements** view.

11 PTM Asset data

This section describes the data in the **Asset** view when you create a new or edit an existing asset from the **Manage** view.

11.1 Transformer data

The following tables describe the transformer data.

Table 11-1: Winding configuration

Data	Description
Phases	Number of transformer phases
Vector group	Vector group of the transformer (see "Setting the vector group of a transformer" on page 120)
Unsupported vector group (for documentation)	Vector group not supported by *Primary Test Manager* as text for documentation

Table 11-2: Ratings

Data	Description
Rated frequency	Rated frequency of the transformer
Voltage ratings	
Winding	Transformer's winding
Voltage L-L	L-L voltage of the transformer's winding
Voltage L-N	L-N voltage of the transformer's winding
Insul. level L-L (BIL)	L-L basic impulse level rating of the transformer's winding
Power ratings	
Rated power	Power rating of the transformer
Cooling class	Cooling class of the transformer
Temp. rise wind.	Temperature rise of the transformer's winding
Current ratings at rated power	
H/X/Y[1]	Maximum power frequency current of the transformer at rated power
Short-circuit rating	
Max. short-circuit current	Maximum short-circuit current of the transformer in kA during a given time in seconds

1. Set by the regional conventions (see "Settings" on page 96).

Table 11-3: Impedances

Data	Description
Ref. temp.	Reference temperature
Short-circuit impedances H - X[1], H - Y[1], X - Y[1]	
Short-circuit impedance Z (%)[1]	Short-circuit impedance of the transformer
Base power	Base power used for calculating the percent values of impedances
Base voltage	Base voltage used for calculating the percent values of impedances
Load losses Pk	Load loss at the transformer's rated load
OLTC position	Tap position of the OLTC
DETC position	Tap position of the DETC
Zero sequence impedance	
Base power	Base power used for calculating the percent values of impedances
Base voltage	Base voltage used for calculating the percent values of impedances
Winding	Transformer's winding
Zero sequence impedance Z0 (%)	Zero sequence impedance of the transformer

1. Set by the regional conventions (see "Settings" on page 96).

Table 11-4: Others

Data		Description
Category		Application category of the transformer
Status		Usage status of the transformer
Tank type		Type of transformer tank
Insulation medium		Insulation medium of the transformer
Insulation	Weight	Weight of transformer insulation
	Volume	Volume of transformer insulation
Total weight		Total weight of the transformer
Winding		Transformer's winding
Conductor material		Conductor material of the transformer's winding

11.1.1 Bushing data

For the data of the transformer's bushings, see 11.2 "Spare bushing data" on page 155.

11.1.2 Tap changer data

The following table describes the on-load tap changer (OLTC) and the de-energized tap changer (DETC) data.

Table 11-5: Tap changer data

Data	Description
OLTC/DETC	Select the **OLTC** check box to set the OLTC data. Select the **DETC** check box to set the DETC data.
Tap changer configuration	
Winding	Transformer's winding to which the tap changer is connected
Tap scheme	Notation scheme for tap identification
No. of taps	Number of the tap changer's taps
Current tap position[1]	Current position of the tap
Voltage table	
Tap	Number of the tap
Voltage	Voltage on the tap

1. Only available for the DETC

11.1.3 Surge arrester

The following table describes the surge arrester data.

Table 11-6: Surge arrester data

Data	Description
Ratings	
Units in stack	Number of the surge arrester's units
Numerical positions	Select the **Numerical positions** check box to set numerical positions of the surge arrester.
Literal positions	Select the **Literal positions** check box to set alphabetical positions of the surge arrester.
Position	Position of the surge arrester
Serial no.	Serial number of the surge arrester
Voltage L-L Voltage L-N	Values needed to calculate the maximum test voltages
MCOV rating	Maximum continuous operating voltage between the terminals of the surge arrester
Unit catalog no.	Identifier of the surge arrester unit

11.2 Spare bushing data

The following table describes the spare bushing data.

Table 11-7: Spare bushing data

Data	Description
Pos.[1]	Terminal of the transformer's winding to which the spare bushing is connected
Ratings	
Rated frequency	Rated frequency of the spare bushing
Insul. level LL (BIL)	L-L basic impulse level rating of the spare bushing
Voltage L-ground	Rated line-to-ground voltage
Max. system voltage	Maximum voltage between phases during normal service
Rated current	Rating current of the spare bushing
Manufacturer info	
Catalog no.	Catalog number of the spare bushing
Drawing no.	Drawing number of the spare bushing
Style no.	Style number of the spare bushing
Nominal values	
PF (C1)/ DF (C1)/ Tanδ (C1)[2]	Power factor, dissipation factor, or tangent delta of the capacitance C1 between the top of the spare bushing and the voltage/test tap
Cap. (C1)	Capacitance C1 between the top of the spare bushing and the voltage/test tap
PF (C2)/ DF (C2)/ Tanδ (C2)[2]	Power factor, dissipation factor, or tangent delta of the capacitance C2 between the voltage/test tap of the spare bushing and ground
Cap. (C2)	Capacitance C2 between the voltage/test tap of the spare bushing and ground

Table 11-7: Spare bushing data (continued)

Data	Description
Other	
Insulation type	Insulation type of the spare bushing
Outer insulation type	Outer insulation type of the spare bushing

1. Only available for spare bushings mounted on another assets
2. Set by the regional conventions (see "Settings" on page 96).

12 PTM Transformer tests

This chapter lists the *Primary Test Manager* transformer tests available for *TESTRANO 600*.

► For details on safely performing tests, refer to chapters 1 "Safety instructions" on page 8 and 5 "Application" on page 25.

Guided transformer tests	Page
12.1 Power factor/Dissipation factor/Tanδ & Capacitance[1]	158
• Overall PF/DF/Tanδ & Cap	
• Bushing PF/DF/Tanδ & Cap	
• Bushing – Energized Collar	
• Surge Arrester Watt Losses	
• Insulating Fluids PF/DF/Tanδ & Cap	
12.2 Exciting Current	162
12.3 HV Turns Ratio	164
12.4 Leakage Reactance/Short-circuit Impedance	167
12.5 Turns Ratio	170
12.6 DC Winding Resistance	173
12.7 Dynamic OLTC-Scan (DRM)	176
12.8 Demagnetization	179
12.9 Vector Group Check	180

1. Depending on the **Profile** selected in **Settings** – **Profiles** (see "Profiles" on page 99).

Manual transformer tests	Page
12.10 Manual Demagnetization test	181
12.11 Manual Power losses at low voltage test	183
12.12 Manual Turns ratio test	185
12.13 Manual Exciting current test	188
12.14 Manual HV Turns Ratio test	190
12.15 Manual DC winding resistance test	193
12.17 Manual Leakage reactance/Short-circuit impedance test	199
12.16 Manual Dynamic OLTC-Scan (DRM)	197
12.18 Manual Tan delta test	202
12.19 Manual Vector Group Check	204
12.20 Quick test	205

Note: The chapters list the available options and settings for the tests. Depending on the individual asset and the general *Primary Test Manager* settings, not every test displays all listed items.

► For information on how to group tests and execute them in sequence, refer to "Grouping tests" on page 126.

12.1 Power factor/Dissipation factor/Tanδ & Capacitance

Capacitance and power factor/dissipation factor measurements are performed to investigate the condition of the insulation of power transformers and bushings. Both insulation systems are essential for the reliable operation of the transformer.

Note: Depending on your settings, some test names include the power factor (PF), the dissipation factor (DF), or the tangent delta (Tanδ). The dissipation factor and the tangent delta are identical characteristics of the primary asset under test. With *Primary Test Manager* you can use your preferred naming. You can also select some test names to match your regional conventions (see "Settings" on page 96).

The following power factor/dissipation factor tests are available for *TESTRANO 600*:

- Overall PF/DF/Tanδ & CAP[1]
- Bushing PF/DF/Tanδ & CAP
- Bushing – Energized Collar
- Surge Arrester Watt Losses
- Insulating fluids PF/DF/Tanδ & CAP

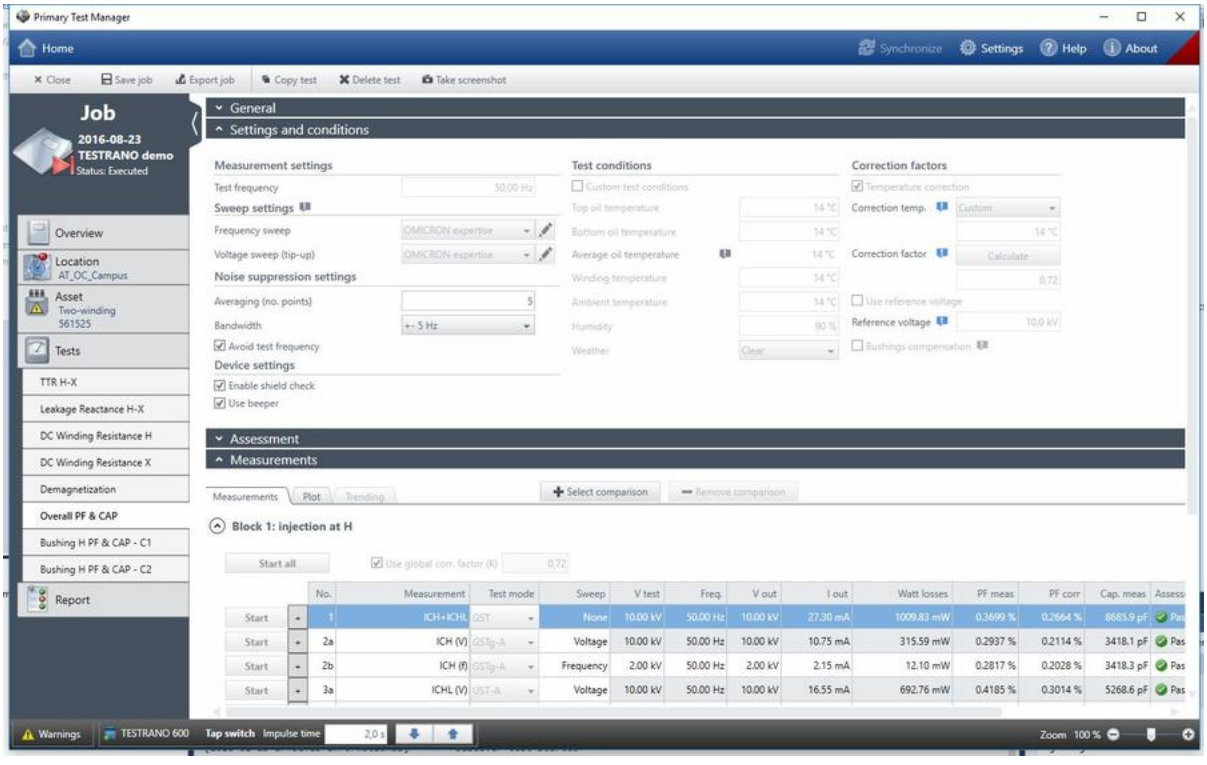


Figure 12-1: Overall DF & Cap test view

1. Depending on the **Profile** selected in **Settings** – **Profiles** (see "Profiles" on page 99).

The table below lists common parameters for the PF/DF/Tanδ tests.

Note: Some tests do not comprise all parameters listed below.

Table 12-1: PF/DF/Tanδ test – Settings and conditions

Option	Description
Measurement settings	
Test frequency	► Set the output frequency for the test.
Show results	► Select the results you want to display. All measurement results are stored and displayed when selected from the list.
Sweep settings	
Frequency sweep	Sweep profile: None, OMICRON expertise (recommended), or CPC template • **None**: no frequency sweep • **OMICRON expertise**: sweep frequencies dynamically distributed within the *TESTRANO 600* frequency range for optimum results • **CPC template**: sweep frequencies specified by the *CPC 100* test templates
Voltage sweep (tip-up)	Sweep profile: None or OMICRON expertise • **None**: no voltage sweep • **OMICRON expertise**: sweep voltages dynamically distributed within the asset-dependent voltage range for optimum results
Sweep profiles	► Click the pen button to create a frequency or voltage sweep profile. ► Add up to 30 measurement points with individual output voltages or frequencies. Double-click a value to change it. ► Mark a favorite ★ to use it as the default sweep profile for future tests. **Note:** The predefined profiles **None**, **OMICRON expertise** and **CPC template** cannot be edited or deleted. The default sweep profiles for this test are: • Frequency sweep: OMICRON expertise • Voltage sweep: None
Noise suppression settings	
Averaging (no. points)	Number of averaged measurements
Bandwidth	*CP TD1* filter bandwidth

Table 12-1: PF/DF/Tanδ test – Settings and conditions (continued)

Option	Description
Avoid test frequency	If this setting is active, the measurement will *not* be performed at the **Test frequency** set in the **Measurement** section. *Primary Test Manager* will instead measure two values at frequencies below and above the entered **Test frequency** and calculate the median of those two values. The **Avoid test frequency** setting is predefined for the selected test. ► Only change the default setting for special applications.
Device settings	
Enable shield check	► Activate the check box if you want *TESTRANO 600* to check whether the shield of the high-voltage cable is connected.
Use beeper	► Activate the check box to activate the *CP TD1* beeper during the measurement.
Test conditions	
Custom test conditions	► Activate the check box to set test conditions differing from the global test conditions.
Top oil temperature	► Enter the temperature of the oil from the top of the transformer tank.
Bottom oil temperature	► Enter the temperature of the oil from the bottom of the transformer tank.
Average oil temperature	Calculated average oil temperature in the tank
Winding temperature	► Enter the winding temperature.
Ambient temperature	► Enter the ambient temperature on site.
Humidity	► Enter the relative ambient humidity on site.
Weather	► Select the weather conditions during the test.
Correction factors	
Temperature correction	► Activate the check box to use temperature correction for this test.
Correction factor	Temperature correction factor
Use reference voltage	► Activate the check box to extrapolate the **I out** and **Watt losses** results for the specified reference voltage.
Reference voltage	Reference voltage for extrapolation of the measurement results
Bushings compensation	► Activate the check box to compensate the effect of the capacitance C1 of the transformer's bushings on the measurement results of the test.

Table 12-2: PF/DF/Tanδ test – Measurements

Option	Description
Table	
Measurement	Arrangement of the measurement
Test mode	► Select a test mode from the drop-down list.
V test	Test voltage
Freq.	Test frequency
V out	Measured output voltage
I out	Measured output current
Watt losses	Measured losses
PF meas	Measured power factor
PF corr	Corrected power factor
Cap. meas	Measured capacitance
Assessment	Measurement assessment

12.2 Exciting Current

Exciting current measurements are performed to assess the turn-to-turn insulation of the windings, the magnetic circuit of a transformer as well as the tap changer. The most valued benefit of the test is to detect turn-to-turn short-circuits in a winding. Physical movement of the core laminations or severe damage to the core can influence the reluctance and, thus, will result in a change in exciting current. Deviations may also indicate contact wear or improper wiring of the tap changer.

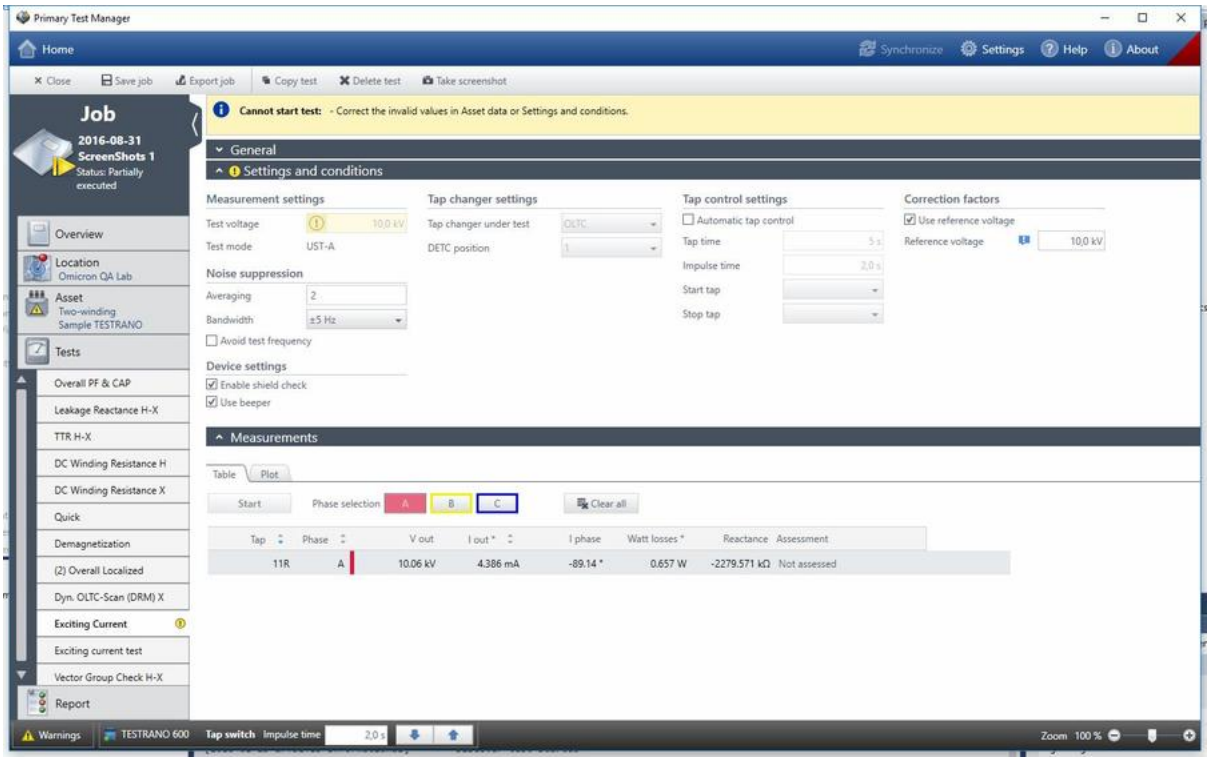


Figure 12-2: Exciting current test

Table 12-3: Exciting current test – Settings and conditions

Option	Description
Measurement settings	
Test voltage	Output voltage
Test mode	Test mode for this test: UST-A
Noise suppression	
Averaging	Number of averaged measurements
Bandwidth	*CP TD1* filter bandwidth

Table 12-3: Exciting current test – Settings and conditions (continued)

Option	Description
Avoid test frequency	If this setting is active, the measurement will *not* be performed at the **Test frequency** set in the **Measurement** section. *Primary Test Manager* will instead measure two values at frequencies below and above the entered **Test frequency** and calculate the median of those two values. The **Avoid test frequency** setting is predefined for the selected test. ► Only change the default setting for special applications.
Tap changer settings	
Tap changer under test	► Select which tap changer to include in the measurement if both an OLTC and a DETC have been defined.
Tap control settings	
Automatic tap control	► Activate the check box to use automatic tap control during the test.
Tap time	Time for the change between two tap positions
Impulse time	Duration of the impulse triggering the tap change
Start tap	Start tap position of the test
Stop tap	Stop tap position of the test

Table 12-4: Exciting current test – Measurements

Option	Description
Tap	Tap under test
Phase	Phase under test
V out	Output voltage
I out	Excitation current
I phase	Measured primary current per phase
Watt losses	Measured losses
Reactance	Main inductance of the transformer
Assessment	Measurement assessment

12.3 HV Turns Ratio

The turns ratio is determined during factory acceptance tests and needs to be checked routinely once the transformer is in service. By measuring the ratio and phase angle from one winding to the other, open circuits and shorted turns can be detected.

A low-voltage turns ratio test may not detect a voltage sensitive failure within the transformer. Therefore, for fault investigations, it is recommended that a high-voltage TTR test is performed to apply a higher electrical stress to the insulation system.

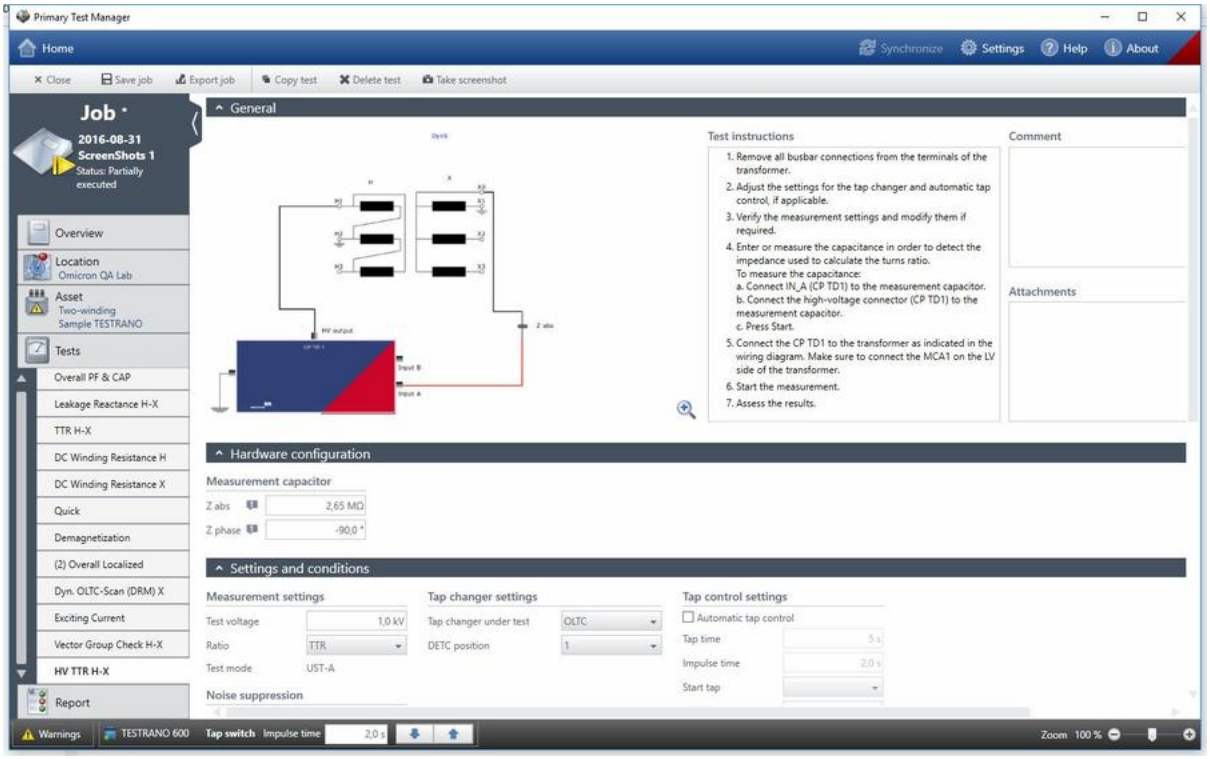


Figure 12-3: HV Turns Ratio test

Table 12-5: HV Turns Ratio – Hardware configuration

Option	Description
Measurement capacitor	
Z abs	Absolute impedance value
Z phase	Phase angle of the impedance

Table 12-6: HV Turns Ratio – Settings and conditions

Option	Description
Measurement settings	
Test voltage	► Enter the output voltage.
Ratio	► Choose between transformer turns ratio (TTR) and voltage ratio (VTR).
Test mode	Test mode for this test: UST-A
Noise suppression	
Averaging	Number of averaged measurements
Bandwidth	*CP TD1* filter bandwidth
Avoid test frequency	If this setting is active, the measurement will *not* be performed at the **Test frequency** set in the **Measurement** section. *Primary Test Manager* will instead measure two values at frequencies below and above the entered **Test frequency** and calculate the median of those two values. The **Avoid test frequency** setting is predefined for the selected test. ► Only change the default setting for special applications.
Device settings	
Enable shield check	► Activate the check box if you want *TESTRANO 600* to check whether the shield of the high-voltage cable is connected.
Use beeper	► Activate the check box to activate the *CP TD1* beeper during the measurement.
Tap changer settings	
Tap changer under test	► Select which tap changer to include in the measurement if both an OLTC and a DETC have been defined.
Tap control settings	
Automatic tap control	► Activate the check box to use automatic tap control during the test.
Tap time	Time for the change between two tap positions
Impulse time	Duration of the impulse triggering the tap change
Start tap	Start tap position of the test
Stop tap	Stop tap position of the test

Table 12-7: HV Turns Ratio – Measurements

Option	Description
Capacitor	
Test voltage	Output voltage
Test mode	► Select a test mode from the drop-down list
V out	Measured output voltage

Table 12-7: HV Turns Ratio – Measurements (continued)

Option	Description
I out	Measured output current
Z abs	Absolute impedance value
Z phase	Phase angle of the impedance
Table	
Phase selection	► After rewiring, select the next phase and press **Start**.
Tap	Tap under test
Phase	Phase under test
Nominal ratio	Nominal transformer ratio
V prim	Output voltage
I sec	Measured current on the secondary side of the transformer
Z sec	**V prim** divided by **I sec** Used to calculate the turns ratio
V phase	Phase shift of the transformer
TTR	Measured transformer turns ratio
VTR	Measured voltage ratio
Ratio dev	Deviation of the nominal ratio from the voltage ratio
Assessment	Measurement assessment

12.4 Leakage Reactance/Short-circuit Impedance

Short-circuit impedance/leakage reactance measurements are sensitive methods to assess possible deformation or displacements in windings.

The frequency response of stray losses (FRSL) test is a measurement of the resistive component of the short-circuit impedances at multiple frequencies. It is an electrical method to identify short-circuits between parallel strands and local overheating due to excessive eddy current losses. The test setup and procedure of the FRSL test is the same as for the per phase short-circuit impedance/leakage reactance test and can be performed simultaneously.

Note: The name of this test depends on the standard set in the Settings view (see "Profiles" on page 99):

- According to the IEEE standard: Leakage Reactance
- According to IEC standard: Short-Circuit Impedance

In this chapter, the test will be referred to as short-circuit impedance.

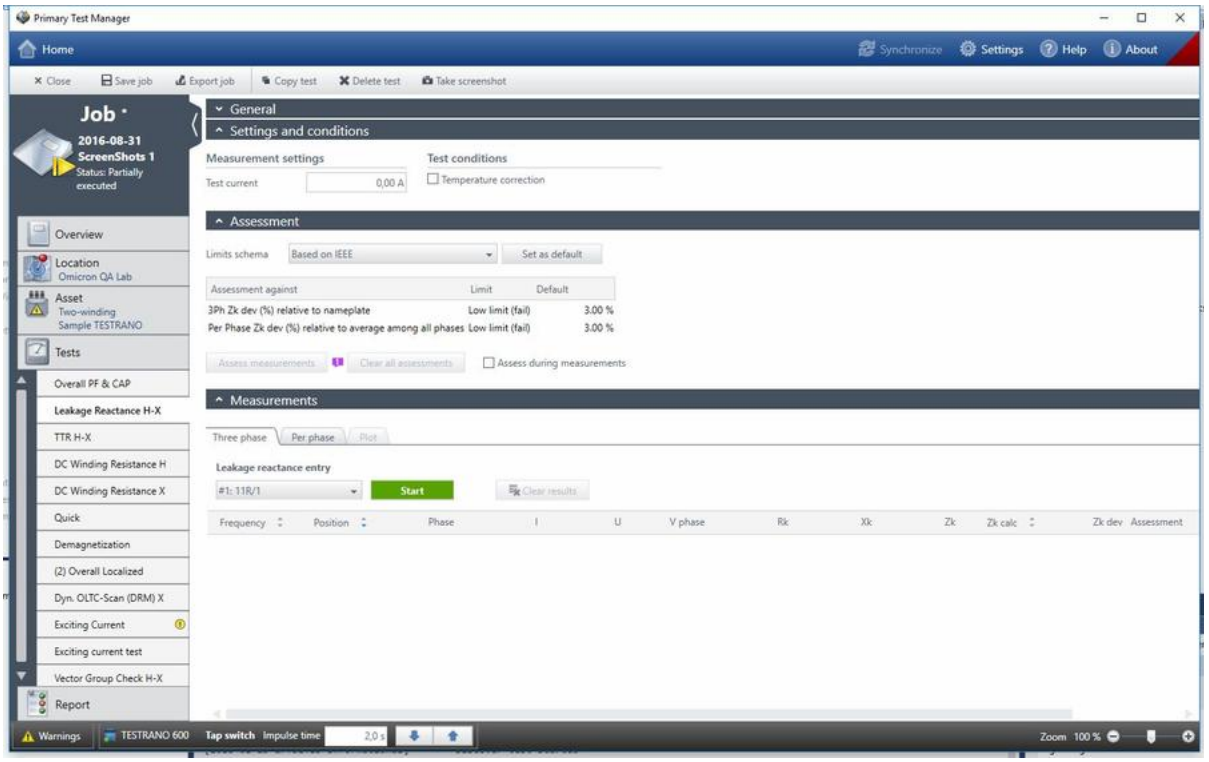


Figure 12-4: Short-circuit impedance test view

Table 12-8: Short-circuit impedance – Settings and conditions

Option	Description
Measurement settings	
Test current	► Enter the maximum test current.
Test conditions	
Temperature correction	► Activate the check box to use temperature correction for this test.
Winding material	Conductor material of the transformer's winding
Winding temp.	Temperature of the transformer's winding
Reference temp.	Reference temperature to be used for temperature correction
Correction factor	Temperature correction factor

Table 12-9: Short-circuit impedance – Assessment

Option	Description
Limits schema	► Select a standard from the drop-down box or set your own limits schema by selecting **Customer specific limits**.
Assess during measurements	► Activate the **Assess during measurements** check box to assess the test while the measurements are running.

Table 12-10: Short-circuit impedance – Measurements

Option	Description
Three phase	The **Three phase** measurement is performed to compare the results to the nameplate data.
Per phase	The **Per phase** measurement is performed for an in-depth error analysis of the individual phases.
Short-circuit impedance entry / Leakage reactance entry	Tap settings for the short-circuit impedance test
Show FRSL results[1]	► Activate the check box to display the FRSL results in the **Per phase** table.
Phase	Phase under test
I	Measured current
U	Measured voltage
V phase	Phase angle between voltage and current
Rk	Real part of the measured Zk
Xk	Imaginary part of the measured Zk (short-circuit impedance)
Zk	Measured short-circuit impedance

Table 12-10: Short-circuit impedance – Measurements (continued)

Option	Description
uk calc / Zk calc[1]	Short-circuit impedance when IEC profile is active
uk avg / Zk avg[1, 2]	Average of **Zk** across all phases
uk dev / Zk dev[2]	Deviation from the nameplate value entered in the **Impedance settings** list
Assessment	Measurement assessment

1. Depending on the **Profile** selected in **Settings** – **Profiles** (see "Profiles" on page 99).
2. Only for **Per phase** test

12.5 Turns Ratio

Transformer turns ratio (TTR) measurements are performed to verify the fundamental operating principle of a power transformer. By measuring the ratio and phase angle from one winding to the other, open circuits and shorted turns can be detected. The turns ratio is determined during factory acceptance tests and needs to be checked routinely once the transformer is in service.

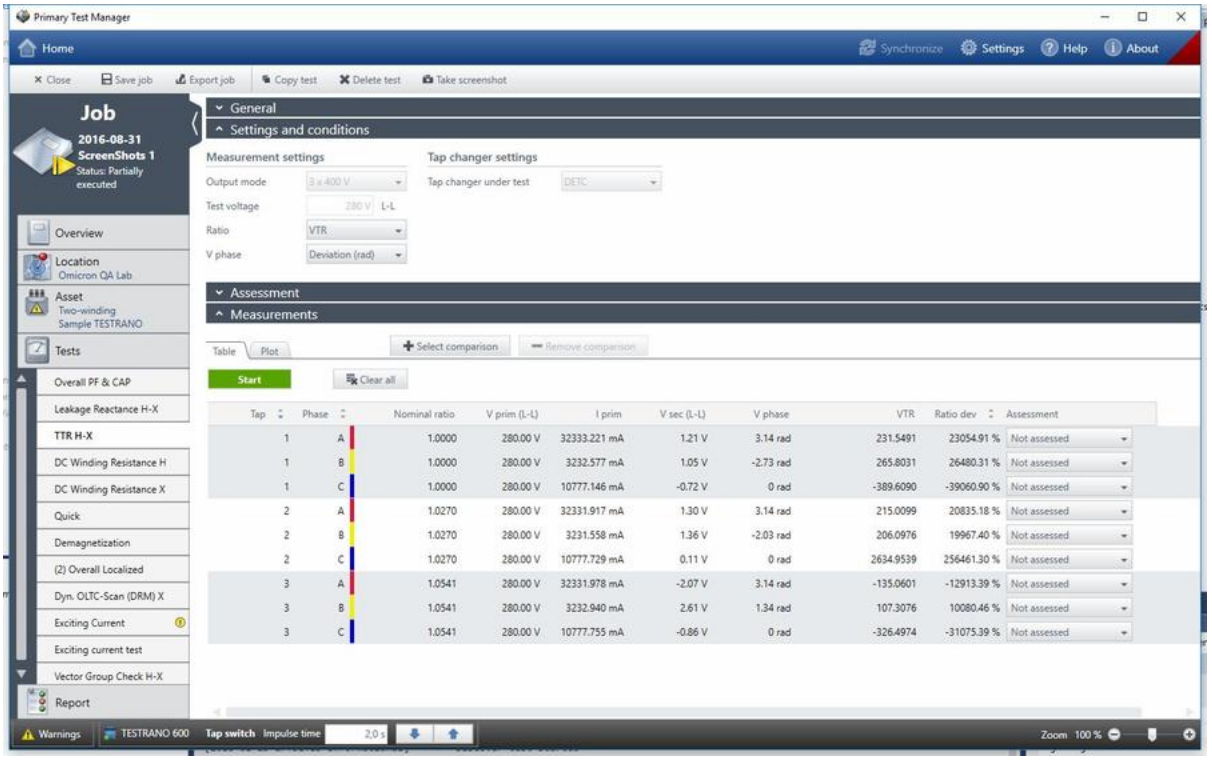


Figure 12-5: Turns Ratio Test view

Table 12-11: Turns ratio test – Settings and Conditions

Option	Description
Measurement settings	
Output mode	Standard setting: 3 x 400 V ► Select the 3 x 120 V output mode if an increased magnetizing current is necessary. ► Refer to "AC high range low current" in Table 15-2, page 219.
Test voltage	Output voltage
Ratio	► Choose between TTR (transformer turns ratio) and VTR (voltage turns ratio) to be displayed in the **Measurements** table.
V phase	Phase shift of the transformer

Table 12-11: Turns ratio test – Settings and Conditions (continued)

Option	Description
Tap changer settings	
Tap changer under test	► Select which tap changer to include in the measurement if both an OLTC and a DETC have been defined.
DETC position	DETC tap position during tap switching on the OLTC
OLTC position	OLTC tap position during tap switching on the DETC
Tap control settings	
Automatic tap control	► Activate the check box to use automatic tap control during the test.
Tap time	Time for the change between two tap positions
Impulse time	Duration of the impulse triggering the tap change
Start tap	Start tap position of the test
Stop tap	Stop tap position of the test

Table 12-12: Turns ratio test – Assessment

Option	Description
Limits schema	► Select a standard from the drop-down box or set your own limits schema by selecting **Customer specific limits**.
Assess during measurements	► Activate the **Assess during measurements** check box to assess the test while the measurements are running.

Table 12-13: Turns ratio test – Measurement results

Option	Description
Table	
Tap	Tap under test
Phase	Phase under test
Nominal ratio	Nominal transformer ratio
V prim	Output voltage
I prim	Excitation current
I phase	Measured primary current per phase
V sec	Secondary voltage
V phase	Phase angle of the measured secondary voltage

Table 12-13: Turns ratio test – Measurement results (continued)

Option	Description
TTR	Measured transformer turns ratio
VTR	Measured voltage turns ratio
Ratio dev	Deviation of the nominal ratio from the voltage ratio
Assessment	Measurement assessment

12.6 DC Winding Resistance

Winding resistance measurements are performed to assess possible damages in windings or contact problems between bushings and windings, windings and tap changer, etc.

The following winding resistance tests are available for *TESTRANO 600*:

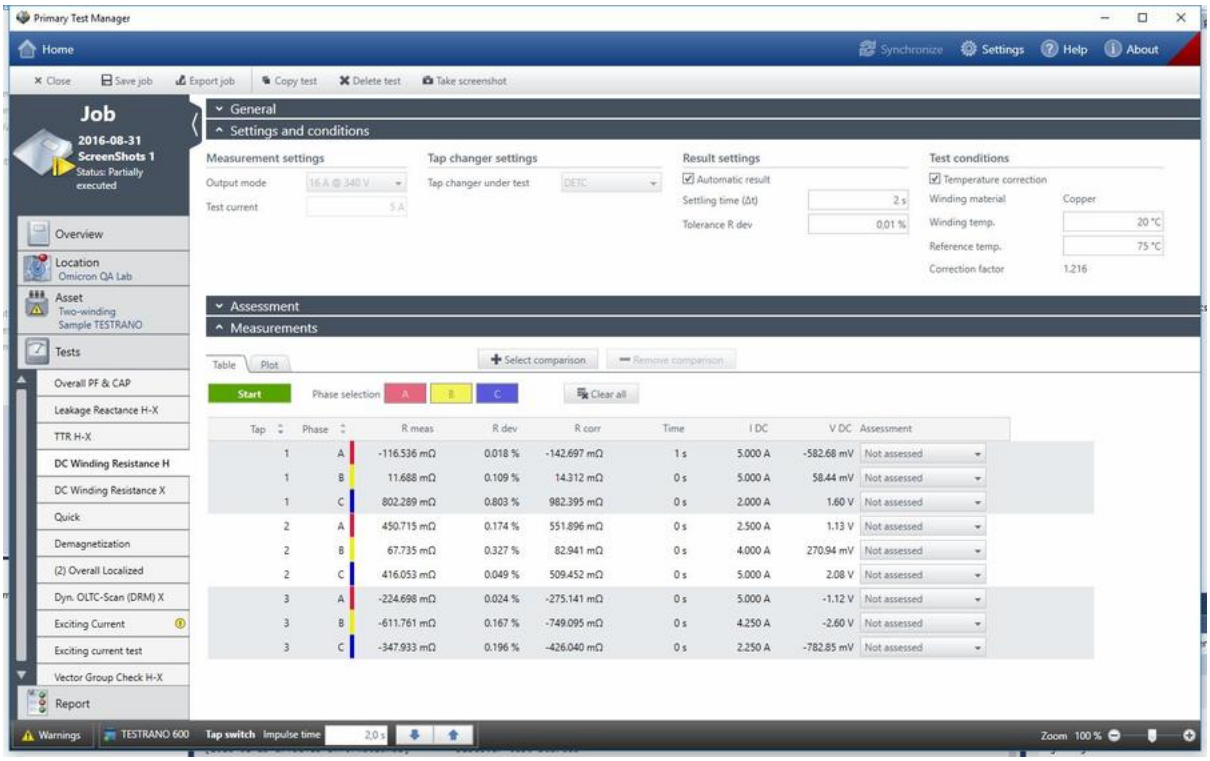


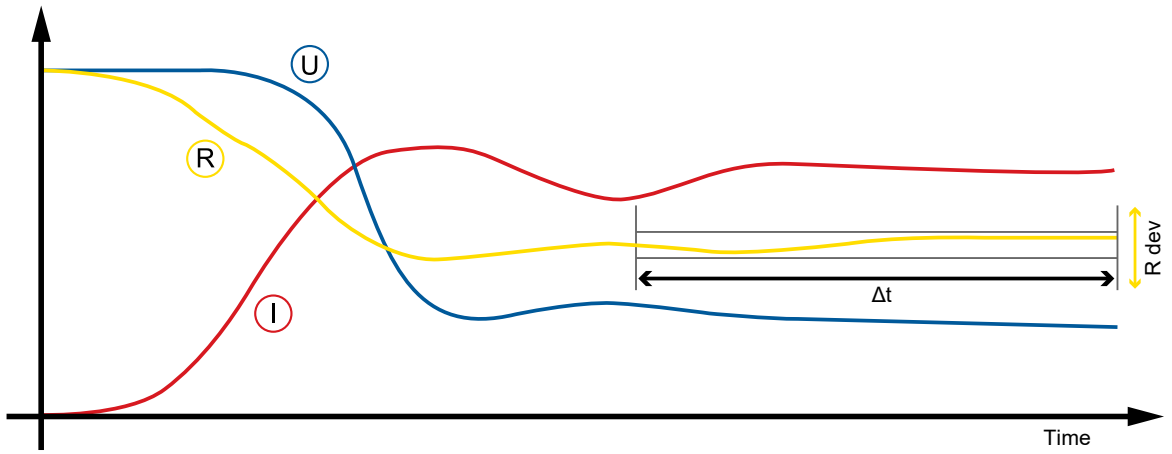
Figure 12-6: Winding Resistance test view

Table 12-14: Winding Resistance – Settings and Conditions

Option	Description
Measurement settings	
Output mode	16 A @ 340 V fast magnetization with elevated Voltage
	33 A @ 170 V for assets with expected low resistances
	100 A @ 56 V for assets with very low resistance ► Refer to the wiring diagram for rewiring.
Test current	Current output during the test
Tap changer settings	
Tap changer under test	Tap changer actuated during the test

Table 12-14: Winding Resistance – Settings and Conditions (continued)

Option	Description
DETC position	DETC tap position during tap switching on the OLTC
OLTC position	OLTC tap position during tap switching on the DETC
Tap control settings[1]	
Automatic tap control	► Activate the check box to activate the automatic tap control.
Tap time	Time for the change between two tap positions
Impulse time	Duration of the impulse triggering the tap change
Start tap	Start tap position of the test
Stop tap	Stop tap position of the test
Up/Down test	► Activate the check box for the automatic change of switching direction after the first/last tap.
Result settings	
Automatic result	► Select **ON** to automatically keep measurement results, depending on tolerance R dev and the settling time.



Settling time (Δt)	Time during which the deviation of measurement results is evaluated. If the deviation is below the defined tolerance R dev, the result is recorded.
Tolerance R dev	Tolerance for the deviation of measurement results within the settling time
Test conditions	
Temperature correction	► Activate the check box to use temperature correction for this test.

Table 12-14: Winding Resistance – Settings and Conditions (continued)

Option	Description
Winding material	Conductor material of the transformer's winding
Winding temp.	Temperature of the transformer's winding
Reference temp.	Reference temperature to be used for temperature correction
Correction factor	Temperature correction factor

1. Only for OLTC

Table 12-15: Winding Resistance H – Measurement results

Option	Description
Table	
Tap	Tap changer position
Phase	Output phase
R meas	Measured resistance
R dev	Deviation of two successive measurement results at the time the test was stopped
R corr	Corrected measured resistance
Time	Time between the start and stop of a measurement
I DC	Measured current
V DC	Measured voltage
Assessment	Measurement assessment

12.7 Dynamic OLTC-Scan (DRM)

Dynamic resistance measurements are performed as a supplementary measurement in order to analyze the transient switching process of a resistive diverter OLTC. They investigate the switching process of the diverter switch itself. When switching the tap changer during winding resistance measurements, the DC current temporarily decreases and this behavior is recorded and analyzed.

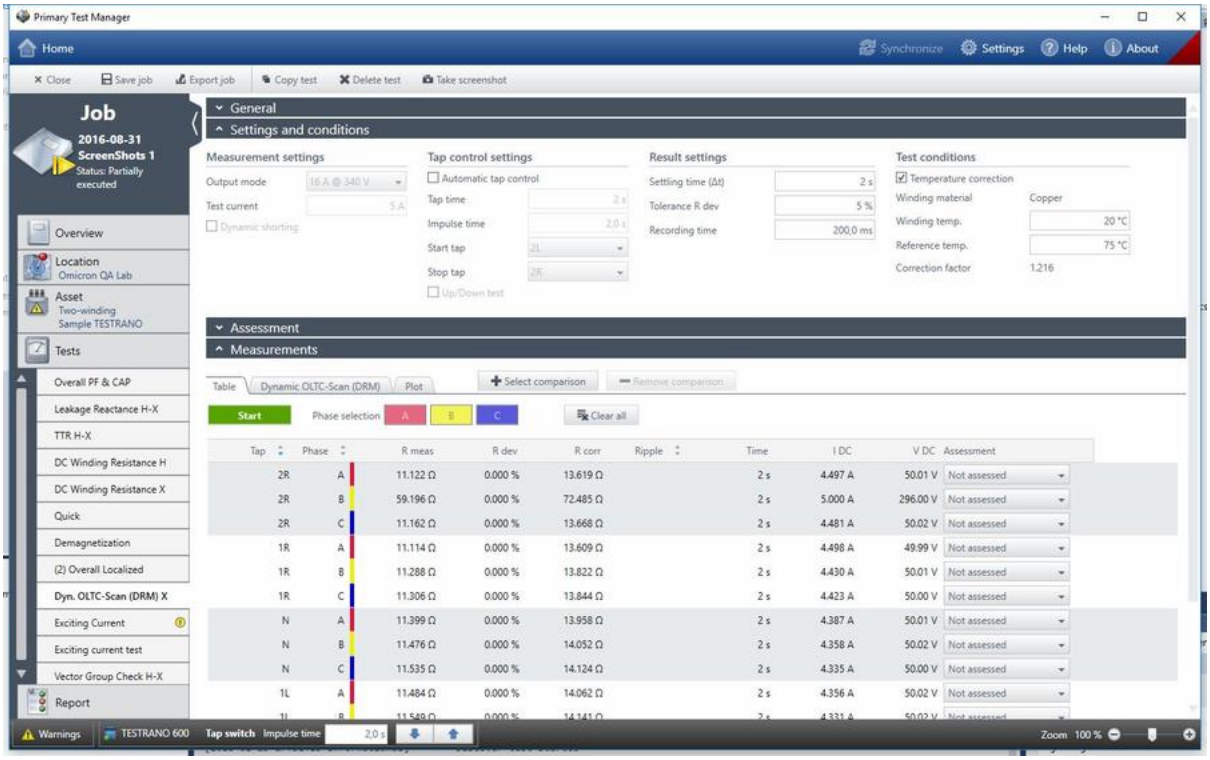


Figure 12-7: Dynamic OLTC-Scan (DRM)

Table 12-16: Dynamic OLTC-Scan (DRM) – Settings and conditions

Option	Description
Measurement settings	
Output mode	DC current output of *TESTRANO 600*
Test current	Current output during the test
Dynamic shorting	Dynamic short-circuit of low-voltage windings on single- and three-phase transformers. Only selectable for two- and three-winding transformers with an OLTC on the high-voltage winding.
Motor supply	
Record motor supply	► Activate the check box to record the current and voltage supply to the tap changer motor.
Clamp ratio	► Enter the current clamp's transformer ratio (current to voltage).

Table 12-16: Dynamic OLTC-Scan (DRM) – Settings and conditions (continued)

Option	Description
Tap control settings	
Automatic tap control	Taps are switched automatically during this measurement
Tap time	Time for the change between two tap positions
Impulse time	Duration of the impulse triggering the tap change
Start tap	Start tap position of the test
Stop tap	Stop tap position of the test
Up/Down test	► Activate the check box for the automatic change of switching direction after the first/last tap.
Result settings	
Settling time (Δt)	Time during which the deviation of measurement results is evaluated. If the deviation is below the defined tolerance R dev, the result is recorded.
Tolerance R dev	Tolerance for the deviation of measurement results within the settling time.
Recording time	Recording period during the switching cycle
Test conditions	
Temperature correction	► Activate the check box to use temperature correction for this test.
Winding material	Conductor material of the transformer's winding
Winding temperature	Temperature of the transformer's winding
Reference temperature	Reference temperature to be used for temperature correction
Correction factor	Temperature correction factor

Table 12-17: Dynamic OLTC-Scan (DRM) – Measurements

Option	Description
Table	
Tap	Tap changer position
Phase	Output phase
R meas	Measured resistance
R dev	Deviation of two successive measurement results at the time the test was stopped
R corr	Temperature-corrected measured resistance
Ripple	Percentage deviation between highest and lowest value in the DRM curve
Time	Time between the start and stop of a measurement
I DC	Measured current
V DC	Measured voltage
Assessment	Measurement assessment

Measurement results – Dynamic OLTC-Scan (DRM) tab

The **Dynamic OLTC-Scan (DRM)** tab displays the measurement results in charts.

If you activated the **Record motor supply** check box in the **Settings and conditions** section, you can compare both charts in this view. The actual tap switch is marked in the **Motor supply** chart.

► Expand the **Legend** tab on the left to select which graphs to display and to color them for easier distinction.

► Expand the **Filters / Cursor values** tab on the right to apply filters and view the detailed values for the positions of the various cursors.

Table 12-18: Cursor values for Dynamic OLTC-Scan measurement results

Option	Description
ΔI [A]	Difference in current values [amperes]
Δt [ms]	Time difference [milliseconds]
ΔU [V]	Difference in voltage values [volts]

12.8 Demagnetization

Whenever a power transformer is isolated from the power system, residual magnetism remains in its core due to a phase shift. Due to residual magnetism in the core, high inrush currents, up to the maximum short-circuit current can occur. This puts undesired stress on the transformer when it is switched back into service. In addition, many diagnostic measurements can be affected by residual magnetism, making a reliable assessment very difficult.

Therefore, it is recommended to demagnetize the core before switching the transformer back into service and after DC voltages have been applied during diagnostic testing.

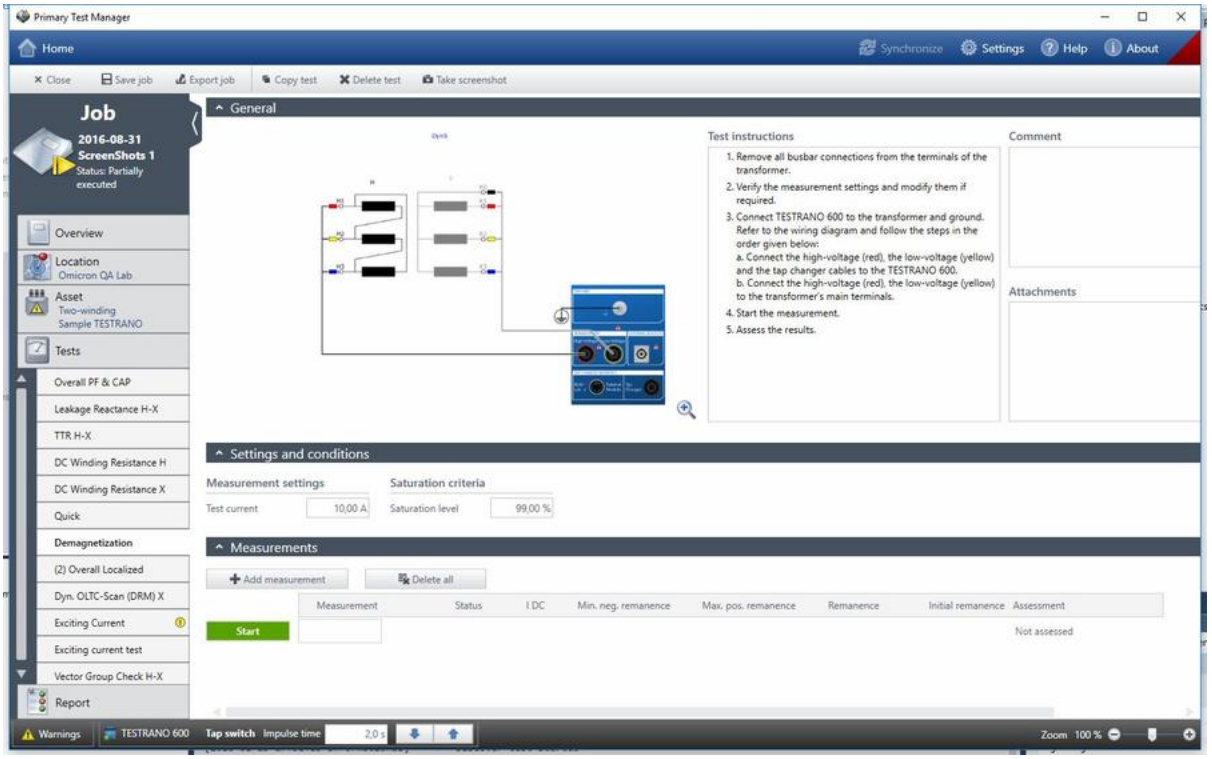


Figure 12-8: Demagnetization test view

Table 12-19: Demagnetization – Settings and conditions

Option	Description
Measurement settings	
Test current	► Set the current injected during the test.
Saturation criteria	
Saturation level	Desired saturation level during the demagnetization process. This value is only adapted in special cases.

Table 12-20: Demagnetization – Measurement results

Option	Description
Measurement	
Measurement	Text field for description or comment
Status	During demagnetization: • Positive saturation running • Negative saturation running • Demagnetization running After demagnetization: • Demagnetization passed • Saturation failed • Demagnetization aborted
I DC	Measured current
Min. neg. remanence	Maximum remanence in negative direction of the hysteresis curve
Max. pos. remanence	Maximum remanence in positive direction of the hysteresis curve
Remanence	Measured remanence
Initial remanence	Measured remanence at the start of the test

12.9 Vector Group Check

The **Vector group check** comprises a three-phase turns ratio measurement, neutral detection and a series of single-phase measurements to determine the vector group.

Table 12-21: Vector group check – Settings and conditions

Option	Description
Measurement settings	
Test voltage	Maximum output voltage ► Perform the vector group check using the default value. ► If there is no conclusive result, try increasing the test voltage.

After the check is completed, *PTM* displays the detected vector group(s) in the **Measurements** section.

► If there is no conclusive result, try increasing the test voltage.

► Press **Copy to asset** to apply the suggested vector group to the **Winding configuration** of the asset.

12.10 Manual Demagnetization test

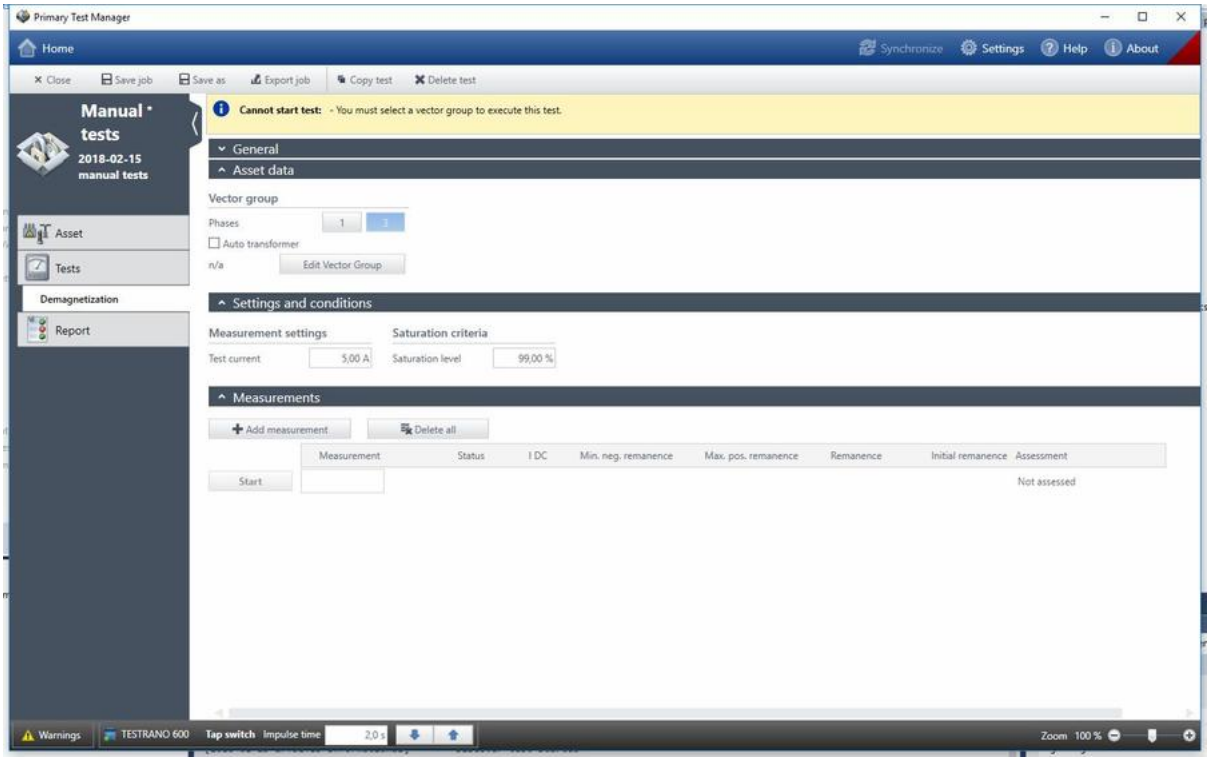


Figure 12-9: Manual Demagnetization test view

Table 12-22: Manual Demagnetization test – Asset data

Option	Description
Vector group	
Phases	► Set the number of transformer phases.
Auto transformer	► Activate the check box if you are testing an auto transformer.
Edit Vector Group	► Set the vector group.
Test settings	
Test current	► Enter the maximum test current.
Saturation level	Desired saturation level during the demagnetization process. This value is only adapted in special cases.

Table 12-23: Manual Demagnetization test – Settings and conditions

Option	Description
Measurement settings	
Test current	► Enter the maximum test current.
Saturation criteria	
Saturation level	Desired saturation level during the demagnetization process. This value is only adapted in special cases.

Table 12-24: Manual Demagnetization test – Measurement

Option	Description
Measurement	
Measurement name	Text field for description or comment
Status	During demagnetization: • Positive saturation running • Negative saturation running • Demagnetization running After demagnetization: • Demagnetization passed • Saturation failed • Demagnetization aborted
I DC	Measured current
Min. neg. remanence	Maximum remanence in negative direction of the hysteresis curve
Max. pos. remanence	Maximum remanence in positive direction of the hysteresis curve
Remanence	Measured remanence
Initial remanence	Measured remanence at the start of the test
Assessment	Measurement assessment

12.11 Manual Power losses at low voltage test

The power losses at low voltage test helps detect open circuits, shorted turns or problems with the transformer core. It is performed during factory acceptance tests and for routine checks on a regular basis to comply with the GOST 3484.1 standard, in countries where it is applicable.

Note: The transformer should always be demagnetized before performing a power losses at low voltage test.
TESTRANO 600 currently only supports the power losses at low voltage test on transformers with vector groups YNd11, Yd11 and YNyn0.

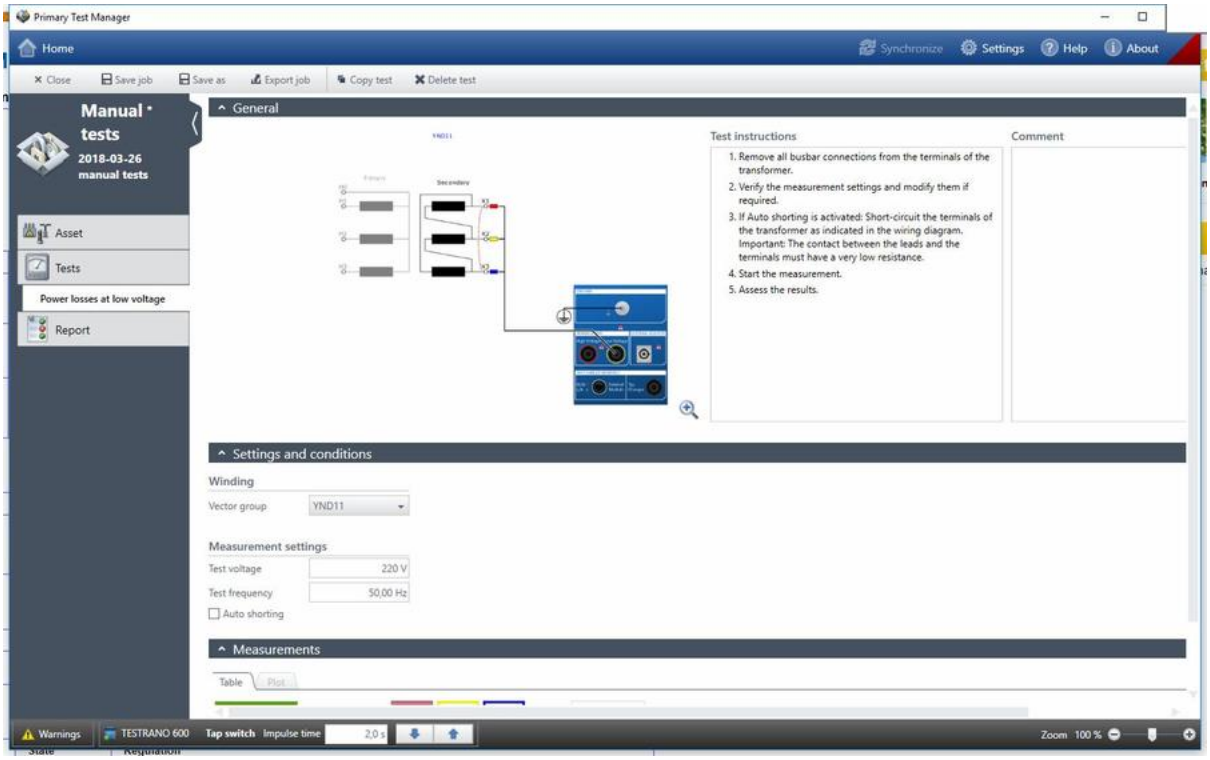


Figure 12-10: Power losses at low voltage test

Table 12-25: Power losses at low voltage test – Settings and conditions

Option	Description
Winding	
Vector group	► Select from vector groups YNd11, Yd11 and YNyn0.
Measurement settings	
Test voltage	► Enter the output voltage.
Test frequency	► Enter the mains frequency.
Auto shorting	On: Automatic phase switch and short-circuiting of the phases *not* under test Off: Manual phase switching via the **Phase selection** buttons and manual short-circuiting of the phases *not* under test

Table 12-26: Power losses at low voltage test – Measurements

Option	Description
Phase selection	
► After rewiring, select the next phase and press **Start**.	
Table	
Phase	Phase under test ► Refer to the wiring diagram for correct wiring after changing the phase.
V out	Measured output voltage
I out	Measured output current
I phase	Measured current per phase
Watt losses	Measured losses
cos φ	Power factor

12.12 Manual Turns ratio test

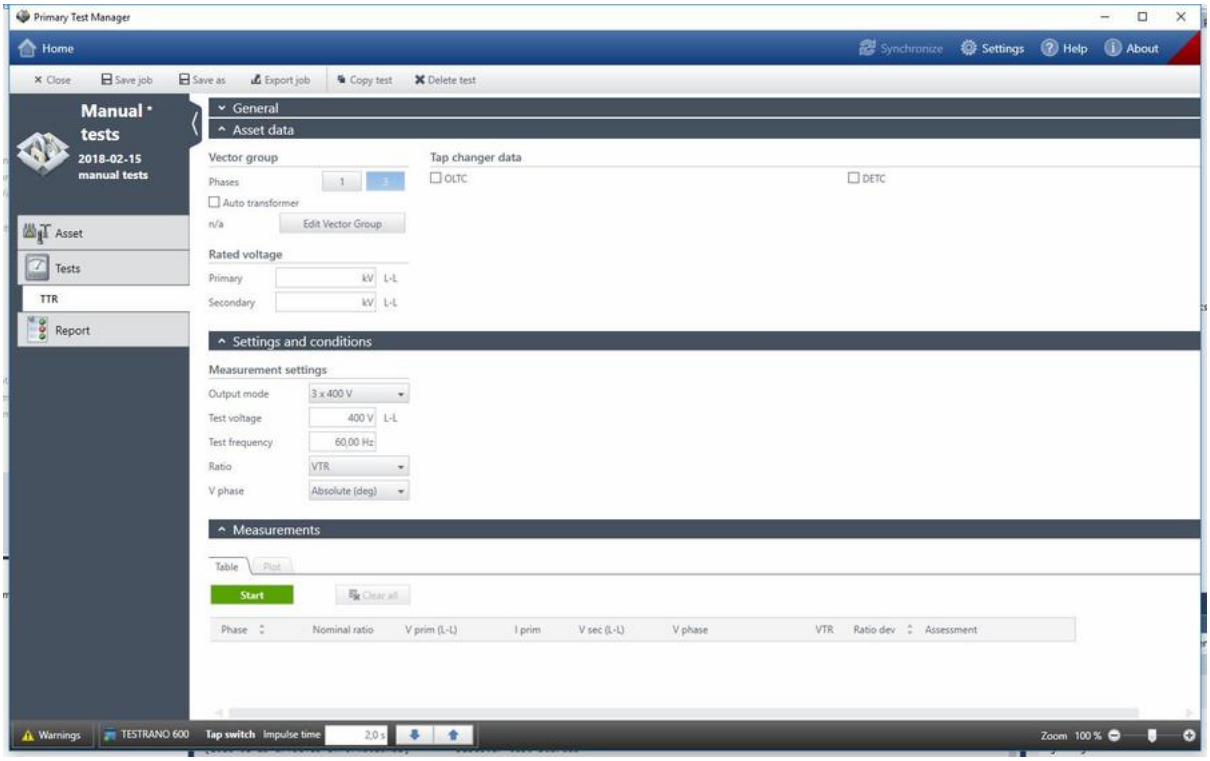


Figure 12-11: Manual Turns ratio test view

Table 12-27: Manual Turns ratio test – Asset data

Option	Description
Winding	
Phases	► Set the number of transformer phases.
Auto transformer	► Activate the check box if you are testing an auto transformer.
Edit Vector Group	► Set the vector group.
Rated voltage	► Enter the transformer's rated voltage.
Tap changer data	
OLTC	► Activate the check box to select the tap changer and enter the corresponding data.
DETC	
Winding	► Select the tap changer's position.
Tap scheme	► Select the notation scheme for tap identification from the drop-down box.
No. of taps	► Enter the number of taps.
Current tap position	► Select the currently active tap.
Rated voltage	
Primary	► Enter the transformer's rated voltage on the primary side.

Table 12-27: Manual Turns ratio test – Asset data (continued)

Option	Description
Secondary	► Enter the transformer's rated voltage on the secondary side.
Voltage table	
Voltage	► Enter the reference voltage for each tap or use the calculation.
Calculate	► Refer to "Specifying an on-load tap changer (OLTC)" on page 122.

Table 12-28: Manual Turns ratio test – Settings and conditions

Option	Description
Measurement settings	
Output mode	► Select the output mode from the drop-down list.
Test voltage	Output voltage during the test
Test frequency	Output frequency during the test
V phase	Phase shift of the transformer
Tap changer settings	
Tap changer under test	► Select which tap changer to include in the measurement if both an OLTC and a DETC have been defined.
DETC position	DETC tap position during tap switching on the OLTC
OLTC position	OLTC tap position during tap switching on the DETC
Tap control settings[1]	
Automatic tap control	► Activate the check box to activate the automatic tap control.
Tap time	Time for the change between two tap positions
Impulse time	Duration of the impulse triggering the tap change
Start tap	Start tap position of the test
Stop tap	Stop tap position of the test

1. Only for OLTC

Table 12-29: Manual Turns ratio test – Measurement

Option	Description
Tap	Tap under test
Phase	Phase under test
Nominal ratio	Nominal transformer ratio
V prim	Output voltage
I prim	Measured current on the primary side of the transformer
V sec	Secondary voltage
V phase	Phase shift of the transformer

Table 12-29: Manual Turns ratio test – Measurement (continued)

Option	Description
TTR	Measured transformer turns ratio
VTR	Measured voltage ratio
Ratio deviation	Deviation of the nominal ratio from the voltage ratio
Assessment	Measurement assessment

12.13 Manual Exciting current test

Exciting current measurements are performed to assess the turn-to-turn insulation of the windings, the magnetic circuit of a transformer as well as the tap changer. The most valued benefit of the test is to detect turn-to-turn short-circuits in a winding. Physical movement of the core laminations or severe damage to the core can influence the reluctance and, thus, will result in a change in exciting current. Deviations may also indicate contact wear or improper wiring of the tap changer.

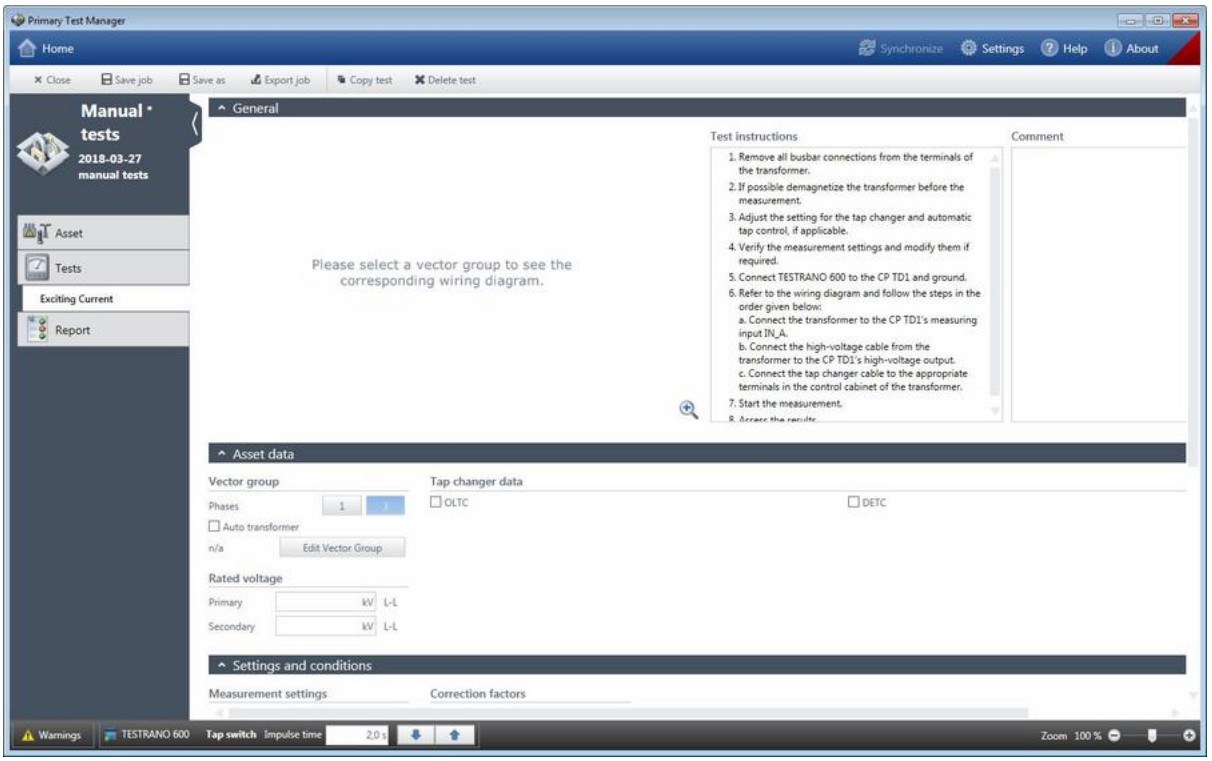


Figure 12-12: Manual Exciting current test

Table 12-30: Exciting current test – Asset data

Option	Description
Vector group	
Phases	► Set the number of transformer phases.
Auto transformer	► Activate the check box if you are testing an auto transformer.
Edit Vector Group	► Set the vector group.
Tap changer data	
OLTC	► Activate the check box to select the tap changer and enter the corresponding data.
DETC	
Winding	► Select the tap changer's position
Tap scheme	► Select the notation scheme for tap identification from the drop-down box.

Table 12-30: Exciting current test – Asset data (continued)

Option	Description
No. of taps	► Enter the number of taps.
Current tap position	► Select the currently active tap.
Rated voltage	
Primary	► Enter the transformer's rated voltage on the primary side.
Secondary	► Enter the transformer's rated votlage on the secondary side.

Table 12-31: Exciting current test – Settings and conditions

Option	Description
Measurement settings	
Test voltage	Output voltage during the test
Test frequency	Output frequency during the test
Test mode	Test mode for this test: UST-A
Noise suppression	
Averaging	Number of averaged measurements
Bandwidth	*CP TD1* filter bandwidth
Avoid test frequency	If this setting is active, the measurement will *not* be performed at the **Test frequency** set in the **Measurement** section. *Primary Test Manager* will instead measure two values at frequencies below and above the entered **Test frequency** and calculate the median of those two values. The **Avoid test frequency** setting is predefined for the selected test. ► Only change the default setting for special applications.

Table 12-32: Exciting current test – Measurements

Option	Description
Phase	Phase under test
V out	Output voltage
I out	Excitation current
I phase	Measured primary current per phase
Watt losses	Measured losses
Reactance	Main inductance of the transformer
Assessment	Measurement assessment

12.14 Manual HV Turns Ratio test

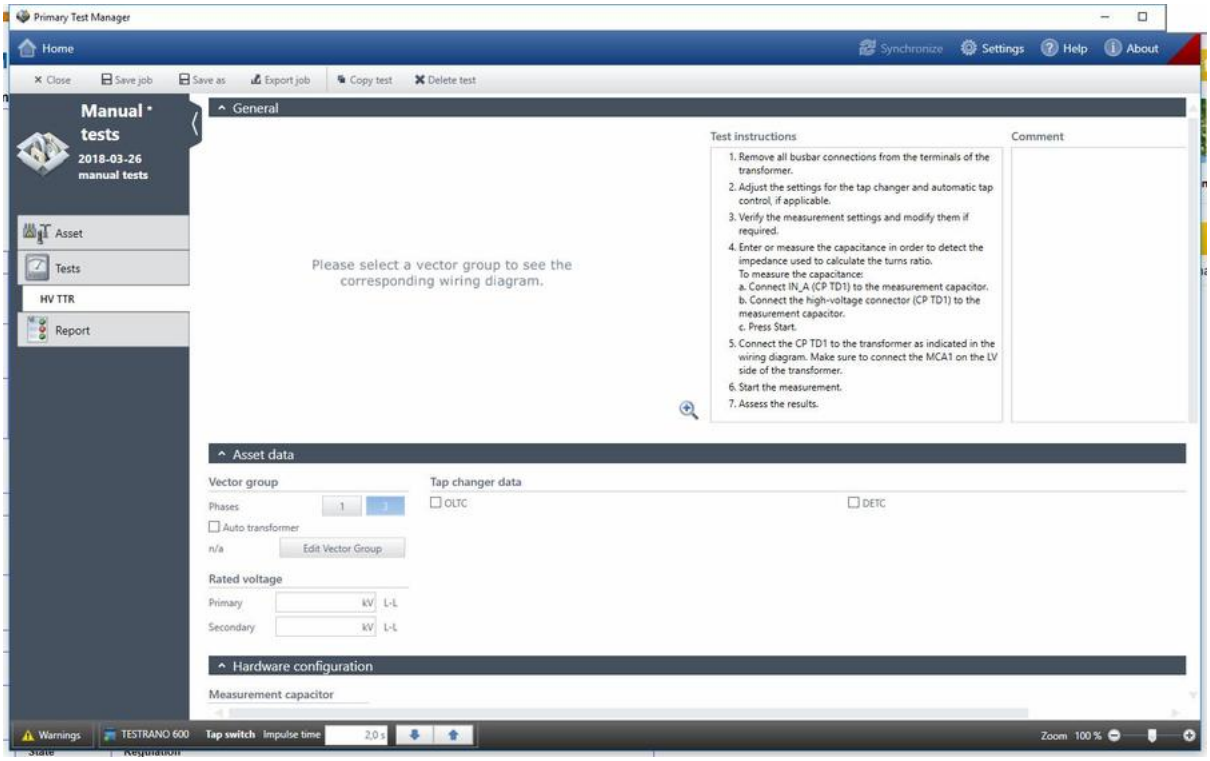


Figure 12-13: Manual HV Turns Ratio test

Table 12-33: Manual HV Turns ratio test – Asset data

Option	Description
Vector group	
Phases	► Set the number of transformer phases.
Auto transformer	► Activate the check box if you are testing an auto transformer.
Edit Vector Group	► Set the vector group.
Rated voltage	
Primary	► Enter the transformer's rated voltage on the primary side.
Secondary	► Enter the transformer's rated voltage on the secondary side.
Tap changer data	
OLTC	► Activate the check box to select the tap changer and enter the corresponding data.
DETC	
Winding	► Select the tap changer's position.
Tap scheme	► Select the notation scheme for tap identification from the drop-down box.

Table 12-33: Manual HV Turns ratio test – Asset data (continued)

Option	Description
No. of taps	► Enter the number of taps.
Voltage table	
Voltage	► Enter the reference voltage for each tap or use the calculation.
Calculate	► Refer to "Specifying an on-load tap changer (OLTC)" on page 122.

Table 12-34: Manual HV Turns Ratio test – Settings and conditions

Option	Description
Measurement settings	
Test voltage	► Enter the output voltage.
Test frequency	► Enter the output frequency during the test.
Ratio	► Choose between transformer turns ratio (TTR) and voltage ratio (VTR).
Test mode	Test mode for this test: UST-A
Noise suppression	
Averaging	Number of averaged measurements
Bandwidth	*CP TD1* filter bandwidth
Avoid test frequency	If this setting is active, the measurement will *not* be performed at the **Test frequency** set in the **Measurement** section. *Primary Test Manager* will instead measure two values at frequencies below and above the entered **Test frequency** and calculate the median of those two values. The **Avoid test frequency** setting is predefined for the selected test. ► Only change the default setting for special applications.
Device settings	
Enable shield check	► Activate the check box if you want *TESTRANO 600* to check whether the shield of the high-voltage cable is connected.
Use beeper	► Activate the check box to activate the *CP TD1* beeper during the measurement.
Tap changer settings	
Tap changer under test	► Select which tap changer to include in the measurement if both an OLTC and a DETC have been defined.
DETC position	DETC tap position during tap switching on the OLTC
OLTC position	OLTC tap position during tap switching on the DETC

Table 12-35: Manual HV Turns ratio test – Measurements

Option	Description
Tap	Tap under test
Phase	Phase under test
Nominal ratio	Nominal transformer ratio
V prim	Output voltage
I sec	Measured current on the primary side of the transformer
Z sec	**V prim** divided by **I sec** Used to calculate the turns ratio
V phase	Phase shift of the transformer
TTR	Measured transformer turns ratio
VTR	Measured voltage ratio
Ratio dev	Deviation of the nominal ratio from the voltage ratio
Assessment	Measurement assessment

12.15 Manual DC winding resistance test

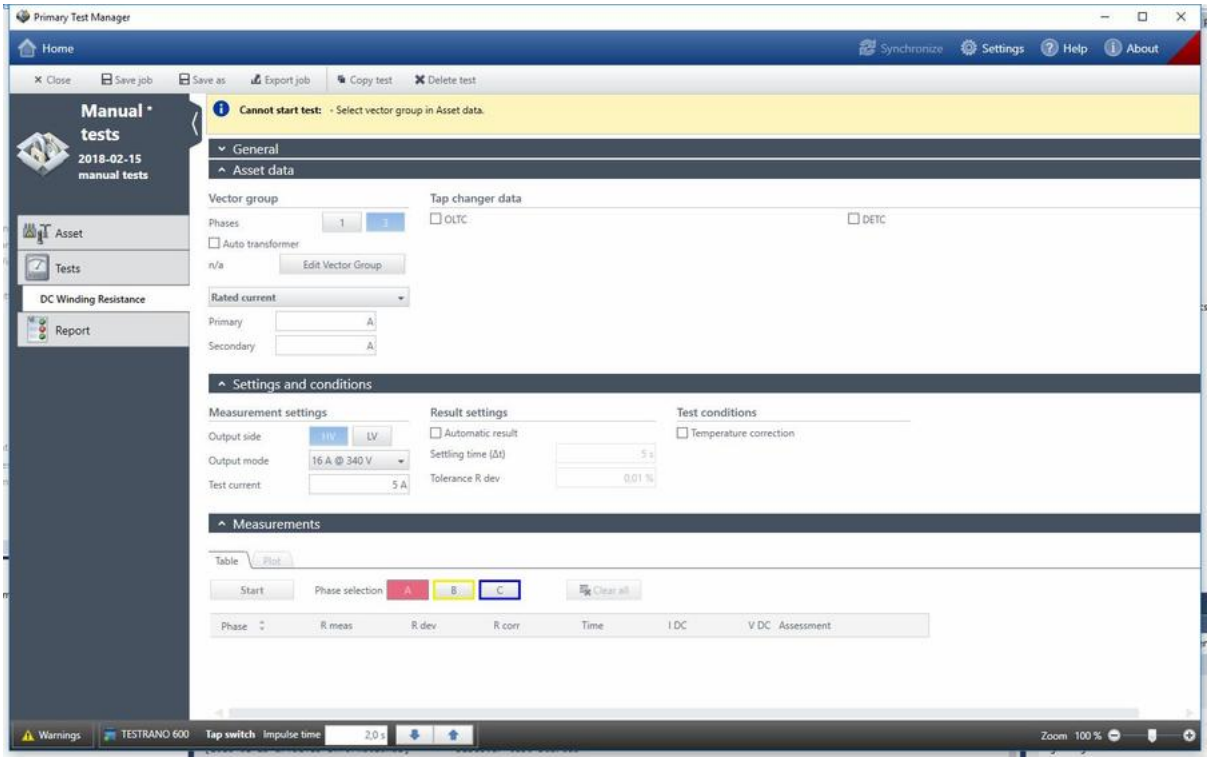


Figure 12-14: Manual DC winding resistance test

Table 12-36: Manual DC winding resistance test – Asset data

Option	Description
Vector group	
Phases	► Set the number of transformer phases.
Auto transformer	► Activate the check box if you are testing an auto transformer.
Vector group	► Set the vector group.
Rated current	► Select the value you want to specify for **Primary** and **Secondary**.
Rated voltage	
Primary	► Enter the transformer's rated current/voltage on the primary side.
Secondary	► Enter the transformer's rated current/voltage on the secondary side.
Tap changer data	
OLTC	► Activate the check box to select the tap changer and enter the corresponding data.
DETC	
Winding	► Select the tap changer's position.
Tap scheme	► Select the notation scheme for tap identification from the drop-down box.
No. of taps	► Enter the number of taps.

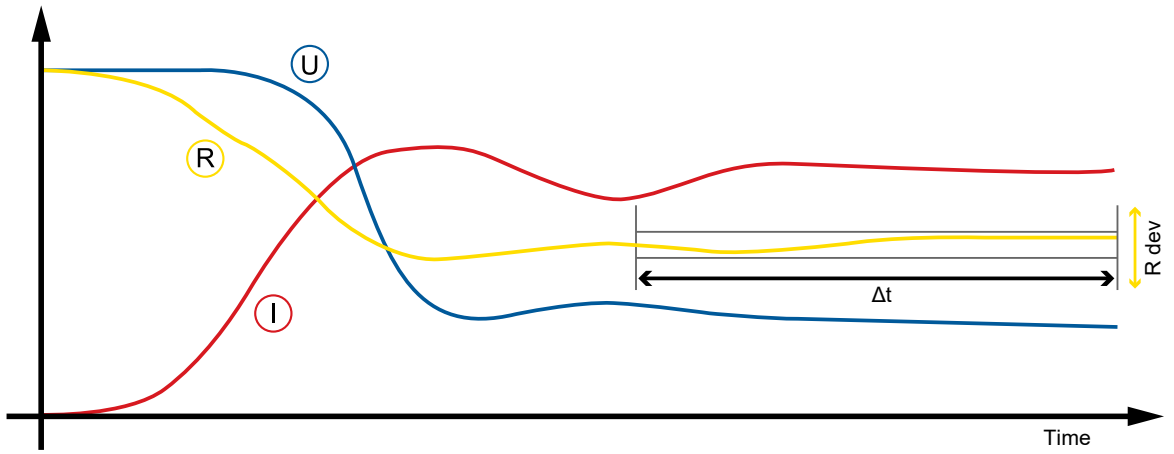
Table 12-36: Manual DC winding resistance test – Asset data (continued)

Option	Description
Current tap position	► Select the currently active tap.
Voltage table	
Voltage	► Enter the reference voltage for each tap or use the calculation.
Calculate	► Refer to "Specifying an on-load tap changer (OLTC)" on page 122.

Table 12-37: Manual DC winding resistance test – Settings and conditions

Option	Description
Measurement settings	
Output side	► Select the transformer side for the current output.
Output mode	► Select the output mode from the drop-down list.
Test current	► Enter the output current for the test.
Tap changer settings	
Tap changer under test	► Select which tap changer to include in the measurement if both an OLTC and a DETC have been defined.
DETC position	DETC tap position during tap switching on the OLTC
OLTC position	OLTC tap position during tap switching on the DETC
Tap control settings[1]	
Automatic tap control	► Select **ON** to activate the automatic tap control.
Tap time	Time for the change between two tap positions
Impulse time	Duration of the impulse triggering the tap change
Start tap	Start tap position of the test
Stop tap	Stop tap position of the test
Up/Down test	► Activate the check box for the automatic change of switching direction after the first/last tap.

Table 12-37: Manual DC winding resistance test – Settings and conditions (continued)

Option	Description
Result settings	
Automatic result	► Activate the check box to automatically keep measurement results, depending on tolerance R dev and the settling time.
	
Tolerance R dev	Tolerance for the deviation of measurement results within the settling time
Settling time (Δt)	If during the settling time the deviation remains below the defined **Tolerance R dev**, the result is recorded.
Test conditions	
Temperature correction	► Select the check box to activate temperature correction.
Winding material	► Select the winding material: copper or aluminium.
Winding temp.	Temperature of the transformer windings.
Reference temp.	Reference temperature for the temperature correction
Correction factor	Temperature correction factor calculated from the values entered above

1. Only for OLTC

Table 12-38: Manual DC winding resistance test – Measurement

Option	Description
Tap	Tap under test
Phase	Output phase
R meas	Measured resistance
R dev	Deviation of two successive measurement results at the time the test was stopped
R corr	Corrected measured resistance

Table 12-38: Manual DC winding resistance test – Measurement (continued)

Option	Description
Time	Time until a stable condition was reached
I DC	Measured current
V DC	Measured voltage
Assessment	Measurement assessment

12.16 Manual Dynamic OLTC-Scan (DRM)

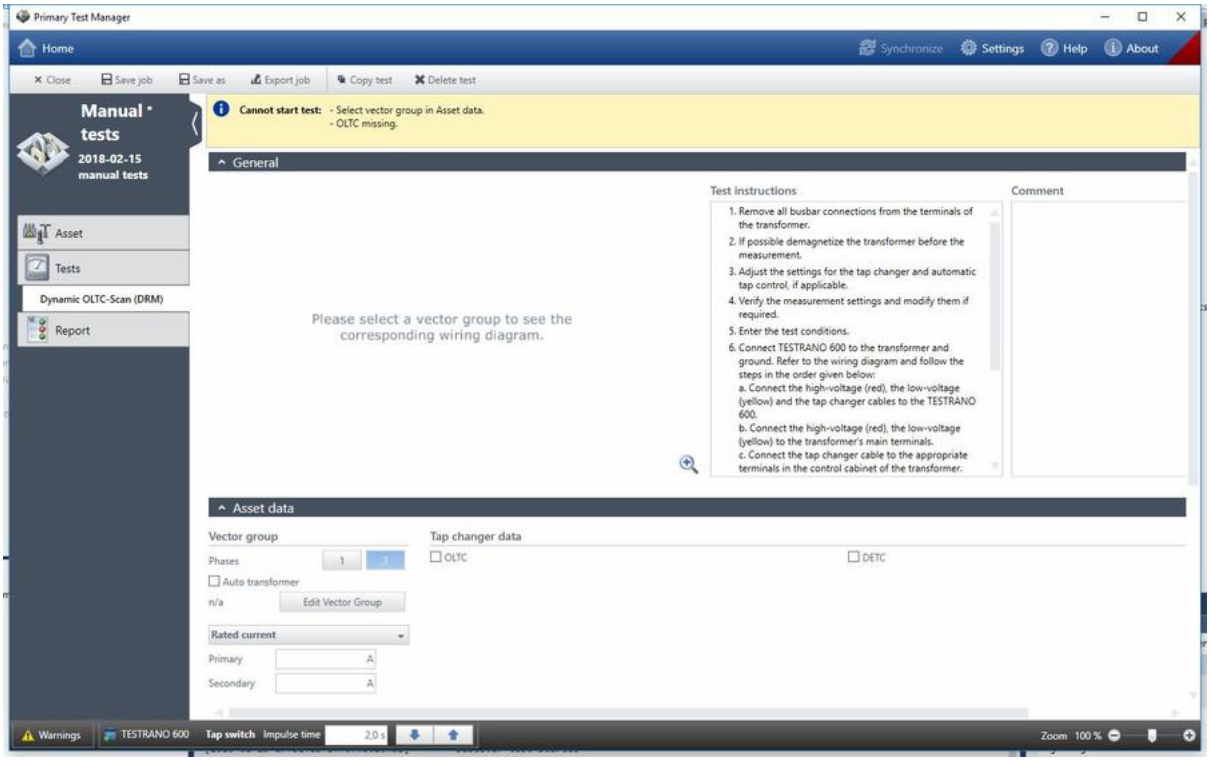


Figure 12-15: Manual Dynamic OLTC-Scan (DRM)

Table 12-39: Manual Dynamic OLTC-Scan (DRM) – Asset data

Option	Description
Vector group	
Phases	► Set the number of transformer phases.
Auto transformer	► Activate the check box if you are testing an auto transformer.
Edit Vector Group	► Set the vector group.
Rated current Rated voltage	► Select the value you want to specify for **Primary** and **Secondary**.
Primary	► Enter the transformer's rated current/voltage on the primary side.
Secondary	► Enter the transformer's rated current/voltage on the secondary side.

Table 12-39: Manual Dynamic OLTC-Scan (DRM) – Asset data (continued)

Option	Description
Tap changer data	
OLTC	► Activate the check box to select the tap changer and enter the corresponding data.
DETC	
Winding	► Select the tap changer's position.
Tap scheme	► Select the notation scheme for tap identification from the drop-down box.
No. of taps	► Enter the number of taps.
Current tap position	► Select the currently active tap.

► For information on **Settings and conditions** and **Measurements**, refer to:
Table 12-16: "Dynamic OLTC-Scan (DRM) – Settings and conditions" on page 176 and
Table 12-17: "Dynamic OLTC-Scan (DRM) – Measurements" on page 177
Section "Measurement results – Dynamic OLTC-Scan (DRM) tab" on page 178

12.17 Manual Leakage reactance/Short-circuit impedance test

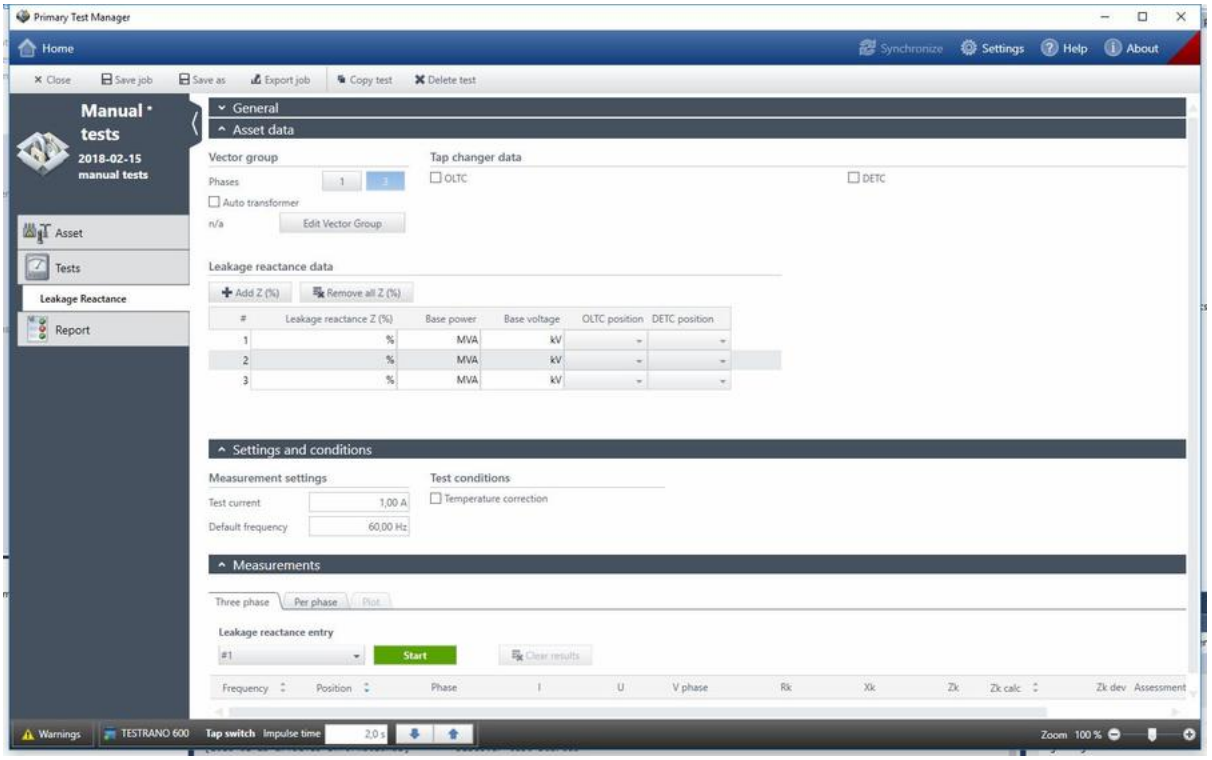


Figure 12-16: Manual Leakage reactance/Short-circuit impedance test

Note: The name of this test depends on the standard set in the Settings view (see 6.4 "TouchControl settings" on page 36):

- According to the IEEE standard: Leakage Reactance
- According to IEC standard: Short-Circuit Impedance

In this chapter, the test will be referred to as short-circuit impedance.

Table 12-40: Manual Short-circuit impedance test – Asset data

Option	Description
Vector group	
Phases	► Set the number of transformer phases.
Auto transformer	► Activate the check box if you are testing an auto transformer.
Edit Vector Group	► Set the vector group.
Rated voltage	► Enter the transformer's rated voltage.
Tap changer data	
OLTC	► Activate the check box to select the tap changer and enter the corresponding data.
DETC	

Table 12-40: Manual Short-circuit impedance test – Asset data (continued)

Option	Description
Winding	► Select the tap changer's position.
Tap scheme	► Select the notation scheme for tap identification from the drop-down box.
No. of taps	► Enter the number of taps.
Current tap position	► Select the currently active tap.
Voltage table	
Voltage	► Enter the reference voltage for each tap or use the calculation.
Calculate	► Refer to "Specifying an on-load tap changer (OLTC)" on page 122.
Short circuit impedance data	
► Define the tap settings for the short-circuit impedance test. In the **Measurements** view you will be able to filter the results for the individual entries in this list, using the **Short-circuit impedance entry** drop-down box.	
Short-circuit impedance Z/uk[1]	Short-circuit impedance of the transformer
Base power	Base power used for calculating the percent values of impedances
Base voltage	Base voltage used for calculating the percent values of impedances
OLTC position	Tap position of the OLTC corresponding to the impedance value
DETC position	Tap position of the DETC corresponding to the impedance value

1. Depending on the **Profile** selected in **Settings** – **General** (see6.4.1 "General settings" on page 36).

Table 12-41: Manual Short-circuit impedance test – Settings and conditions

Option	Description
Measurement settings	
Test current	Current output during the test.
Default frequency	► Enter the mains frequency.
Test conditions	
Temperature correction	► Select the check box to activate temperature correction.
Winding material	► Select the winding material: copper or aluminium.
Winding temp.	Temperature of the transformer windings.
Reference temp.	Reference temperature for the temperature correction
Correction factor	Temperature correction factor calculated from the values entered above

Table 12-42: Manual Short-circuit impedance test – Measurements

Option	Description
Three phase	The **Three phase** measurement is performed to compare the results to the nameplate data.
Per phase	The **Per phase** measurement is performed for an in-depth error analysis of the individual phases.
Short-circuit impedance entry / Leakage reactance entry	Tap settings for the short-circuit impedance test
Phase selection[2]	► Select the phase for the **Per phase** mode.
Show FRSL results[2]	► Activate the check box to display the FRSL results in the **Per phase** table.
Position	Short-circuit impedance entry
Phase	Phase under test
I	Measured current
U	Measured voltage
V phase	Phase shift of the transformer
Rk	Real part of the measured Zk
Xk	Imaginary part of the measured Zk (short-circuit impedance)
Zk	Measured short-circuit impedance
uk calc / Zk calc[1]	Short-circuit impedance when IEC profile is active
uk avg / Zk avg[1, 2]	Average of **Zk** across all phases
uk dev / Zk dev[2]	Deviation from the nameplate value entered in the **Impedance settings** list
Assessment	Measurement assessment

1. Depending on the **Profile** selected in **Settings** – **Profiles** (see "Profiles" on page 99).
2. Only for **Per phase** test

12.18 Manual Tan delta test

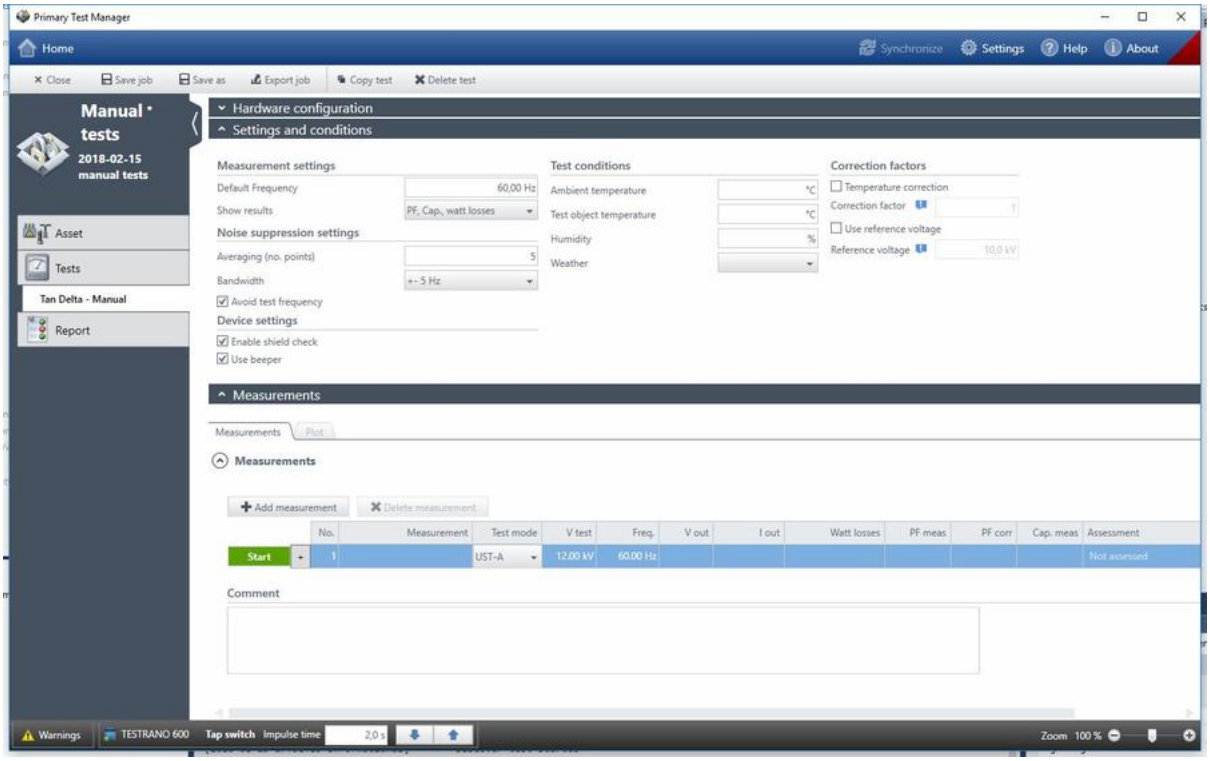


Figure 12-17: Manual Tan delta test

Table 12-43: Manual Tan delta test – Settings and conditions

Option	Description
Measurement settings	
Default frequency	► Set the output frequency for the test.
Show results	► Select the results you want to display. All measurement results are stored and displayed when selected from the list.
Noise suppression settings	
Averaging (no. points)	Number of averaged measurements
Bandwidth	*CP TD1* filter bandwidth
Avoid test frequency	If this setting is active, the measurement will *not* be performed at the **Test frequency** set in the **Measurement** section. *Primary Test Manager* will instead measure two values at frequencies below and above the entered **Test frequency** and calculate the median of those two values. The **Avoid test frequency** setting is predefined for the selected test. ► Only change the default setting for special applications.

Table 12-43: Manual Tan delta test – Settings and conditions (continued)

Option	Description
Device settings	
Enable shield check	► Activate the check box if you want *TESTRANO 600* to check whether the shield of the high-voltage cable is connected.
Use beeper	► Activate the check box to activate the *CP TD1* beeper during the measurement.
Test conditions	
Ambient temperature	► Enter the ambient temperature on site.
Test object temperature	► Enter the test object's temperature.
Humidity	► Enter the relative ambient humidity on site.
Weather	► Select the weather conditions during the test.
Correction factors	
Temperature correction	► Activate the check box to use temperature correction for this test.
Correction factor	Temperature correction factor
Use reference voltage	► Activate the check box to extrapolate the **I out** and **Watt losses** results for the specified reference voltage.
Reference voltage	Reference voltage for extrapolation of the measurement results
Bushings compensation	► Activate the check box to compensate the effect of the capacitance C1 of the transformer's bushings on the measurement results of the test.

Table 12-44: Manual Tan delta test – Measurements

Option	Description
Table	
Measurement	Text field for description or comment
Test mode	► Select a test mode from the drop-down list.
V test	Test voltage
Freq.	Test frequency
V out	Measured output voltage
I out	Measured output current
Watt losses	Measured losses
PF/DF[1] meas	Measured power factor
PF/DF[1] corr	Corrected power factor
Cap. meas	Measured capacitance
Assessment	Measurement assessment

1. Depending on the **Profile** selected in **Settings** – **Profiles** (see "Profiles" on page 99).

12.19 Manual Vector Group Check

The **Vector group check** comprises a three-phase turns ratio measurement, neutral detection and a series of single-phase measurements to determine the vector group.

Table 12-45: Manual vector group check – Settings and conditions

Option	Description
Measurement settings	
Test voltage	Maximum output voltage ► Perform the vector group check using the default value. ► If there is no conclusive result, try increasing the test voltage.
Test frequency	► Enter the mains frequency

After the check is completed, *PTM* displays the detected vector group(s) in the **Measurements** section.

► If there is no conclusive result, try increasing the test voltage.

12.20 Quick test

Quick is the most basic mode to operate all of the *TESTRANO 600* outputs in a manual-like mode using *Primary Test Manager*.

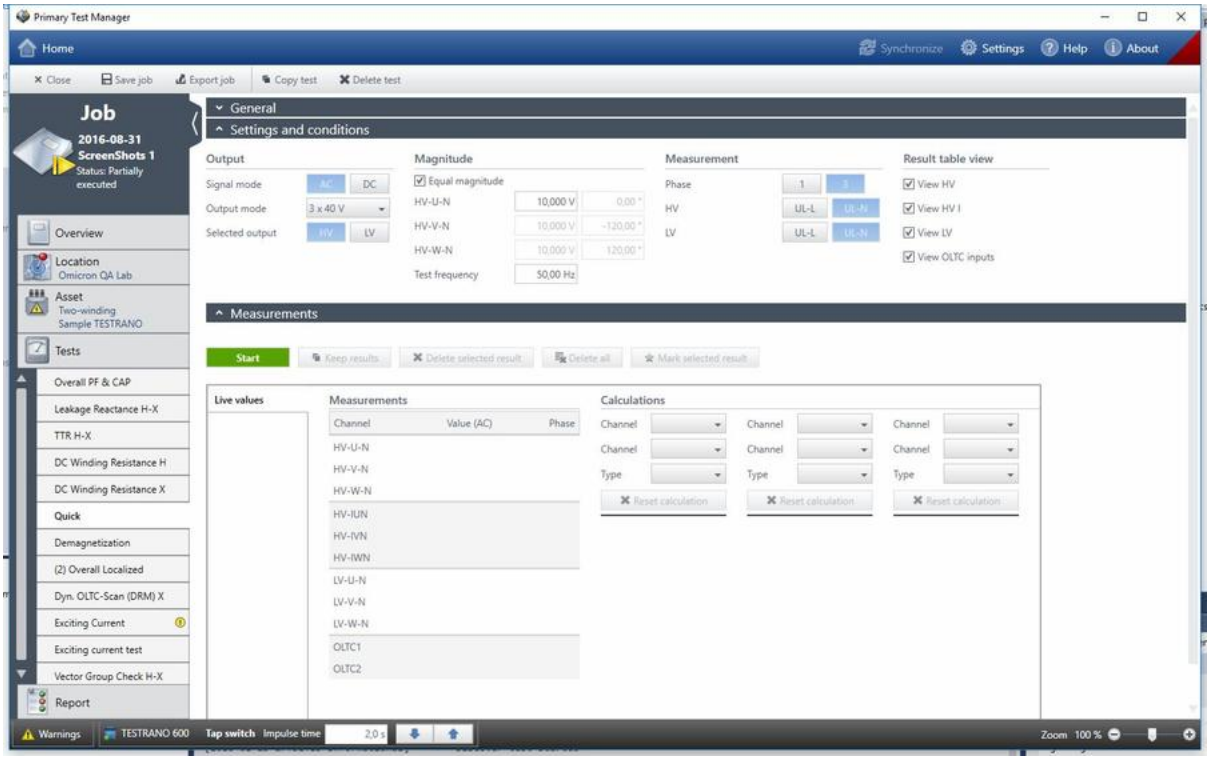


Figure 12-18: Quick test view

Table 12-46: Quick test – Settings and conditions

Option	Description
Output	
Signal mode	► Set AC or DC as output signal.
Output mode	► Select 1-phase or 3-phase voltage (V) or current (A) control from the drop-down list.
Selected output	► Select the *TESTRANO 600* output: HV (red) or LV (yellow). ► See 3.1.5 "TESTRANO 600 measuring cables" on page 18
Magnitude	
Equal magnitude	► Activate the check box for magnitude distribution to all three phases (phase shift = 120°)
Test frequency	Output frequency during the test

Table 12-46: Quick test – Settings and conditions (continued)

Option	Description
Measurement	
Phase	Number of phases
HV	► Choose the cable pair for the measurement.
LV	► Choose between line-to-line (L-L) and line-to-neutral (L-N) voltage.

Quick test – Measurements

In the **Measurement** view, you can add up to three calculations based on the measured current, voltage and frequency values.

► Choose two **Channels** and the **Calculation type** for each calculation.

► Press **Reset calculation** to delete your settings.

13 PTM Bushing tests

This chapter lists the bushing tests available for *TESTRANO 600*.

► For details on safely performing tests, refer to chapters 1 "Safety instructions" on page 8 and 5 "Application" on page 25.

Note: Depending on your settings, some test names include the power factor (PF), the dissipation factor (DF), or the tangent delta (Tanδ). The dissipation factor and the tangent delta are identical characteristics of the primary asset under test. With *Primary Test Manager* you can use your preferred naming. You can also select some test names to match your regional conventions (see "Settings" on page 96).

Note: The chapters list the available options and settings for the tests. Depending on the individual asset and the general *Primary Test Manager* settings, not every test displays all listed items.

13.1 Spare bushing tests

The following Spare Bushing tests are available for *TESTRANO 600*:

- Spare Bushing PF/DF/Tanδ & CAP – Overall
- Spare Bushing PF/DF/Tanδ & CAP – C1
- Spare Bushing PF/DF/Tanδ & CAP – C2
- Spare Bushing – Energized Collar

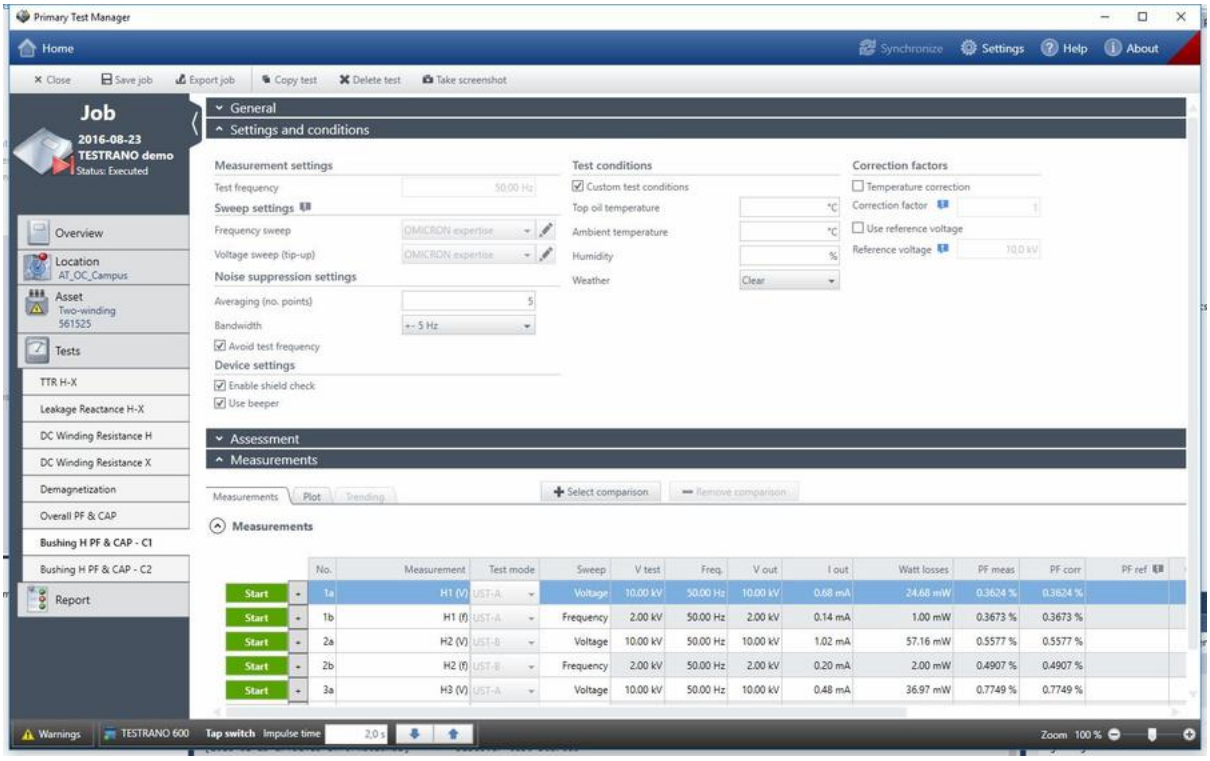


Figure 13-1: Bushing C1 test

The following table describes the parameters for spare bushing tests.

Note: Some tests do not comprise all parameters listed below.

Table 13-1: Spare Bushing test – Settings and conditions

Setting	Description
Measurement settings	
Test frequency	Test frequency
Sweep settings	
Frequency sweep	Sweep profile: None, OMICRON expertise (recommended), or CPC template • **None**: no frequency sweep • **OMICRON expertise**: sweep frequencies dynamically distributed within the *CPC 100* frequency range for optimum results • **CPC template**: sweep frequencies specified by the *CPC 100* test templates
Voltage sweep (tip-up)	Sweep profile: None or OMICRON expertise • **None**: no voltage sweep • **OMICRON expertise**: sweep voltages dynamically distributed within the asset-dependent voltage range for optimum results
Sweep profiles	► Click the pen button to create a frequency or voltage sweep profile. ► Add up to 30 measurement points with individual output voltages or frequencies. Double-click a value to change it. ► Mark a favorite to use it as the default sweep profile for future tests. **Note:** The predefined profiles **None**, **OMICRON expertise** and **CPC template** cannot be edited or deleted. The default sweep profiles for this test are: • Frequency sweep: OMICRON expertise • Voltage sweep: none
Noise suppression settings	
Averaging (no. points)	Number of averaged measurements
Bandwidth	*CP TD1* filter bandwidth
Device settings	
Enable shield check	► Activate the check box if you want *TESTRANO 600* to check whether the shield of the high-voltage cable is connected.
Use beeper	► Activate the check box to activate the *CP TD1* beeper during the measurement.

Table 13-1: Spare Bushing test – Settings and conditions (continued)

Setting	Description
Test conditions	
Custom test conditions	► Activate the check box to set test conditions differing from the global test conditions.
Top oil temperature	► Enter the temperature of the oil from the top of the transformer tank.
Ambient temperature	► Enter the ambient temperature on site.
Humidity	► Enter the relative ambient humidity on site.
Weather	► Select the weather conditions during the test.
Correction factors	
Temperature correction	► Activate the check box to use temperature correction for this test.
Correction factor	Temperature correction factor
Use reference voltage	► Activate the check box to extrapolate the **I out** and **Watt losses** results for the specified reference voltage.
Reference voltage	Reference voltage for extrapolation of the measurement results

The following table describes the Spare Bushing test measurement data.

Table 13-2: Spare Bushing test – overall measurement data

Data	Description
No.	Number of the measurement
Measurement	Arrangement of the measurement
Test mode	Test mode according to the IEEE Std 62-1995
Sweep	Swept variable: frequency, voltage, or none
V test	Test voltage
Freq.	Test frequency
V out	Measured output voltage
I out	Measured output current
Watt losses	Measured losses
PF meas/ DF meas/ Tanδ meas[1]	Measured power factor, dissipation factor, or tangent delta
PF corr/ DF corr/ Tanδ corr[1]	Corrected measured power factor, dissipation factor, or tangent delta
Cap. meas	Measured capacitance
Assessment	Measurement assessment

1. Set by the regional conventions (see "Settings" on page 96).

14 Device-independent PTM tests

This chapter lists device-independent tests available in *Primary Test Manager*.

► For details on safely performing tests, refer to chapters 1 "Safety instructions" on page 8 and 5 "Application" on page 25.

Chapter	Page
14.1 Oil Analysis	210
14.2 Insulation Resistance test	216

14.1 Oil Analysis

The Oil analysis test is used to add the results of oil analyses performed by an oil laboratory or using a mobile DGA test instrument. The values can be entered directly or imported from an Excel file.

For the dissolved gas in oil values the standard assessments and visualization according to IEEE C57.104-2008 and IEC 60599-2007-05 Edition 2.1. are performed.

The following table describes the Oil analysis test settings.

Table 14-1: Oil analysis – Settings and conditions

Setting	Description
Asset	
Asset	Asset under test – set in the asset data (see chapter 11 "PTM Asset data" on page 152)
Tank type	Type of transformer tank
Insulation medium	Insulation medium of the transformer – set in the asset data (see chapter 11 "PTM Asset data" on page 152) **Note:** The DGA is only valid for the insulation medium **Mineral oil**.
Oil type	Type of transformer oil
Test conditions	
Sample date	Date of sample collection
Oil sample temperature	Oil temperature at the time of sampling

Table 14-1: Oil analysis – Settings and conditions (continued)

Setting	Description
Measurement	
Analyzed by	Information on how the sample was analyzed • **Oil lab:** The sample was analyzed by a laboratory. After selecting **Oil lab**, you can enter the **Name** and **Address** of the laboratory. • **Mobile DGA:** The sample was analyzed using a mobile DGA device. After selecting **Mobile DGA**, you can enter the device **Manufacturer/Type** and its **Serial** number. • **Online DGA:** The sample was analyzed using a permanently installed monitoring device. After selecting **Online DGA**, you can enter the device **Manufacturer/Type** and its **Serial** number.
Use C3 hydrocarbons	Activate the **Use C3 hydrocarbons** check box to add C_3H_6 and C_3H_8 to the list of **Gas in oil values**, and to activate ratio assessment according to the MSS scheme.
Sampling point	Sampling point on the transformer tank: • Top • Middle • Bottom

The following table describes the gas-in-oil values.

Table 14-2: Oil analysis – Gas-in-oil values

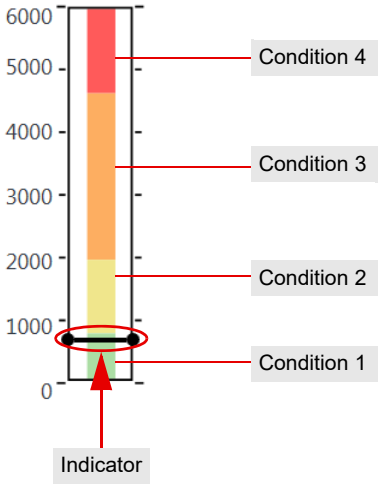
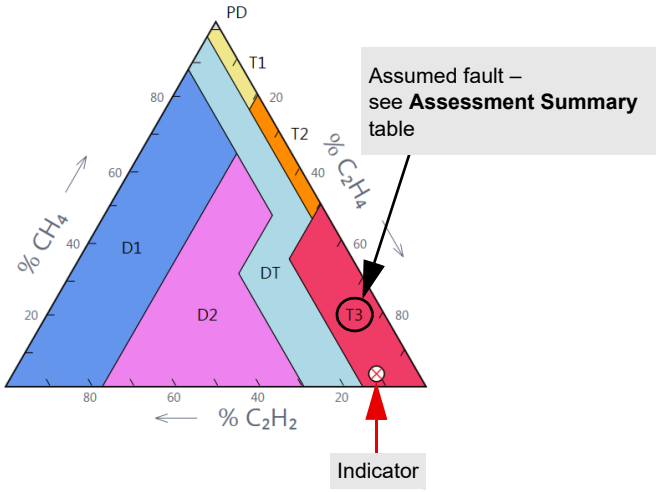
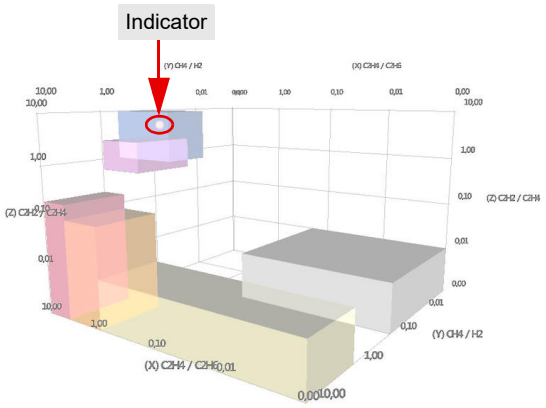
Data	Description
TDCG	Total dissolved combustible gas
TDG	Total dissolved gas
TCGe	Estimation of the percentage of total combustible gas in the gas space. It will only correspond to the actually measured value if there is a balance between the gas blanket and the oil.
Lab. result	Assessment result of the laboratory according to the IEEE or IEC standard.
Assessment	Manual Gas-in-oil analysis assessment: • Manual pass • Manual fail • Manual investigate • Not assessed

Assessment Summary

The results are assessed using the following interpretation methods:

- Duval’s triangles (see Table 14-3 below)
- IEC basic gas ratios
- Roger’s ratios
- Doernenburg’s ratios
- Key gases according to IEEE C57.104 and IEC 60599 (see Table 14-3 below)
- MSS scheme

Table 14-3: Examples of result visualization in the **Assessment Summary** section

Key gas ranges and conditions according to IEEE C57.104	
Duval's triangle 1	
Key gas ranges and conditions according to IEC 60599, visualized in 3D	

Assessment Details

- The **Table** contains condition ranges and states for individual gases.
- The **Ratio Table** lists all used gas ratios, depending on the selected standard, and provides an **Interpretation** of the recorded values.

Table 14-4: Oil analysis – Assessment Details

Data	Description
Table	
Standard	Standard used for the condition assessment
Overall assessment	Condition fulfilled by the measured value of an individual gas
TDCG units/day	Increase in TDCG per day since the last measurement
Recommendation	Recommended interval for future measurements
Ratio Table	
Sample Date	Date of the sampling

Duval Triangle

Duval's triangles visualize faults in a triangular coordinate system (see Table 14-3).

- Triangle 1: gases formed by faults of low to high energy
- Triangle 4: gases formed more specifically by faults of low energy or temperature
- Triangle 5: gases formed more specifically by faults of high temperature

Pattern

The key gas results are visually compared to four reference patterns. If a reference graph matches the measured value, it is highlighted.

Physico-chemical oil analysis

The following table describes the physico-chemical oil analysis data.

Table 14-5: Oil analysis – Physico-chemical oil analysis data

Data	Description
Water content	
H_2O meas.	Measured water content in oil
H_2O @ 20 ºC	Calculated water content in oil
Relative saturation	Relative water saturation
Assessment	Water content assessment
DC conductivity	
Meas. value	Measured DC conductivity
Test temperature	Temperature of the oil during DC conductivity test
Field strength	Field strength
Assessment	DC conductivity assessment

Table 14-5: Oil analysis – Physico-chemical oil analysis data (continued)

Data	Description
Power factor	
Standard	Standard underlying the power factor analysis
Meas. value @ 25 ºC	Power factor measured at 25 ºC
Meas. value @ 100 ºC	Power factor measured at 100 ºC
Assessment	Power factor assessment
Dielectric breakdown voltage	
Standard	Standard underlying the dielectric breakdown voltage analysis
Meas. value	Measured dielectric breakdown voltage
Test temperature	Oil temperature during dielectric breakdown voltage test
Assessment	Dielectric breakdown voltage assessment
Chemical	
Interfacial tension	Interfacial tension of the oil
Neutralization value	Neutralization value of the oil
Particle count	Particle count of the oil
Color	Color of the oil
Assessment	Chemical assessment

The following table describes the test status.

Table 14-6: Test status

Status	Description
Prepared	See Table 9-8: "Job statuses" on page 110.
Partially executed	
Executed	

Note: The test status set in the Oil Analysis test is displayed in the job overview (see 9.7.2 "Job overview" on page 112) under **Tests**.

14.2 Insulation Resistance test

The Insulation Resistance test is used to import or enter data from an insulation testing device.

Table 14-7: Insulation Resistance – Settings and conditions

Setting	Description
Test conditions	
Test object temperature	Temperature of the test object
Custom test conditions	Activate the **Custom test conditions** check box to set test conditions differing from the global test conditions.
Ambient temperature	Ambient temperature on site
Humidity	Relative ambient humidity
Calculations	
PI calculation	Calculation of polarization index
Time 1	In the standard PI calculation, the testing device is applied and insulation resistance measurements are taken after 60 seconds (**Time 1**) and 600 seconds (**Time 2**). The polarization index (PI) is calculated as follows: $PI = \frac{R_{600}}{R_{60}}$
Time 2	
DAR calculation	Calculation of dielectric absorption ratio
Time 1	In the standard DAR calculation, the testing device is applied and insulation resistance measurements are taken after 30 seconds (**Time 1**) and 60 seconds (**Time 2**). The dielectric absorption ratio (DAR) is calculated as follows: $DAR = \frac{R_{60}}{R_{30}}$
Time 2	
Correction factors	
Temperature correction	Select the **Temperature correction** check box to activate temperature correction.
Correction temp.	Temperature correction factor

Table 14-8: Insulation Resistance – Measurements

Setting	Description
Test data	To import a file containing test data: ► Press **Add** + to browse your PC and add data from a file. To directly import data from a measurement file: ► Open the file on your computer. ► In the file press CTRL+A to mark all content, then press CTRL+C to copy. ► In *Primary Test Manager* press **Paste from clipboard**. The results may take a few seconds to load.
Measurement	Name or number of the measurement
PI	Polarization index
DAR	Dielectric absorption ratio
Time	Time at which the given values were recorded
Voltage	Voltage and current values recorded at the **Time** specified in the first column
V DC	
I DC	

15 Technical data

At the time of factory adjustment all units are within the typical accuracy values specified in this document.

Typical accuracy means that 98 % of all units meet the specified values at 23 °C ± 5 °C/73 ºF ± 10 ºF, after a warm-up time of more than 25 min., and in a frequency range of 45 Hz to 65 Hz or DC.

The typical accuracy values multiplied by 3 are guaranteed at an ambient temperature of 23 ºC ± 5 ºC/73 ºF ± 10 ºF, after a warm-up time more than 25 min., and in a frequency range of 45 Hz to 65 Hz or DC.

Accuracy values indicate that the error is smaller than:

± (value read × reading error [rd] + full scale of range × range error [rg]).

For mains voltages below 190 V AC the system is subject to power restrictions.

OMICRON suggests that you send in your unit for calibration at least once a year.

Technical data are subject to change without notice.

CAT level

The CAT level required depends on the *TESTRANO 600* application. All CAT ratings are defined for sea levels below 2000 m. There are some limitations between 2000 m and 5000 m sea level (see section 15.4 "Environmental conditions" on page 229).

CAT I is required when the measured voltage is generated by the test set itself. No voltages from other sources are measured.

CAT II is required when measuring within electrical devices or between mains supply and devices.

CAT III is required when measuring in electrical installations such as control cubicles that are still connected to the station battery or mains. The electrical installations are protected by a fuse.

15.1 TESTRANO 600 specifications

15.1.1 Output specifications

Table 15-1: General output specifications

Characteristic	Rating		
Frequency	DC or 15 Hz … 599 Hz		
Power	**Vmains**	**$P_{30\ s}$**	**$P_{continuous}$**
	>100 V_{RMS}	1500 W	1000 W
	>190 V_{RMS}	4000 W	2400 W

Table 15-2: Voltage source (HV and LV connectors)

Source	Range	$I_{max,\ continuous}$
DC high range	3 × 0 … ±113 V_{DC}[1] 1 × 0 … ±340 V_{DC}[2]	16 A_{DC}
DC low range	3 × 0 … ±56 V_{DC}[1] 1 × 0 … ±170 V_{DC}[2]	33 A_{DC}
AC high range low current	3 × 0 … 230 V_{RMS} (LN)[3]	100 mA_{RMS}
AC high range	3 × 0 … 80 V_{RMS} (LN)[4] 1 × 0 … 240 V_{RMS}[5]	16 A_{RMS}
AC low range	3 × 0 … 40 V_{RMS} (LN)[5] 1 × 0 … 120 V_{RMS}	33 A_{RMS}

1. See Figure 15-3: "Permitted operating range 3 x DC 113 V 16 A" on page 222
2. See Figure 15-1: "Permitted operating range 1 x DC 340 V 16 A" on page 221
3. See Figure 15-5: "Derating of output power and output voltage 3 x 230 V_{RMS}" on page 223
4. See Figure 15-4: "Permitted operating range 3 x AC 80 V 16 A" on page 222
5. See Figure 15-2: "Permitted operating range 1 x AC 240 V 16 A" on page 221

Table 15-3: Voltage source accuracy

Characteristic	Accuracy[1]
Voltage accuracy DC	0.033 % rd ± 0.017 % range
Voltage accuracy AC (50 Hz) at burden open load	0.33 % rd ± 0.17 % range
Phase accuracy AC (50 Hz) burden open load, V>20 V_{RMS}	± 0.36°

1. Typical accuracy at 23 °C ±5 K

Table 15-4: Current source (HV and LV)

Source	Range	$V_{max, continuous}$
DC source high range	3 × 0 ... ±33 A_{DC}[1] or 1 × 0 ... ±100 A_{DC} (3 × 33.33 A_{DC})	56 V_{DC}
	1 × 0 ... ±33 A_{DC}[2]	170 V_{DC}
DC source low range	3 × 0 ... ±16 A_{DC}[1]	113 V_{DC}
	1 × 0 ... ±50 A_{DC} (3 × 16.66 A_{DC})[1]	
	1 × 0 ... ±16 A_{DC}[2]	340 V_{DC}
AC source high range	3 × 0 ... 33 A_{RMS} (LN)[3]	40 V_{RMS}
	1 × 0 ... 33 A_{RMS}[4]	120 V_{RMS}
AC source low range	3 × 0 ... 16 A_{RMS} (LN)[3] or 1 × 0 ... 50 A_{RMS} (3 × 16.66 A_{RMS})	80 V_{RMS}
	1 × 0 ... 16 A_{RMS}[4]	240 V_{RMS}

1. See Figure 15-3: "Permitted operating range 3 x DC 113 V 16 A" on page 222
2. See Figure 15-1: "Permitted operating range 1 x DC 340 V 16 A" on page 221
3. See Figure 15-4: "Permitted operating range 3 x AC 80 V 16 A" on page 222
4. See Figure 15-2: "Permitted operating range 1 x AC 240 V 16 A" on page 221

Table 15-5: Current source accuracy

Characteristic	Accuracy[1]
Current accuracy DC	0.033 % rd ± 0.017 % range
Current accuracy AC 50/60 Hz at burden 0.1 Ω	0.33 % rd ± 0.17 % range

1. Typical accuracy at 23 °C ±5 K

Table 15-6: Voltage source (Booster)

Source	Range	$I_{max, cont.}$[1]	$I_{max, 30\ s}$[1]
Power	–	3 kVA	4.4 kVA
AC high voltage	1 × 0 ... 240 V_{RMS}	16 A_{RMS}	20 A_{RMS}
Characteristic		**Rating**	
Channels		1	
Voltage accuracy[2] AC (50/60 Hz) at burden open load		0.33 % rd ± 0.16 % range	

1. Within the above specified power limit
2. Typical accuracy at 23 °C ±5 K

The following figures display the output characteristics of *TESTRANO 600*.

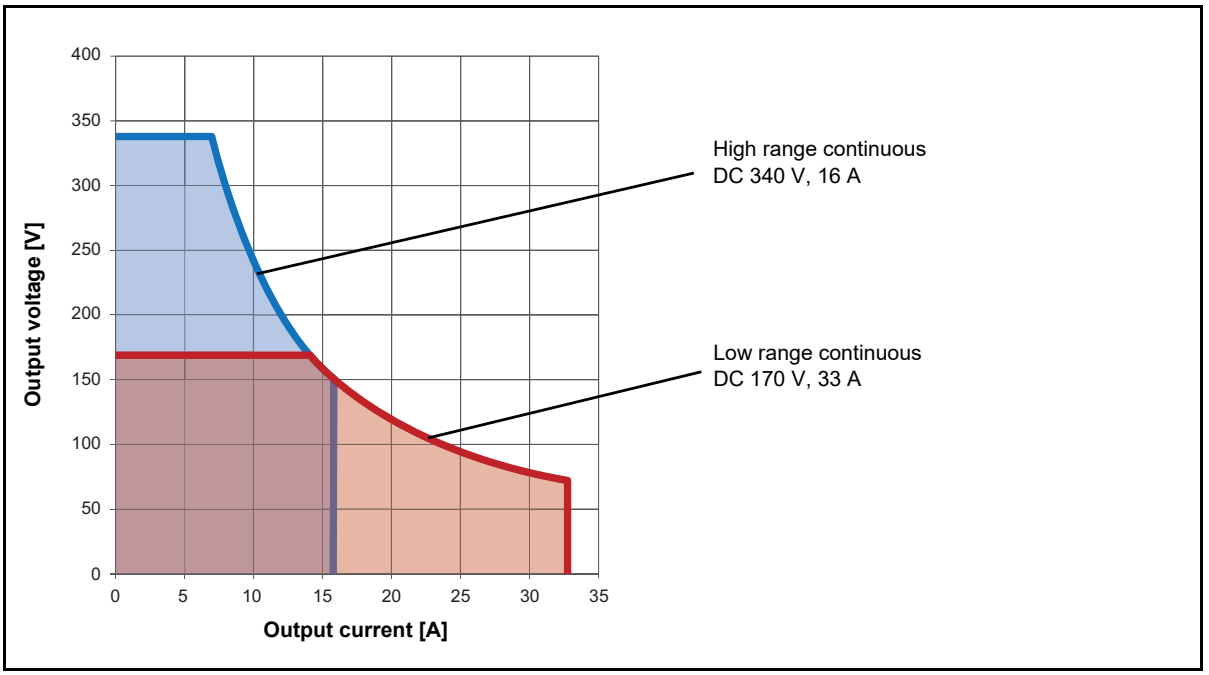


Figure 15-1: Permitted operating range 1 x DC 340 V 16 A

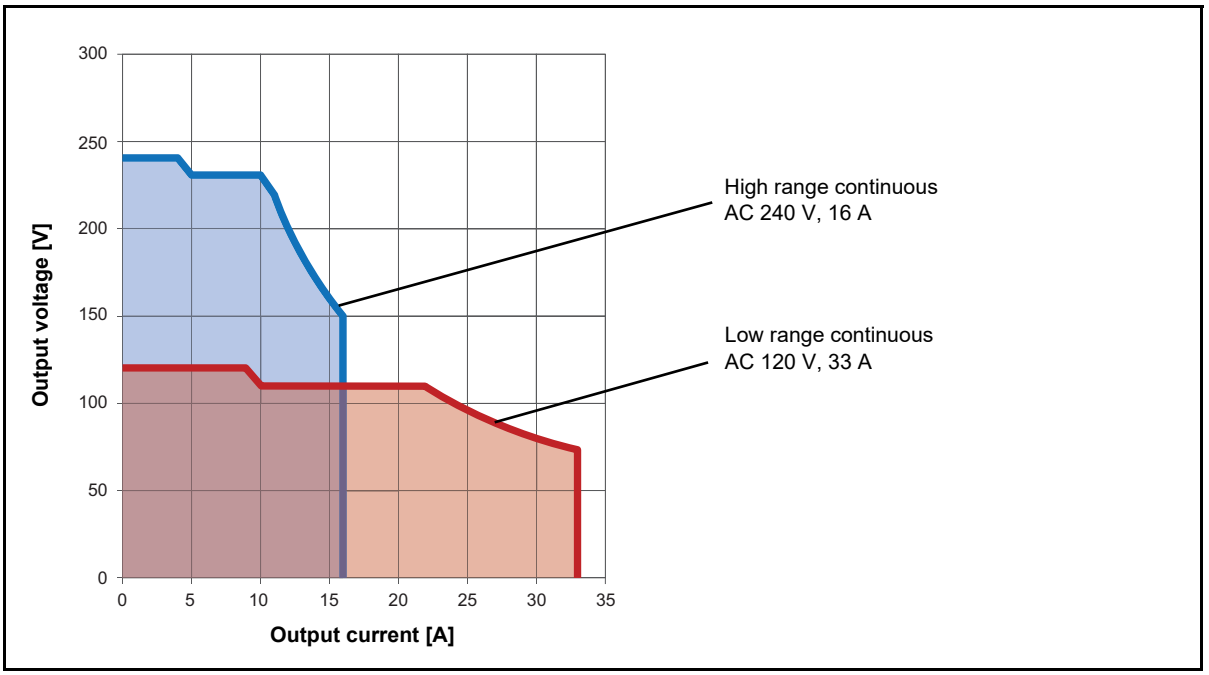


Figure 15-2: Permitted operating range 1 x AC 240 V 16 A

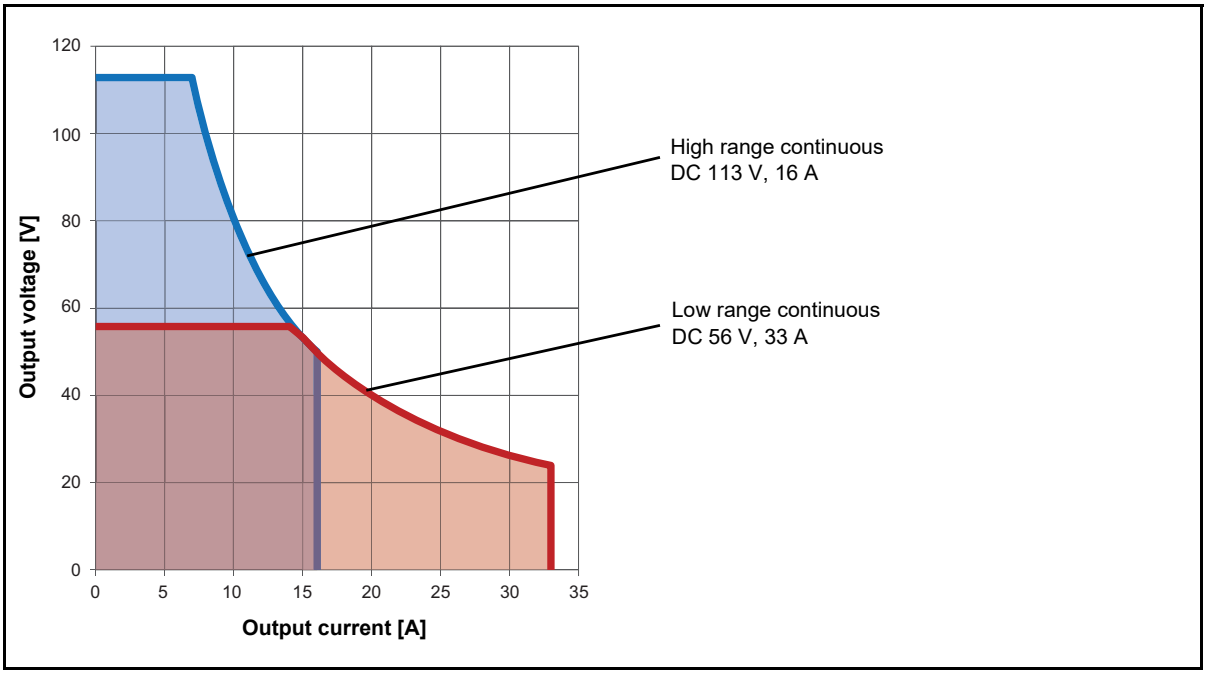


Figure 15-3: Permitted operating range 3 x DC 113 V 16 A

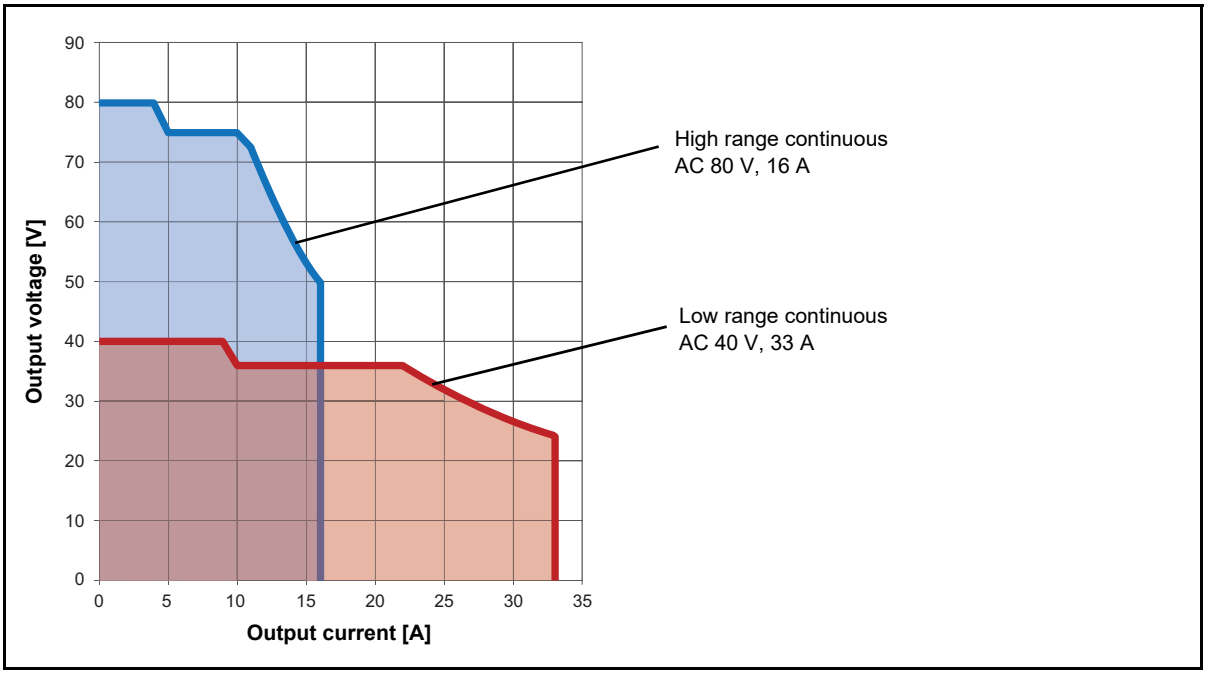


Figure 15-4: Permitted operating range 3 x AC 80 V 16 A

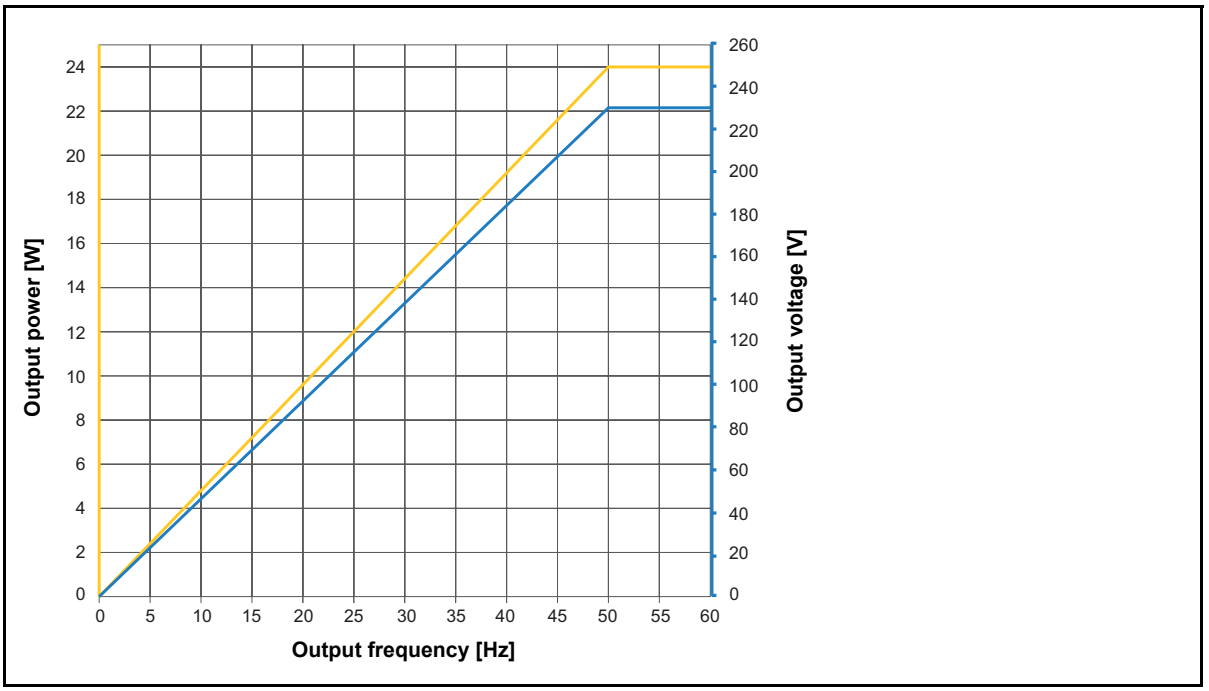


Figure 15-5: Derating of output power and output voltage 3 x 230 V_{RMS}

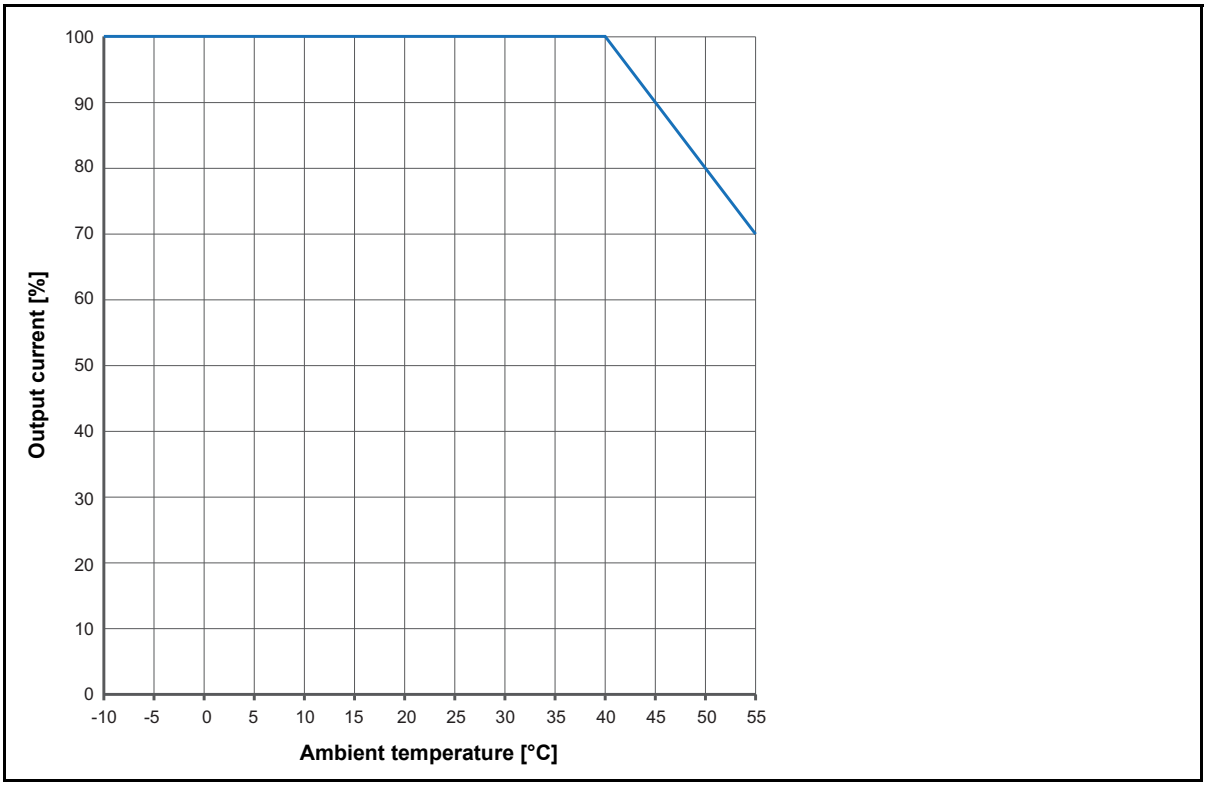


Figure 15-6: Derating of continuous output current

15.1.2 Input specifications

Table 15-7: Voltage inputs (HV and LV) 3 phase

Range name	Range value	Accuracy[1]
AC		
300 mV_{RMS}	0 ... 300 mV_{RMS}	0.01 % rd + 0.003 % range
3 V_{RMS}	0 ... 3 V_{RMS}	0.01 % rd + 0.003 % range
30 V_{RMS}	0 ... 30 V_{RMS}	0.01 % rd + 0.003 % range
300 V_{RMS}	0 ... 300 V_{RMS}	0.012 % rd + 0.003 % range
DC		
42.4 mV_{DC}	0 ... 42.4 mV_{DC}	0.022 % rd + 0.032 % range
424 mV_{DC}	0 ... 424 mV_{DC}	0.01 % rd + 0.017 % range
4.24 V_{DC}	0 ... 4.24 V_{DC}	0.007 % rd + 0.012 % range
42.4 V_{DC}	0 ... 42.4 V_{DC}	0.01 % rd + 0.017 % range
424 V_{DC}	0 ... 424 V_{DC}	0.007 % rd + 0.012 % range

1. Typical accuracy at 23 °C ±5 K

Typical phase accuracy at 50/60 Hz, V>30 % of used range: 0.017°

Table 15-8: Voltage input (Booster)

Range name	Range value	Accuracy[1]
280 V_{RMS}	0 ... 280 V_{RMS}	0.012 % rd + 0.003 % range

1. Typical accuracy at 23 °C ±5 K

Typical phase accuracy at 50/60 Hz, V>30 % of used range: 0.017°

Table 15-9: Current inputs (internal)

Range name	Range value	Accuracy[1]
AC		
4 A_{RMS}	0 ... 4 A_{RMS}	0.036 % rd + 0.0033 % range
40 A_{RMS}	0 ... 40 A_{RMS}	0.023 % rd + 0.013 % range
DC		
0.56 A_{DC}	0 ... 0.56 A_{DC}	0.01 % rd + 0.023 % range
5.6 A_{DC}	0 ... 5.6 A_{DC}	0.037 % rd + 0.026 % range
56 A_{DC}	0 ... 56 A_{DC}	0.008 % rd + 0.01 % range

1. Typical accuracy at 23 °C ±5 K

Typical phase accuracy at 50/60 Hz, I>30 % of used range: 0.017°

Table 15-10: On-load tap changer measurement (tap changer connector)

Characteristic	Rating
Voltage	300 V_{RMS}
Accuracy[1] AC (50/60 Hz)/DC	0.07 % rd + 0.07 % range
Current clamp input	3 V_{RMS}
Tap up/down switch current	300 mA continuous, 9 A for 0.7 s (AC permitted only)
Tap up/down switch voltage	300 V_{RMS} (AC permitted only)

1. Typical accuracy at 23 °C ±5 K

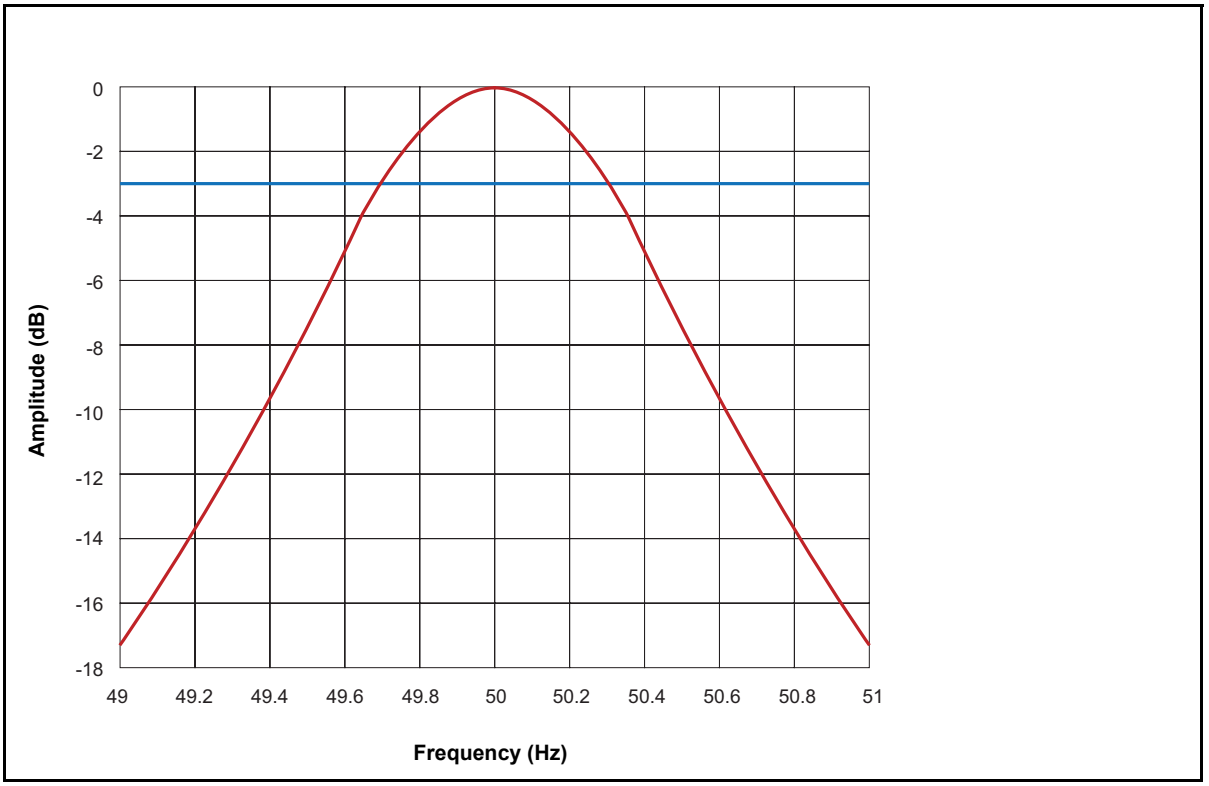


Figure 15-7: Filter characteristic of frequency-selective measurements (example at 50 Hz)

15.1.3 Interfaces

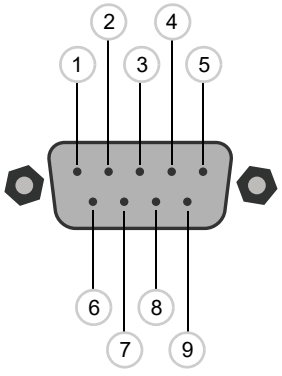
Table 15-11: Connector overview

Interface	Rating
Digital	1 × EtherCAT®[1] 1 × Ethernet 1 × Serial 2 × Safety
Analog	6 × Configurable outputs: – (HV) 3 × analog output – (LV) 3 × analog output
	6 × Configurable inputs: – (HV) 3 × analog input – (LV) 3 × analog input
	On-load tap changer interface: – 2 × internal switch – 1 × voltage measurement – 1 × current clamp measurement
	1 × Booster interface

1. EtherCAT® is registered trademark and patented technology, licensed by Beckhoff automation GmbH, Germany.

SAFETY connectors

Table 15-12: SAFETY 1 and SAFETY 2 pin assignment



Pin no.	SAFETY 1	SAFETY 2
1*	Warning light green	Warning light green
2*	Warning light red	Warning light red
3	Start button IN (n/o)	Start button OUT (n/o)
4	Common start n/o + emergency stop	Common start n/o + emergency stop
5	Emergency stop	Emergency stop
6	Ground	Ground
7	Ground	Ground
8	Start button IN (n/c)	Start button OUT (n/c)
9	Ground	Ground

*) **Typical output pin 1 and pin 2**:

- 10 ... 14 V per connector (**SAFETY 1** or **SAFETY 2**)
- 400 mA combined (**SAFETY 1** and **SAFETY 2**)

Display

Table 15-13: Display

Characteristic	Rating
Size	10.6 in 26.9 cm
Resolution	1280 x 768 WXGA
Type	Color touch TFT LCD
Contrast ratio	1000:1
Luminance	800 cd/m^2
Viewing angle (CR ≥ 10)	85° (H), 85° (V)

15.2 Combined values

Table 15-14: Resistance measurement AC

Range name	Current	Range	Accuracy[1]
40 A_{RMS}	30 A_{RMS}	1 Ω ... 10 Ω	0.053 % rd + 0.033 % range
		0.1 Ω ... 1 Ω	0.053 % rd + 0.033 % range
		10 mΩ ... 100 mΩ	0.053 % rd + 0.033 % range
		1 mΩ ... 10 mΩ	0.053 % rd + 0.033 % range
		100 µΩ ... 1000 µΩ	0.063 % rd + 0.033 % range
4 A_{RMS}	3 A_{RMS}	10 Ω ... 100 Ω	0.053 % rd + 0.037 % range
		1 Ω ... 10 Ω	0.053 % rd + 0.037 % range
		0.1 Ω ... 1 Ω	0.053 % rd + 0.037 % range
		10 mΩ ... 100 mΩ	0.053 % rd + 0.037 % range
		1 mΩ ... 10 mΩ	0.067 % rd + 0.037 % range

1. Typical accuracy at 23 °C ±5 K

Table 15-15: Resistance measurement DC

Range name	Current	Range	Accuracy[1]
4 A_{RMS}	3 A_{DC}	10 Ω ... 100 Ω	0.1 % rd + 0.18 % range
		1 Ω ... 10 Ω	0.1 % rd + 0.267 % range
		0.1 Ω ... 1 Ω	0.1 % rd + 0.18 % range
		10 mΩ ... 100 mΩ	0.1 % rd + 0.267 % range
		1 mΩ ... 10 mΩ	0.113 % rd + 0.433 % range
40 A_{RMS}	30 A_{DC}	1 Ω ... 10 Ω	0.037 % rd + 0.017 % range
		0.1 Ω ... 1 Ω	0.04 % rd + 0.027 % range
		10 mΩ ... 100 mΩ	0.033 % rd + 0.017 % range
		1 mΩ ... 10 mΩ	0.037 % rd + 0.027 % range
		100 µΩ ... 1000 µΩ	0.05 % rd + 0.043 % range
120 A_{RMS}	100 A_{DC}	30 mΩ ... 300 mΩ	0.04 % rd + 0.027 % range
		3 mΩ ... 30 mΩ	0.033 % rd + 0.017 % range
		300 µΩ ... 3000 µΩ	0.037 % rd + 0.027 % range
		30 µΩ ... 300 µΩ	0.05 % rd + 0.043 % range
		3 µΩ ... 30 µΩ	0.07 % rd + 0.44 % range

1. Typical accuracy at 23 °C ±5 K

Table 15-16: Ratio measurement

Range name (LV voltage range)	Voltage at HV	Range[1]	Accuracy[2]
300 V_{RMS}	230 V_{RMS} HV (LN)	$\frac{1}{1 \ldots 10}$	0.03 % rd + 0.043 % range
30 V_{RMS}		$\frac{1}{10 \ldots 100}$	0.027 % rd + 0.043 % range
3 V_{RMS}		$\frac{1}{100 \ldots 1000}$	0.027 % rd + 0.043 % range
300 mV_{RMS}		$\frac{1}{1000 \ldots 10000}$	0.027 % rd + 0.043 % range

1. Range = $\frac{LV}{HV}$
2. Typical accuracy at 23 °C ±5 K

15.3 Power supply specifications

Table 15-17: Power supply specifications

Characteristic		Rating
Voltage	Nominal	100 V … 240 V_{AC}
	Permitted	85 V … 264 V_{AC}
Current	Nominal	16 A
Frequency	Nominal	50 Hz/60 Hz
	Permitted	45 Hz … 65 Hz
Power fuse		Automatic circuit breaker with magnetic overcurrent tripping at I >16 A
Power consumption	Continuous	<3.6 kW
	Peak	<5.0 kW
Current consumption, continuous		<16 A_{AC}
Connector type		IEC320/C20, 1 phase

15.4 Environmental conditions

Table 15-18: Climate

Characteristic		Rating
Temperature	Operating	-10 ºC … +55 ºC/+14 ºF…+131 ºF
	Storage	-30 ºC … +70 ºC/-22 ºF…+158 ºF
Max. altitude	Operating	2000 m/6550 ft, up to 5000 m/16400 ft with limited specifications[1]
	Storage	12 000 m/40 000 ft

1. Output **TAP CHANGER (CAT III / 300 V)**: from 2000 m/6550 ft to 5000 m/16400 ft altitude only CAT II compliance or CAT III compliance with half voltage

15.5 Mechanical data

Table 15-19: Mechanical data

Characteristic		Rating
Dimensions (w × h× d)	With cover, without handles	464 × 386 × 229 mm 18.3 × 15.2 × 9 in
	With cover, with handles	580 × 386 × 229 mm 22.8 × 15.2 × 9 in
Weight	Device with display	20.6 kg/45.5 lb
	Device without display	19.5 kg/43 lb

15.6 Standards

Table 15-20: Standards conformity

EMC, safety	
EMC	IEC/EN 61326-1 (industrial electromagnetic environment) FCC subpart B of part 15, class A
Safety	IEC/EN/UL 61010-1, IEC/EN/UL 61010-2-30
Other	
Shock	IEC/EN 60068-2-27 (15 g/11 ms, half-sinusoid, 3 shocks in each axis)
Vibration	IEC/EN 60068-2-6 (frequency range 10 Hz…150 Hz, acceleration 2 g continuous (20 m/s^2/65 ft/s^2), 20 cycles per axis)
Humidity	IEC/EN 60068-2-78 (5 % … 95 % relative humidity, no condensation), tested at 40 °C/104 °F for 48 hours

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