FRANEO 800 PTM

User Manual

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1   Introduction

1.1   About this document

This document provides information on how to use this product safely, properly and efficiently.

It contains important safety rules for working with this product and gets you familiar with operating this product. Following the instructions in this document will help you to prevent danger, repair costs, and avoid possible down time due to incorrect operation.

This document is to be supplemented by existing national safety standards for accident prevention and environmental protection.

1.2   Symbols and conventions

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

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In this document, the following signs and formatting styles are used:

Sign/formatting style	Description
▶ Instruction	Single-step instruction
1. Step 2. Step	Individual steps of step-by-step instructions
2.1 Substep 2.2 Substep	Individual substeps of step-by-step instructions
Text in bold	Text that is shown on a device, its display or on a software user interface
Text in italics	OMICRON product name
ⓘ / **Note:**	Notes are introduced by **Note:** or are indicated by the **i** icon.

1.3 Compliance statements

The device is designated in the following statements as 'product', 'equipment', or 'apparatus'.

The OMICRON contact address can be found on the last page (back page) of this document.

Declaration of conformity (EU)

The equipment adheres to the guidelines of the council of the European Community for meeting the requirements of the member states regarding one or a combination of the following directives:

• Electromagnetic compatibility (EMC) directive

• Low voltage directive (LVD)

• RoHS directive

FCC compliance (USA)

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

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.

ℹ The use of shielded LAN cables is required when connecting this equipment to any and all optional peripheral or host devices. Failure to do so may violate FCC and ICES rules, and the EMC directive.

ℹ Grounding is required to fulfill the immunity requirements according to the EMC directive.

1.4 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 (WEEE directive). As part of our legal obligations under this legislation, OMICRON offers to take back the test set and to ensure that it is disposed of by authorized recycling agents.

For customers outside the European Economic Area

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

2 Safety

▶ Before operating the device, carefully read the instructions in this document. Only install and operate the device and any accessories after you have read this document, and fully understood all instructions.

▶ Contact OMICRON Support (→ Support on page 138) if you do not understand any of the instructions in this document.

2.1 Disclaimer

▶ Only use this device and its accessories in accordance with the corresponding user documentation.

Improper use may result in damage to persons or property and could invalidate warranty claims.

2.2 Operator qualifications

Only authorized and qualified personnel who are qualified, skilled and regularly trained in electrical engineering are allowed to operate the device and any accessories.

Personnel receiving training, instructions, directions, or education on the device must be under constant supervision of an experienced operator while working with the equipment. The supervising operator must be familiar with the equipment and the regulations on site.

▶ Before starting to work, clearly establish the responsibilities.

▶ The supervising operator must coordinate the communication with all persons involved in work activities.

2.3 Safety standards

Using the device 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"
- LAPG 1710.6 NASA "Electrical Safety"

▶ Observe all applicable standards and regulations for accident prevention on site.

2.4 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.

2.5 Orderly measures

This document has to be available on the site where the device is operated, either digitally or in print.

▶ Read this document before operating the device, and comply with any included instructions and workflows.

Opening the device or any accessories without authorization invalidates all warranty claims.

▶ Contact OMICRON Support (→ Support on page 138) for maintenance and repair.

2.6 General instructions

▶ Avoid interruptions or distractions that could affect safety.

▶ If the device or any accessory does not seem to function properly, do not use it. If in doubt, contact OMICRON Support (→ Support on page 138).

▶ Only use cables supplied by OMICRON.

▶ Only use original accessories available from OMICRON.

▶ Make sure that during a test, the device is the only power source for a test object.

ⓘ OMICRON offers a range of accessories for added safety during the operation of our test systems. For further information and specifications, contact OMICRON Support (→ Support on page 138).

2.7 Work environment

▶ Only use the device on dry, solid ground.

▶ Do not operate the device in a condensing environment.

▶ Do not operate the device in the presence of explosive gas or vapors.

▶ Do not operate the device under ambient conditions that exceed the temperature and humidity limits listed in the user documentation.

▶ Before use, check that the environmental conditions are suitable for any additional equipment such as your computer.

▶ Make sure that the device and all accessories are dry and clean. In dusty regions, use protective cable caps.

2.8 Mechanical safety

▶ Do not insert objects into any of the device's openings.

▶ Do not cover the device and make sure any ventilation openings remain unobstructed.

▶ Test leads wired to tall test objects must be sufficiently mechanically secured. Be aware of the hazard of falling adapters or cables.

▶ Do not block access to safety-relevant test set components, such as the emergency stop button.

2.9   Personal safety

▶ Protect others from accessing the test area and accidentally touching live parts by setting up a suitable barrier and, if applicable, warning lights.

▶ Warn other people prior to any operation to make them aware of any possible disturbances.

▶ If you have a cardiac pacemaker, do not use the device. If you have another type of electronic medical implant consult a medical professional before operating the device. Make sure there is no person with an electronic medical implant such as a cardiac pacemaker in the immediate vicinity.

▶ Leave the test area before performing a test with the device. Stay in the work area during the test.

3   System requirements

Table 3-1: *Primary Test Manager* System requirements

Characteristic	Requirement (*recommended)
Operating system	Windows 10 64-bit
CPU	Single-core system with 2 GHz or faster (Multicore 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 (Graphics adapter supporting Microsoft DirectX 9.0 or later*)
Browser	Mozilla Firefox; Google Chrome; Microsoft Edge
Interface	Ethernet Network Interface Card (For testing with *TESTRANO 600*, *CPC 100* and *CIBANO 500*. *TESTRANO 600, CPC 100* and *CIBANO 500* can be connected with RJ-45 connectors either directly to the computer or to the local network by using an Ethernet hub.) USB 2.0 (For testing with *FRANEO 800)*
Installed software required for the optional Microsoft Office interface functions	Microsoft 365*, Office 2019, Office 2016, Office 2013

4 Introduction

4.1 Frequency response analysis (FRA)

Power transformers are essential components of any power transmission and distribution system. The strong electrodynamic forces resulting from short-circuit faults in the power system and the high acceleration potentially emerging during transportation can give rise to severe deformations of the transformer windings and mechanical construction. Transformers can also be exposed to stress during installation and due to inrush current or seismic occurrences.

Consequently, the mechanical construction and the windings of power transformers are subject to high mechanical stress. Depending on the grade of the overstressing, this may cause mechanical deformation or defects of the transformer windings and magnetic core.

The equivalent circuit of the transformer winding includes the coil's resistance and inductance as well as parasitic capacitances between consecutive turns and between the winding and the tank wall and the core. Figure "Equivalent circuit of the transformer winding" shows the circuitry of discrete RLC elements. The frequency response of the particular transformer winding is a unique characteristic depending on the transformer's mechanical construction. Deformations of the transformer's mechanical construction cause altering the values of the RLC elements and, consequently, the frequency response of the transformer windings changes. By measuring the frequency response of the transformer windings in a wide frequency range, defects in the windings and magnetic core of power transformers can be diagnosed.

The following figure shows the equivalent circuit of the transformer winding.
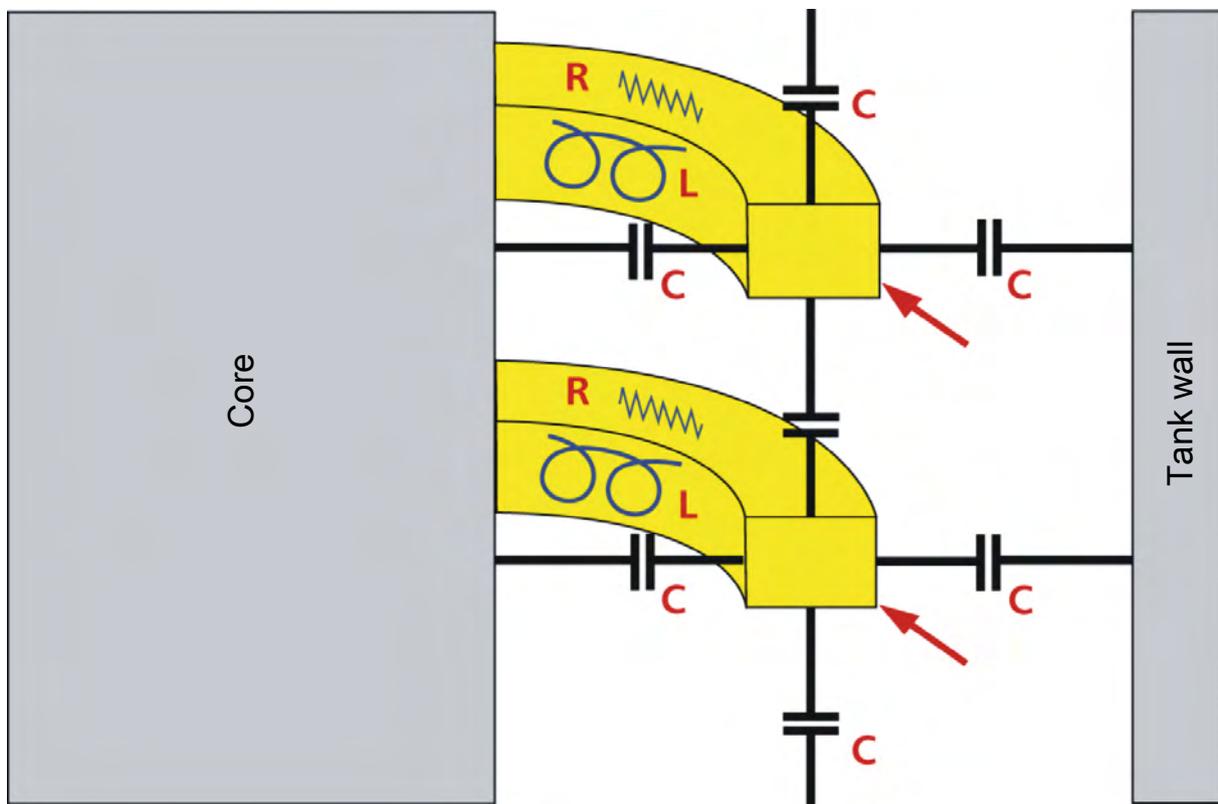
Figure 4-1: Equivalent circuit of the transformer winding

The following figure compares the frequency responses of the phase U, V and W windings of a power transformer with those in a healthy condition. The deviations of the FRA measurement results indicate that the U and W phase windings might have a defect.
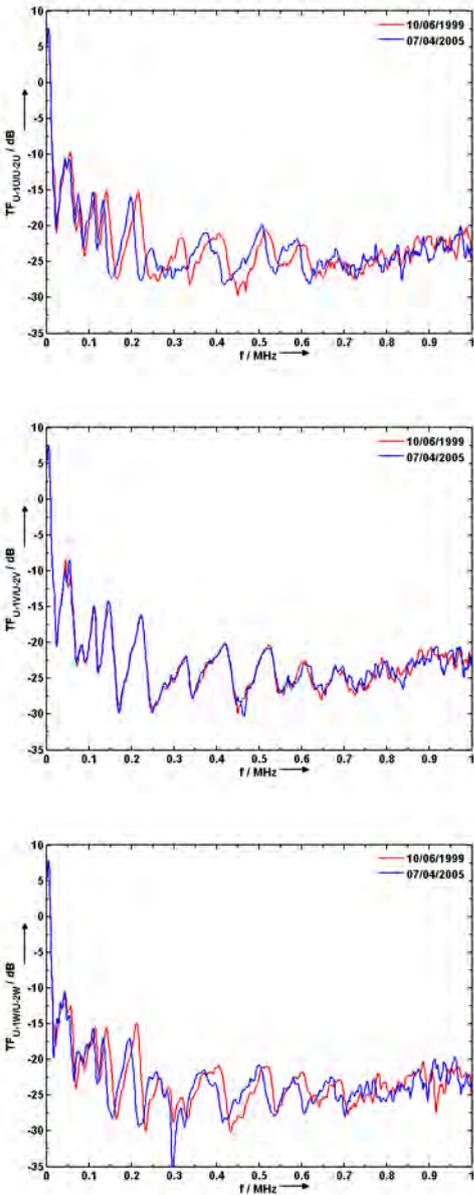
Figure 4-2: FRA measurement results

The following figure shows the windings of the phase U and the radial displacements of the windings.

Figure 4-3: Radial coil deformation

4.2   Designated use

FRANEO 800 is a sweep frequency response analyzer for power transformer core and winding diagnosis. Its concept – universal hardware controlled by *Primary Test Manager* running on a computer – makes *FRANEO 800* an efficient and flexible solution for the diagnosis of power transformer windings and magnetic cores.

FRANEO 800 evaluates the frequency response of the transformer windings by using the sweep frequency response analysis (SFRA) in the frequency domain. Figure "Sweep frequency response analysis" shows the measurement procedure. A sinusoidal voltage with constant amplitude and variable discrete frequencies is applied to the winding under test and the frequency of the input signal is successively increased. The amplitude and phase of the output signal is measured against the frequency and the output-to-input amplitude ratio and the phase shift between the output and input signals are evaluated.

Sine wave generator   Transformer

Variable frequency   Complex RCLM network

Magnitude   Phase
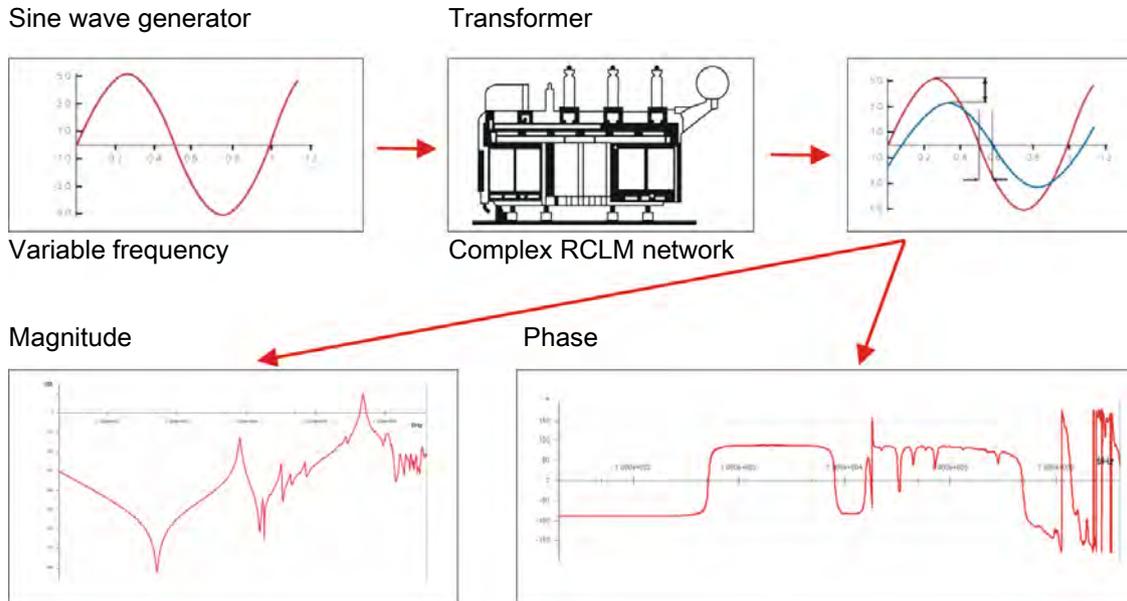
Figure 4-4: Sweep frequency response analysis

FRANEO 800 measures the frequency response of the transformer windings in a wide frequency range and compares it with that in a healthy condition. From the frequency response deviations, you can diagnose many different types of defects in the transformer winding and magnetic core. These include:

- Coil deformation – axial and radial
- Faulty core grounds
- Partial winding collapse
- Hoop buckling
- Broken or loose clamps
- Shorted turns and open windings
- Core deformation

With *FRANEO 800*, you can measure the magnitude and phase, the impedance and the admittance frequency responses of the transformer windings. The measurement results are available on your computer for further processing and documentation.

FRANEO 800 operates only when connected to an external computer with USB interface. With *Primary Test Manager* running on the computer, you can define, parametrize, and execute automated FRA tests.

4.3 Connections and operating controls

The following figures describe the connections and operating controls of *FRANEO 800*.

4.3.1   Front panel
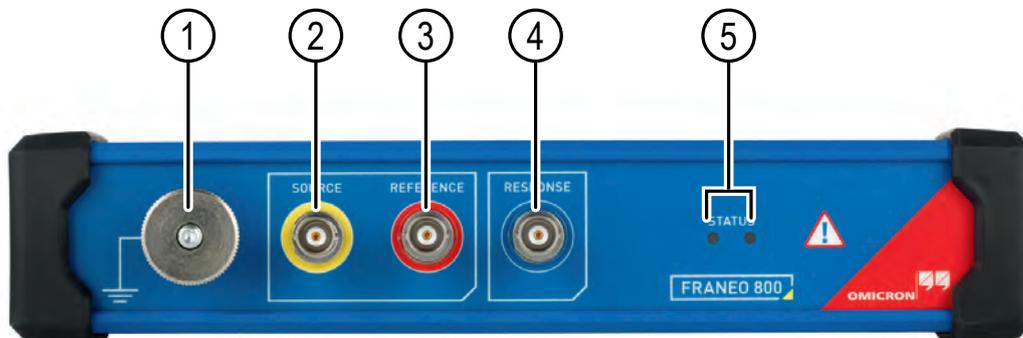
Figure 4-5: Front view of *FRANEO 800*

1	Equipotential ground terminal	4	RESPONSE connector (measurement channel input)
2	SOURCE connector (signal source output)	5	Status LEDs
3	REFERENCE connector (reference channel input)		

4.3.2   Rear panel

Figure 4-6: Rear view of *FRANEO 800*

1	POWER switch	3	USB connector
2	DC IN connector		

4.3.3   Status LEDs

The following table describes the status LEDs.

Table 4-1: Status LEDs

LED	Description
Green	The LED lights when power is on and no measurement is being performed.
Red	The LED lights when power is on and a measurement is being performed.

4.4   Primary Test Manager

Primary Test Manager is a control software for testing power transformers with the *FRANEO 800* test system. *Primary Test Manager* provides a computer interface to *FRANEO 800* and assists you with the hardware configuration and test analysis.

With *Primary Test Manager*, you can create guided workflows, execute prepared jobs, and manage jobs. After you have performed a test, you can generate exhaustive test reports. *Primary Test Manager* runs on a computer and communicates with *FRANEO 800* through USB interface.

For detailed information about *Primary Test Manager*, see the relevant chapters in the FRANEO 800 PTM User Manual.

4.5   Delivery

4.5.1   FRANEO 800 Standard Package

The *FRANEO 800* Standard Package delivery includes:

Transport case	FRANEO 800 Getting Started	*Primary Test Manager* DVD	AC power supply and battery charger (including international mains plug adapters)

FRANEO 800	*RBP1* rechargeable battery pack	Battery connection cable	USB 2.0 A/B cable 2.0 m/6.6 ft
2 × Bushing clamp	4 × Aluminum braid 25 mm^2 roll	Grounding cable (GR/YE) 6 m/20 ft	3 × Carabiner for cable relief
50 Ω coaxial cable 18 m/60 ft (yellow)	50 Ω coaxial cable 18 m/60 ft (red)	50 Ω coaxial cable 18 m/60 ft (blue)	4 × Screw clamp
Insulation sleeve	Crank handle	File	BNC T adapter

4.5.2   FRANEO 800 Quick Package

The *FRANEO 800* Quick Package delivery includes:

Transport case	FRANEO 800 Getting Started	*Primary Test Manager* DVD	AC power supply and battery charger (including international mains plug adapters)
FRANEO 800	*RBP1* rechargeable battery pack	Battery connection cable	USB 2.0 A/B cable 2 m/6.6 ft
Soft bag	2 x Grounding leads 2 m/6.6 ft	2 x Grounding leads 4 m/13 ft	Grounding cable (GR/ YE) 6 m/20 ft
2 x All-in-one cables including ring reference ground connection and easy-to-connect clamps 18 m/60 ft	File		

4.6 Cleaning

> ⚠️ **WARNING**
>
> **Death or severe injury caused by high voltage or current possible**
> ▶ Do not clean the *FRANEO 800* test set when connected to the test object.
> ▶ Before cleaning *FRANEO 800* and its accessories, always disconnect the test object, accessories and connection cables.

To clean *FRANEO 800* and its accessories, use a cloth dampened with isopropanol alcohol.

5 Functional scheme
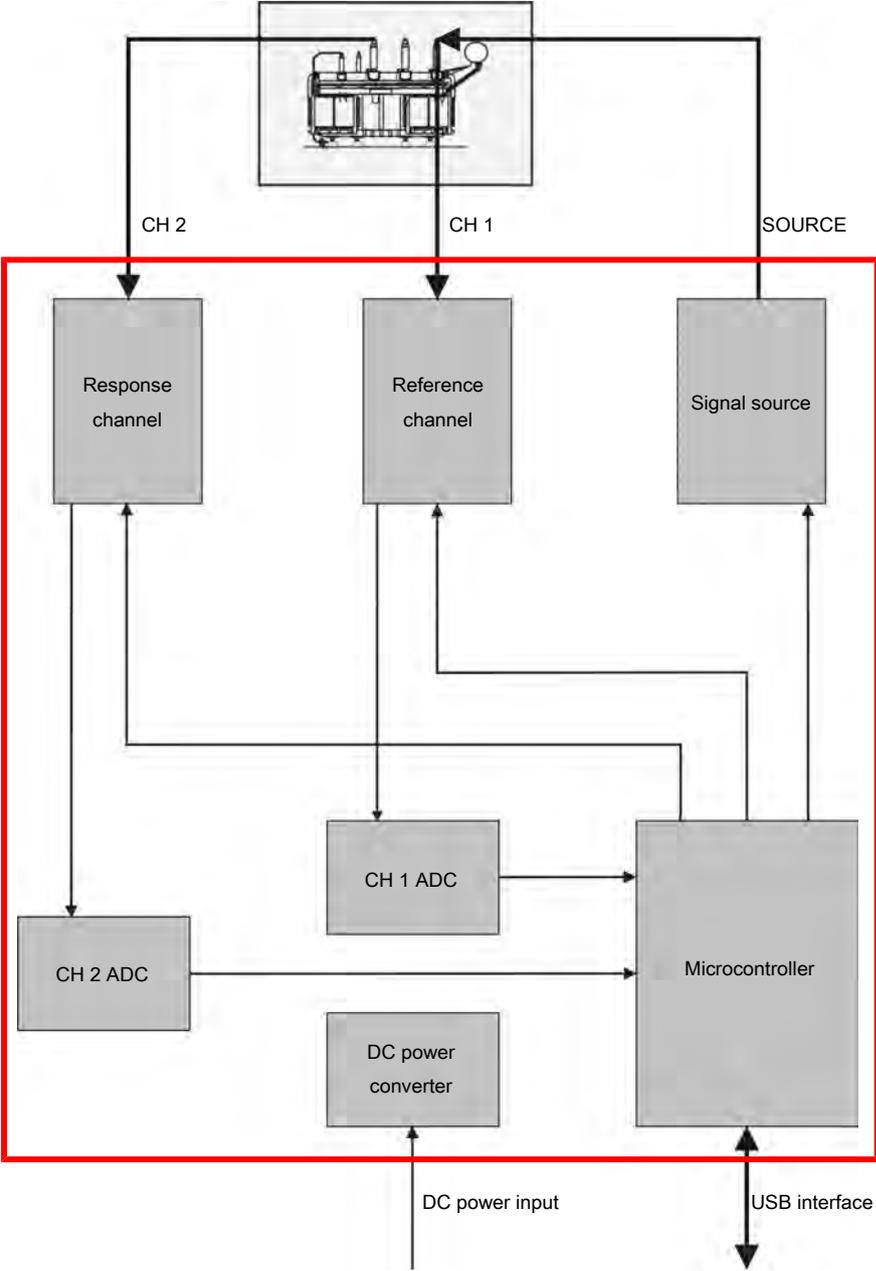
Figure 5-1: *FRANEO 800* functional scheme

6   Installation

Before installing *FRANEO 800*, check the environmental and power requirements (→ Technical data on page 135).

6.1   Install Primary Test Manager

🛈   Install *Primary Test Manager* before connecting *FRANEO 800* to the computer.

For the minimum requirements your computer needs to run *Primary Test Manager*, see → System requirements on page 12.

To install *Primary Test Manager*, put the delivered *Primary Test Manager* DVD in the DVD drive of your computer and follow the instructions on the screen. For detailed instructions about how to migrate your data from the *FRAnalyzer* software database into *Primary Test Manager*, see → Migrate the FRAnalyzer data on page 23.

6.2   Migrate the FRAnalyzer data

You can migrate your data available in the *FRAnalyzer* software into *Primary Test Manager*.

NOTICE

You can migrate data in *FRAnalyzer* 2.2 format.

▶   If your data is available in an earlier version of the *FRAnalyzer* software, update the software to version 2.2 before migrating the data. You can download the *FRAnalyzer* software 2.2 from the OMICRON customer area.

The migration procedure differs according to whether the *FRAnalyzer* software is installed on the same computer or on another computer as *Primary Test Manager*. The following sections describe in detail the different scenarios.

NOTICE

PTM FRAnalyzer Migration Assistant migrates all data available in the *FRAnalyzer* software database into *Primary Test Manager*. If you do not want to migrate all data:

▶   Back up the *FRAnalyzer* software database, delete the data you do not want to migrate, and then start *PTM FRAnalyzer Migration Assistant*.

NOTICE

Duplication of data possible

Importing .dbefra files created with *PTM FRAnalyzer Migration Assistant* that come from the same database already migrated to *Primary Test Manager* could lead to duplication of data.

Importing .fra or .tfra files that come from the same database already migrated to *Primary Test Manager* could lead to duplication of data.

Scenario I

The *FRAnalyzer* **software and** *Primary Test Manager* **are installed on the same computer**

To migrate the *FRAnalyzer* data if the *FRAnalyzer* software and *Primary Test Manager* are installed on the same computer:

1. If you selected during the installation procedure *FRANEO 800* as your test system and the *FRAnalyzer* software 2.0 or later is installed on your computer, *Primary Test Manager* Setup installs *PTM FRAnalyzer Migration Assistant* on your computer.

2. When *Primary Test Manager* Setup prompts you for migration of the *FRAnalyzer* data, do one of the following:

   2.1 Select **Start PTM FRAnalyzer Migration Assistant after setup completion** to migrate data from the *FRAnalyzer* software database into *Primary Test Manager* automatically after *Primary Test Manager* Setup is completed.

   2.2 Select **Create PTM FRAnalyzer Migration Assistant shortcut on the desktop** to create a shortcut on desktop for migration of data from the *FRAnalyzer* software database into *Primary Test Manager* when you want.

3. If you selected **Create PTM FRAnalyzer Migration Assistant shortcut on the desktop** and want to migrate the data now, proceed as follows.

4. Start *PTM FRAnalyzer Migration Assistant*.

5. To export the data, follow the instructions provided by the *PTM FRAnalyzer Migration Assistant*.

6. Start *Primary Test Manager*.

7. In the home view, click the **Manage** button .

8. Under **Jobs**, click the **Import** button .

9. In the **Open** dialog box, select FRAnalyzer 2.2 database export (*.dbefra) data format.

10. Browse to the file you want to import.

Scenario II

The *FRAnalyzer* **software and** *Primary Test Manager* **are installed on different computers**

To migrate the *FRAnalyzer* data if the *FRAnalyzer* software and *Primary Test Manager* are installed on different computers:

1. Do one of the following:

   1.1 Put the delivered *Primary Test Manager* DVD in the DVD drive of the computer the *FRAnalyzer* software is installed on, and then go to the directory PTM_FRAnalyzer_Migration_Assistant.

   1.2 Download the PTM FRAnalyzer Migration Assistant Setup from the OMICRON customer area.

2. Start *PTM FRAnalyzer Migration Assistant* Setup to create a shortcut on the desktop.

3. Start *PTM FRAnalyzer Migration Assistant*.

4. To export the data, follow the instructions provided by the *PTM FRAnalyzer Migration Assistant*.

5. Copy the exported data to a removable storage device such the USB flash drive.

6. Install the removable storage device on the computer Primary Test Manager is installed on.

7. Start *Primary Test Manager*.

8. In the home view, click the **Manage** button ⊞.

9. Under **Jobs**, click the **Import** button ⧉.

10. In the **Open** dialog box, select FRAnalyzer 2.2 database export (*.dbefra) data format.

11. Browse to the file you want to import.

6.3   Power up FRANEO 800

You can power *FRANEO 800* with the delivered AC power supply or from the *RBP1* lithium-ion battery pack.

The delivered AC power supply is a battery charger for the *RBP1* lithium-ion battery pack. It is suitable for powering *FRANEO 800* directly, too.

6.3.1   Powering with the AC power supply

To power *FRANEO 800* by using the delivered AC power supply:

1. Plug the DC output connector of the AC power supply into the **DC IN** connector on the *FRANEO 800* rear panel (→ Rear panel on page 17).

2. Fit the mains plug of the AC power supply to the power outlet, if necessary.

3. Connect the mains plug of the AC power supply to the power outlet.

4. Press the **POWER** switch on the *FRANEO 800* rear panel.
   When power is on, the green LED on the *FRANEO 800* front panel lights up.

6.3.2   Powering from the RBP1 battery pack

To power *FRANEO 800* from the *RBP1* battery pack:

1. Plug the red marked end of the battery connection cable shipped with the *RBP1* into the **OUTPUT** connector of the battery pack.

2. Plug the blue marked end of the battery connection cable into the *FRANEO 800* **DC IN** connector.
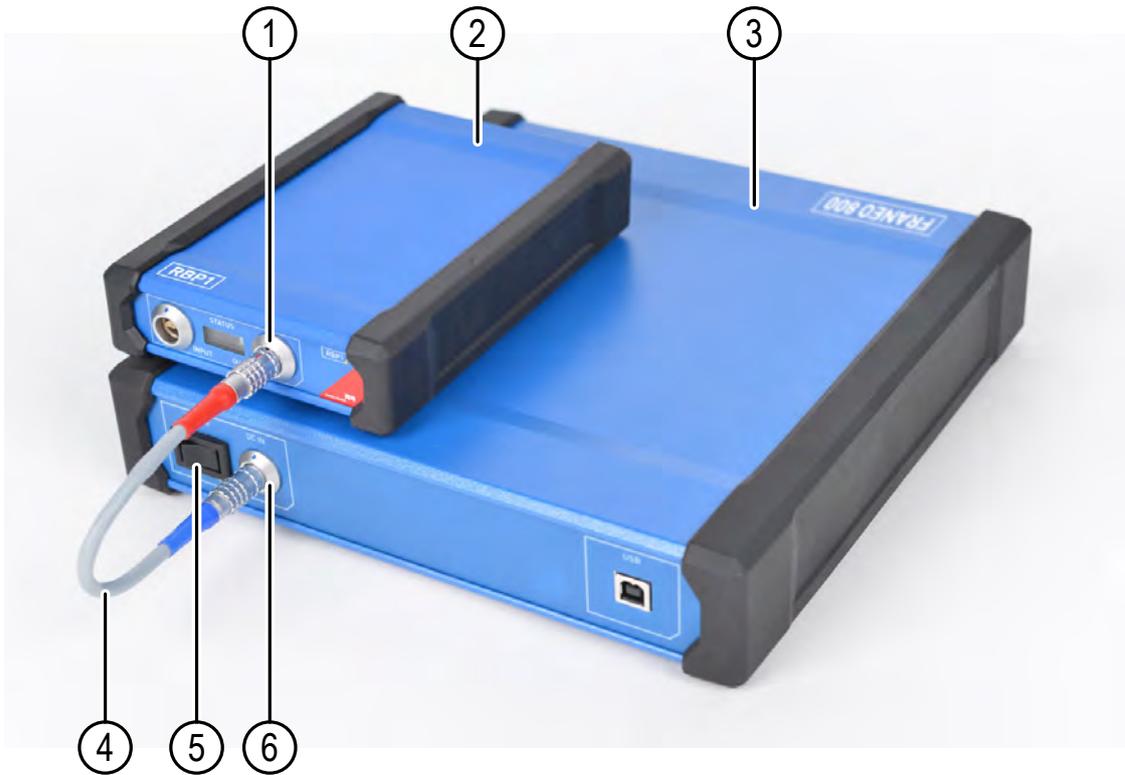
Figure 6-1: Powering *FRANEO 800* from the *RBP1* battery pack

1	OUTPUT connector	4	Battery connection cable
2	RBP1 battery pack	5	POWER switch
3	FRANEO 800	6	DC IN connector

3. Press the **POWER** switch on the *FRANEO 800* rear panel.
   When power is on, the green LED on the *FRANEO 800* front panel lights up.

6.3.3 Charging the RBP1 battery pack

Use only the delivered AC power supply to charge the *RBP1* battery pack. You can charge the *RBP1* even while powering *FRANEO 800* during a test.

6.4 Connect FRANEO 800 to the computer

FRANEO 800 communicates with the computer through USB interface. To connect *FRANEO 800* to the computer:

Connect the delivered USB 2.0 A/B cable to the *FRANEO 800* USB connector.

Connect the USB 2.0 A/B cable to the USB connector of your computer.

NOTICE

Equipment damage possible

▶ Do not crush the cables when closing the transport case.

▶ Always place the cables carefully within the transport case when closing it.

Figure 6-2: Connecting *FRANEO 800* to the computer by using the delivered USB 2.0 A/B cable

6.5 Start PTM and connect to FRANEO 800

To start *Primary Test Manager*, click **Start** on the task bar, and then click **OMICRON Primary Test Manager**, or double-click the **OMICRON Primary Test Manager** icon on the desktop.

To connect to *FRANEO 800*, select the device in the list, and then click **Connect**.

Figure 6-3: Connecting to *FRANEO 800*

Alternatively, you can manage the connection to *FRANEO 800* in the *Primary Test Manager* status bar (→ Status bar on page 52).

6.6 Connect FRANEO 800 to the power transformer

6.6.1 FRANEO 800 Standard Package

For testing a power transformer, the test traces are automatically generated by the selected template or manually configured by the user. For each test trace, *Primary Test Manager* assigns the **SOURCE**, **REFERENCE** and **RESPONSE** connectors of *FRANEO 800* to the transformer's terminal bushings. To connect *FRANEO 800* to the power transformer under test:

1. Fasten a bushing clamp to the transformer's terminal bushing to be connected to the **REFERENCE** connector according to the wiring diagram displayed in the General area of the *Primary Test Manager* test view.

2. Connect the yellow and red coaxial cables to the BNC connector on the bushing clamp by using a delivered BNC adapter.

NOTICE

Equipment damage possible

▶ Do not connect the coaxial cables to the bushing clamp without relieving the pressure on the BNC shield.

▶ Always attach the coaxial cables by provided cord loops and the delivered carabiner to the ring of the bushing clamp's strap as shown in Figure 5-4: "Connecting the yellow and red coaxial cables to the bushing clamp by using the mechanism for relieving the pressure on the BNC shield" later in this section.

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3. Connect the aluminum braid to the bushing clamp by using the screw on the bushing clamp and tighten the screw. If necessary, use the delivered insulation sleeve to prevent electrical contact between the aluminum braid and the bushing.

In the past, we have recommended using two aluminum braids for grounding the bushing clamps. Based on the recommendations given by the IEC 60076-18 standard, only one aluminum braid should be used. If you made previous measurements with two aluminum braids, we recommend repeating the measurements with the same connection technique.

NOTICE

Equipment damage possible

▶ Do not apply force when handling the aluminum braids to prevent breaking the small strands.

▶ Always bend and pull the aluminum braids carefully.

Figure 6-4: Connecting the yellow and red coaxial cables to the bushing clamp by using the mechanism for relieving the pressure on the BNC shield.

4. Connect the aluminum braid to the transformer's tank by using the screw clamp.

> ℹ️ We recommend activating the ground-loop check in *Primary Test Manager* before performing the measurement for checking the quality of the contact. This ensures a proper measurement setup and increases the reproducibility of the measurements.

Figure 6-5: Fastening the screw clamp

Figure 6-6: Alternative way of fastening the screw clamp

5. Fasten a bushing clamp to the transformer's terminal bushing to be connected to the **RESPONSE** connector according to the wiring diagram displayed in the General area of the *Primary Test Manager* test view.

6. Connect the blue coaxial cable to the BNC connector on the bushing clamp.

NOTICE

Equipment damage possible

▶ Do not connect the coaxial cable to the bushing clamp without relieving the pressure on the BNC shield.

▶ Always attach the coaxial cable by the provided cord loop and the delivered carabiner to the ring of the bushing clamp's strap as shown in the following figure.
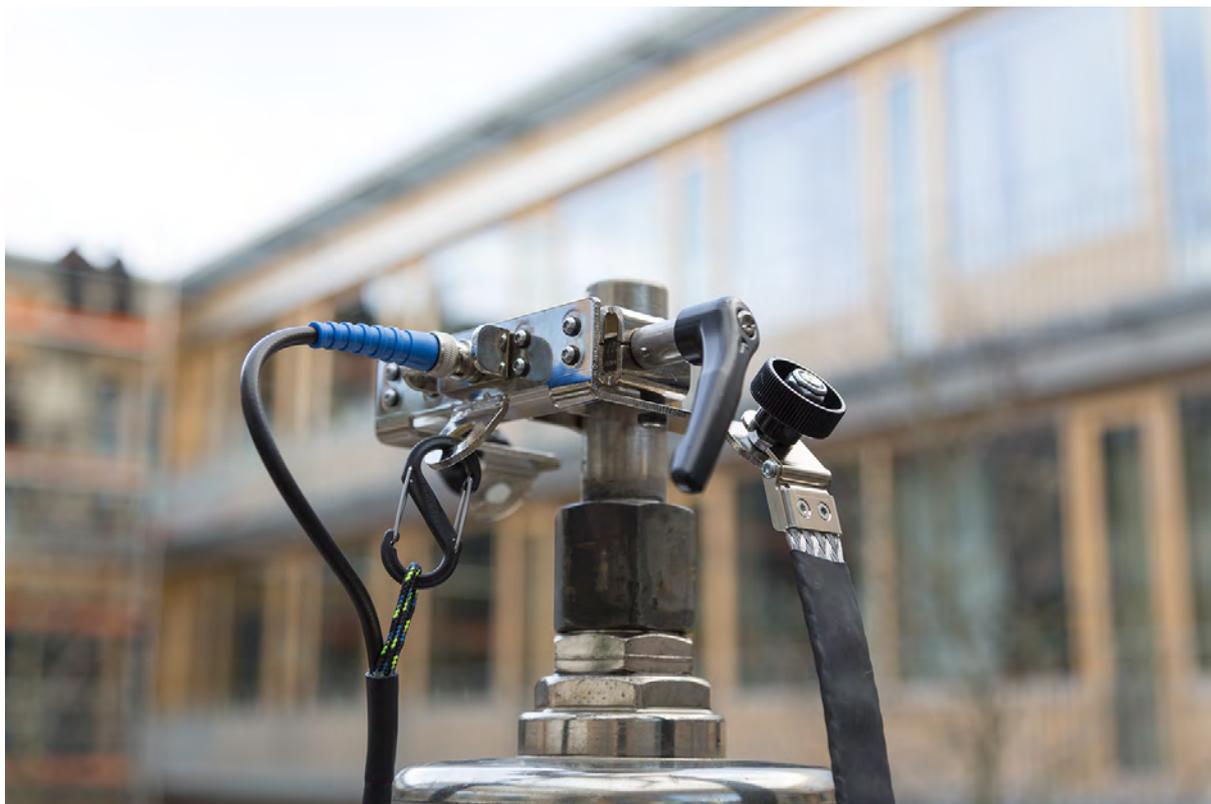
Figure 6-7: Connecting the blue coaxial cable to the bushing clamp by using the mechanism for relieving the pressure on the BNC shield

7. To ground the bushing clamp, repeat steps 3 and 4.

8. Connect the other ends of the three BNC cables to the corresponding color-coded **SOURCE**, **REFERENCE** and **RESPONSE** connectors on the front panel of *FRANEO 800*.

6.6.2   FRANEO 800 Quick Package

For testing a power transformer, the test traces are automatically generated by the selected template or manually configured by the user. For each test trace, *Primary Test Manager* assigns the **SOURCE**, **REFERENCE** and **RESPONSE** connectors of *FRANEO 800* to the transformer's terminal bushings. To connect *FRANEO 800* to the power transformer under test:

1. Fasten the all-in-one cable with the red clamp to the transformer's terminal bushing according to the wiring diagram displayed in the **General** area of the *Primary Test Manager* test view.

2. Connect the yellow and red BNC connectors of the all-in-one cable to the corresponding color-coded **SOURCE** and **REFERENCE** connector on the front panel of *FRANEO 800*.

3. Fasten the all-in-one cable with the black clamp to the transformer's terminal bushing according to the wiring diagram displayed in the **General** area of the *Primary Test Manager* test view.

4. Connect the blue BNC connector of the all-in-one cable to the corresponding color-coded **RESPONSE** connector on the front panel of *FRANEO 800*.

5. Each clamp is equipped with a cable shield ring to ground the shields of the BNC cables. Therefore, connect one end of the OMICRON supplied grounding lead to the cable shield ring and the other end to the flange of the bushing.

> ℹ️ Ensure that the grounding lead runs as tight as possible along the bushing.

6. Repeat step 5 for the second clamp.

7. We recommend activating the ground-loop check in *Primary Test Manager* before performing the measurement for checking the quality of the contact. This ensures a proper measurement setup and increases the reproducibility of the measurements. In case of a failed ground-loop check, check the connections again and, if needed, remove rust or paint by using the file.

7 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 7-1: 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 7-1: 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:

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Table 7-2: Selecting the user tasks

Button	Description	Action
	Manage	Click to open the **Manage** view for locations, assets, jobs, and reports (→ Manage objects on page 79)
	New guided job	Click to start the guided test workflow (→ Create new guided jobs on page 53)
	New manual job	Click to create a new manual test (→ Create new manual jobs on page 85)
	Open job	Click to open a manual test (→ Open jobs on page 88)
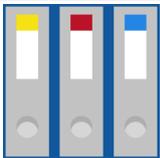
The following table describes the available user interface commands in the Home view.

Table 7-3: Home view user interface commands

User interface element	Action
Title bar	
Settings	Click to open the Settings dialog box
Help	Click to open the PTM help
	Alternatively, press **F1** on your keyboard
Send data to technical support	Click to send system information and your data to OMICRON technical support (→ Send data to technical support on page 46)
About	Click to open the **About Primary Test Manager** dialog box
Device	
Connect/Disconnect	Click to manage connection to the test system
Data	
Synchronize (Only enabled with the appropriate license)	Click to synchronize your local database with the *Primary Test Manager* server database
Import files	Click to import *Primary Test Manager* data
Back up your data	Click to backup the *Primary Test Manager* database

User interface element	Action
Title bar	
Restore data from a backup	Click to restore your data in the database
Information	
Click a list item to get information about your test system and its application.	
Recent guided jobs/Recent manual jobs	
Click a list item to open a recently created guided or manual job.	
Status bar	
In the status bar, you can connect to and disconnect from a test system and view the test set information.	

7.1   Title bar

ℹ The title bar is always displayed at the top of *Primary Test Manager*

7.1.1   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 (→). 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** dialogue box affects all data in *Primary Test Manager*.

▶ Only change settings if you are qualified to do so.

▶ Review your changes before clicking **OK**.

ℹ 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.
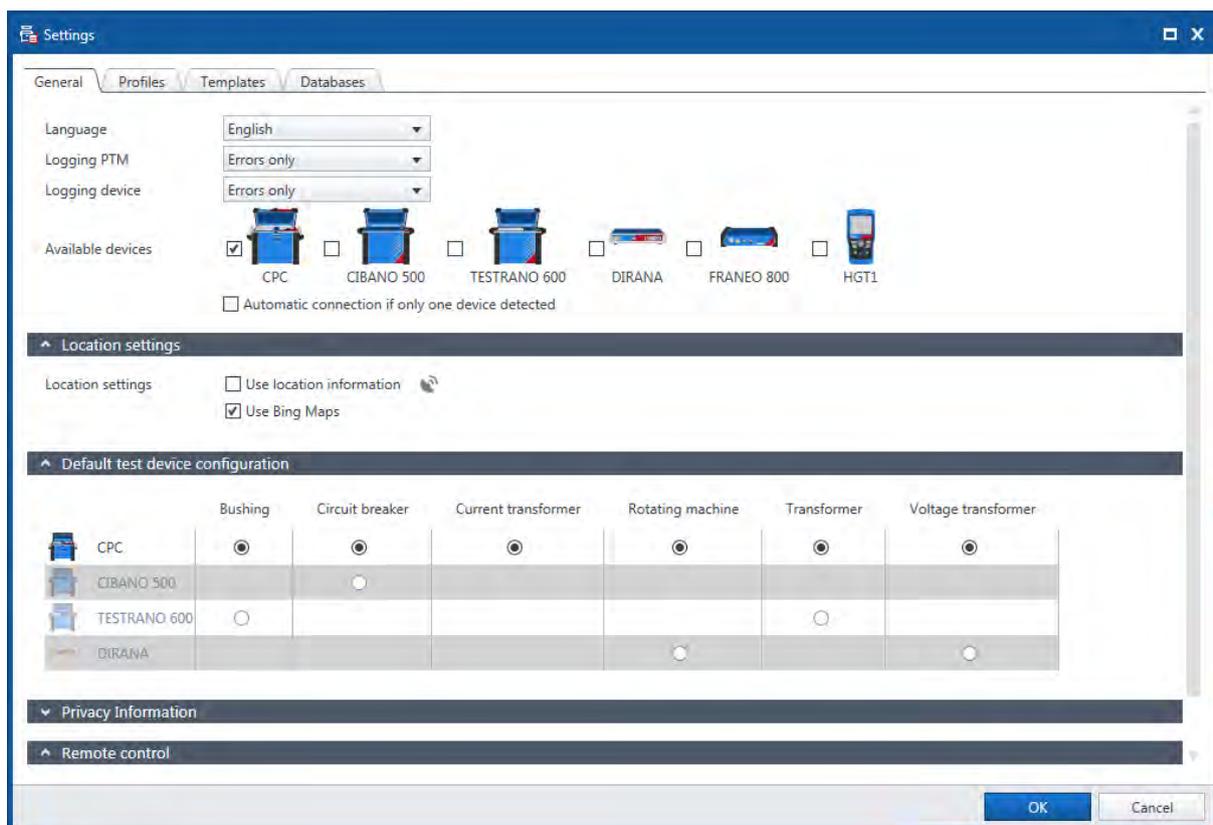
Figure 7-2: General tab

▶ 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.

ℹ️ Log files do not contain any personal information.

Table 7-4: 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 to allow GPS coordinates to be shared by a smartphone running the *PTMate* app connected via Bluetooth or Wi-Fi access point.

Primary Test Manager displays status icons in the bottom bar:

🔵	Waiting for GPS data from devices connected via Bluetooth
🔵	GPS data is available from a device connected via Bluetooth

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.

If no device is connected, *Primary Test Manager* will automatically compile the test list (→ Test view on page 69) 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 PTMate** 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.

   ℹ️ 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, navigate 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:

1️⃣	Number of active remote connections
📶	Active Wi-Fi access point

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▣	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.
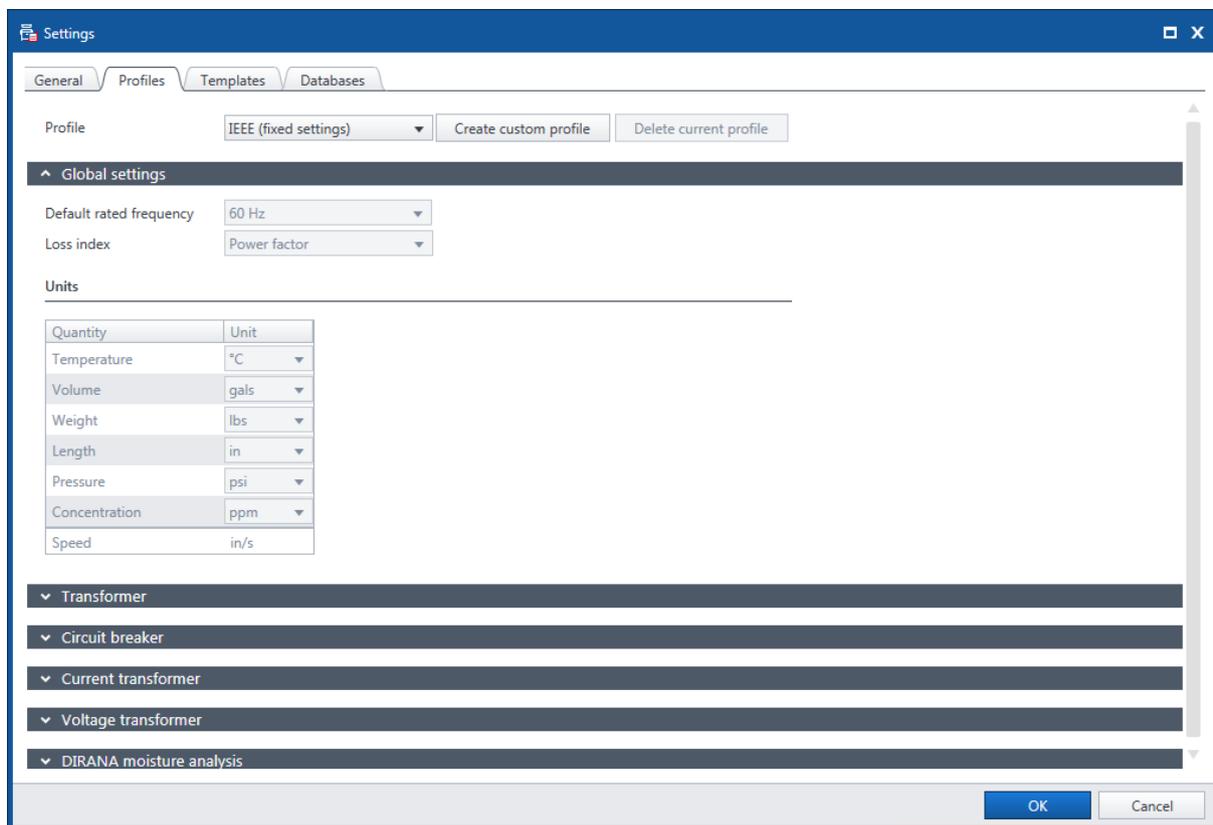
Figure 7-3: Profiles tab

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

> ⓘ 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

▶ 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.
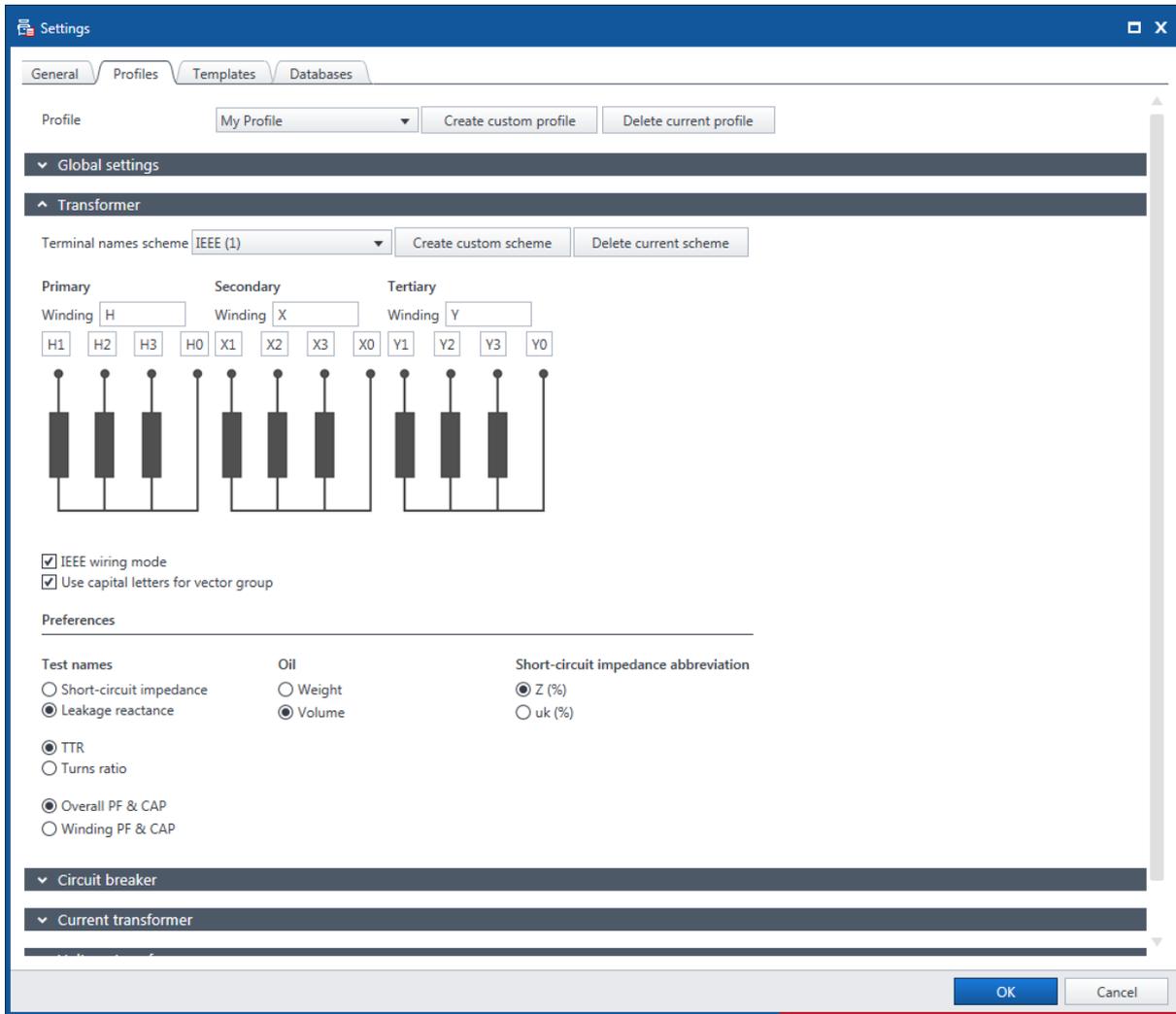
Figure 7-4: Profiles tab: Transformer

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**.

Profiles: Circuit breaker

1. Under **Circuit breaker**, set the circuit breaker terminal name schemes.
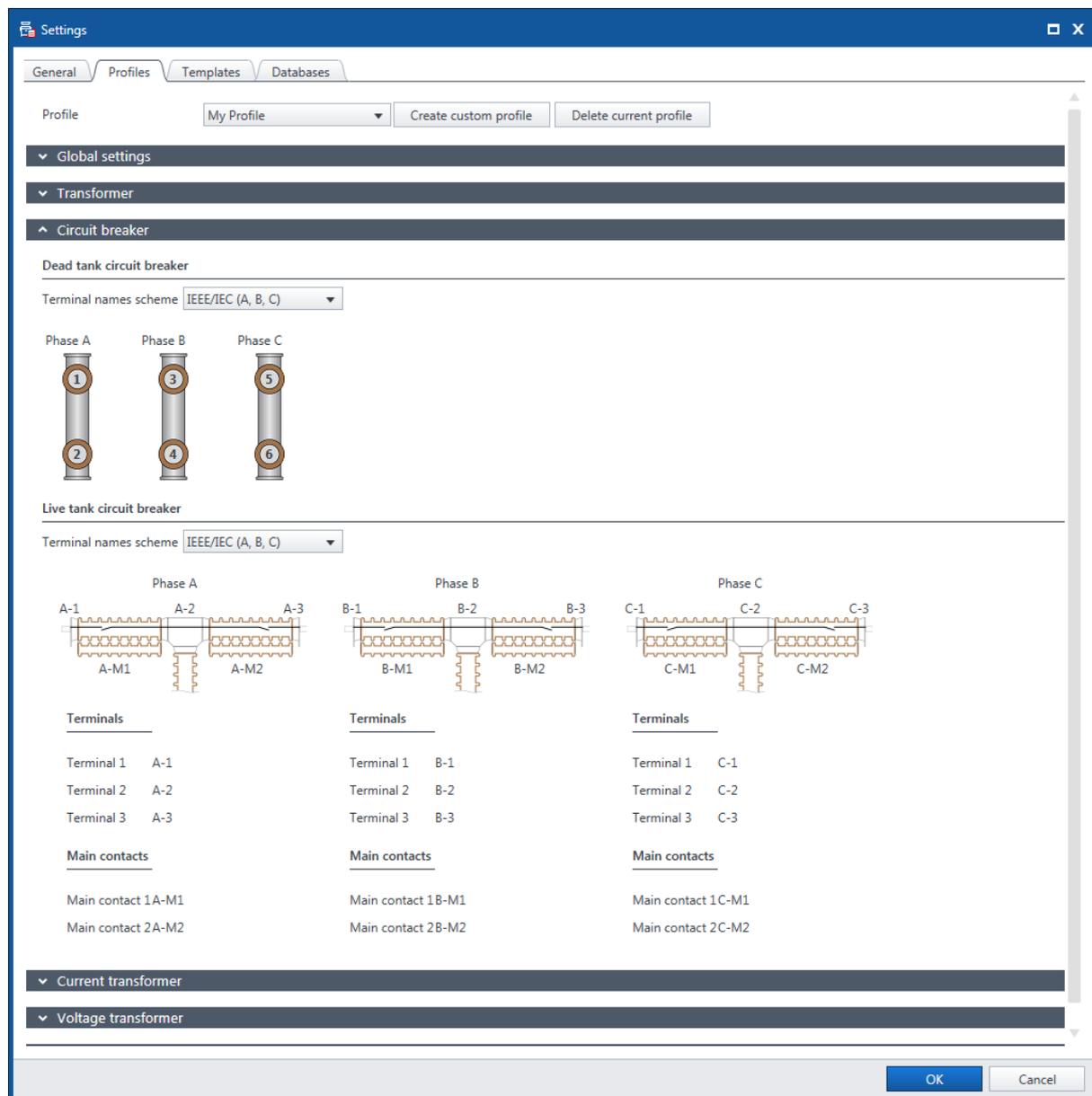
Figure 7-5: Profiles tab: Circuit breaker

Profiles: Current transformer

1. Under **Current transformer**, set the current transformer naming conventions.
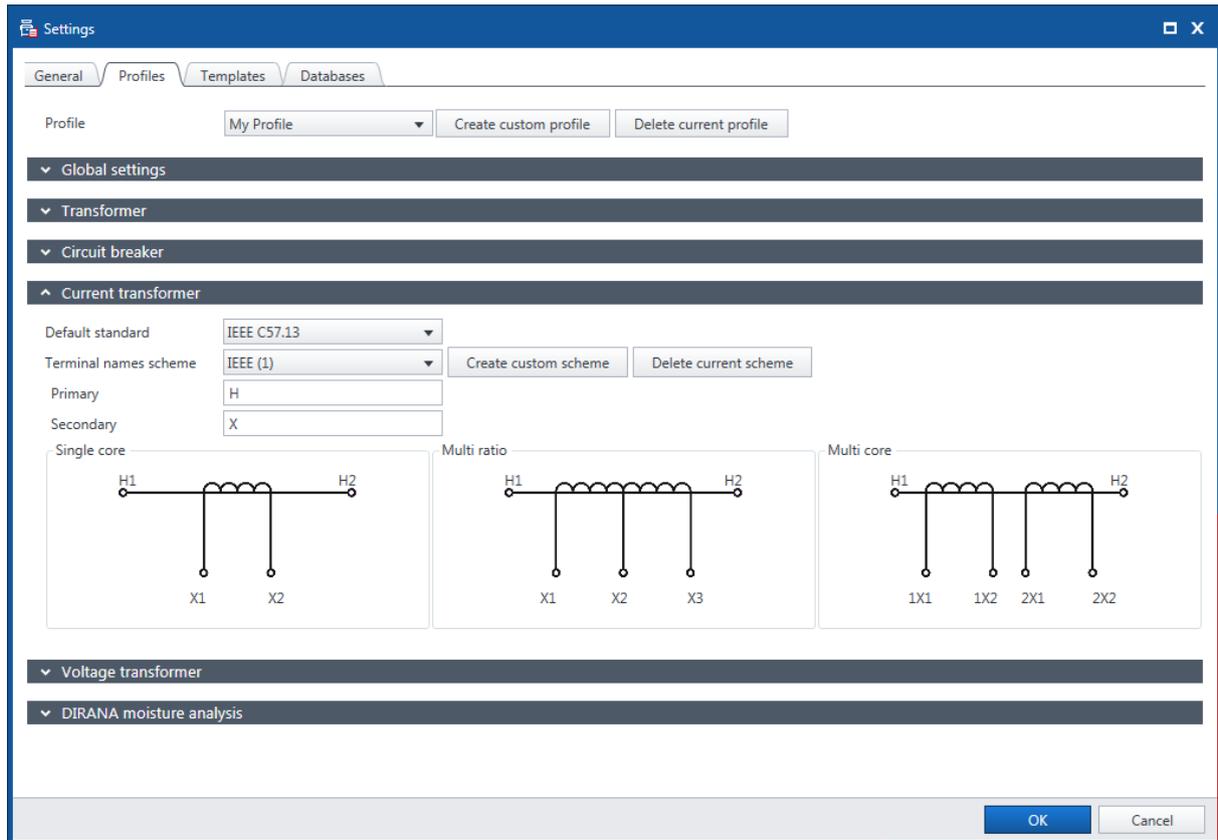
Figure 7-6: Profiles tab: Current transformer

2. Click **OK** to close the **Settings** dialog box.

▶ To delete your own profile, select the profile from the **Profiles** list, and then click **Delete current profile**.

Templates

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

▶ For information on how to process the templates, see → Processing templates on page 73.
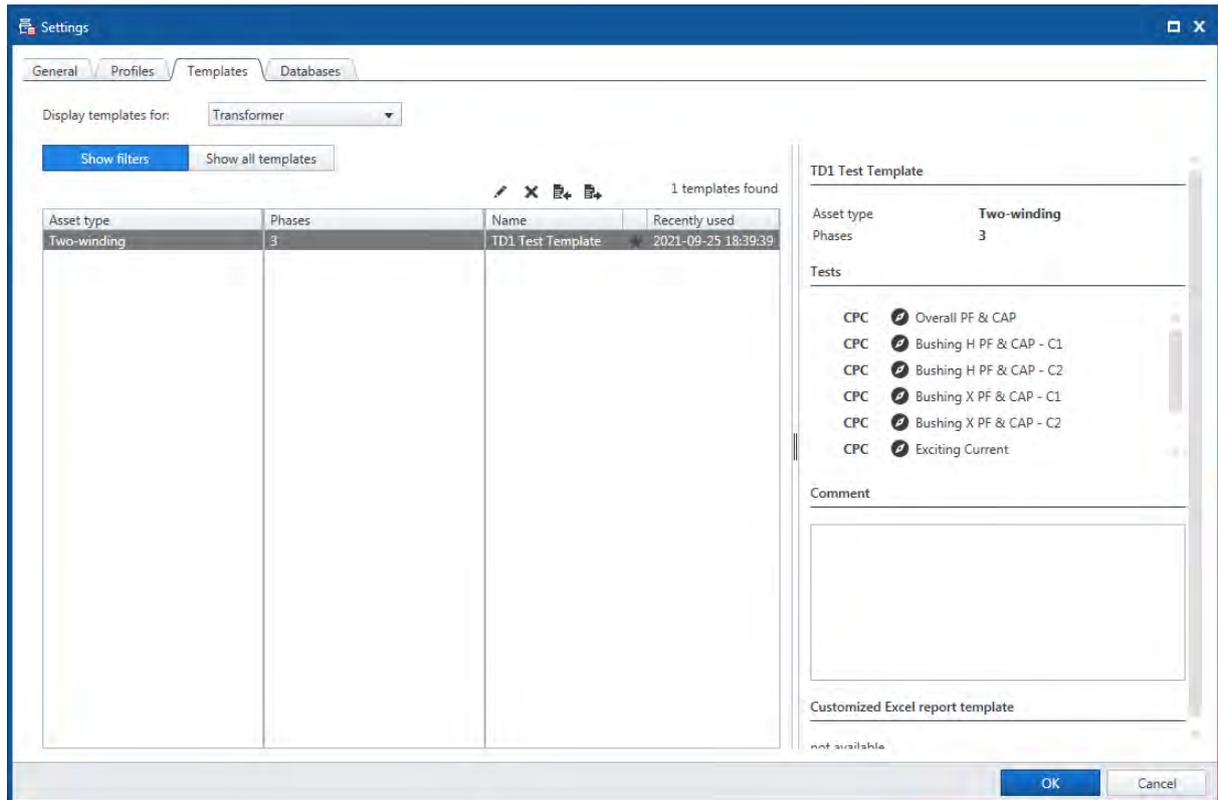
Figure 7-7: Templates tab

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:

1. 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.

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

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

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

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

ⓘ 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.

Note: If you own a CBTL (Circuit Breaker Testing Library) license, additional options are available in the Circuit breaker section:

• Show template
• Show OMICRON CBTL
• Show custom CBTL

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 49.
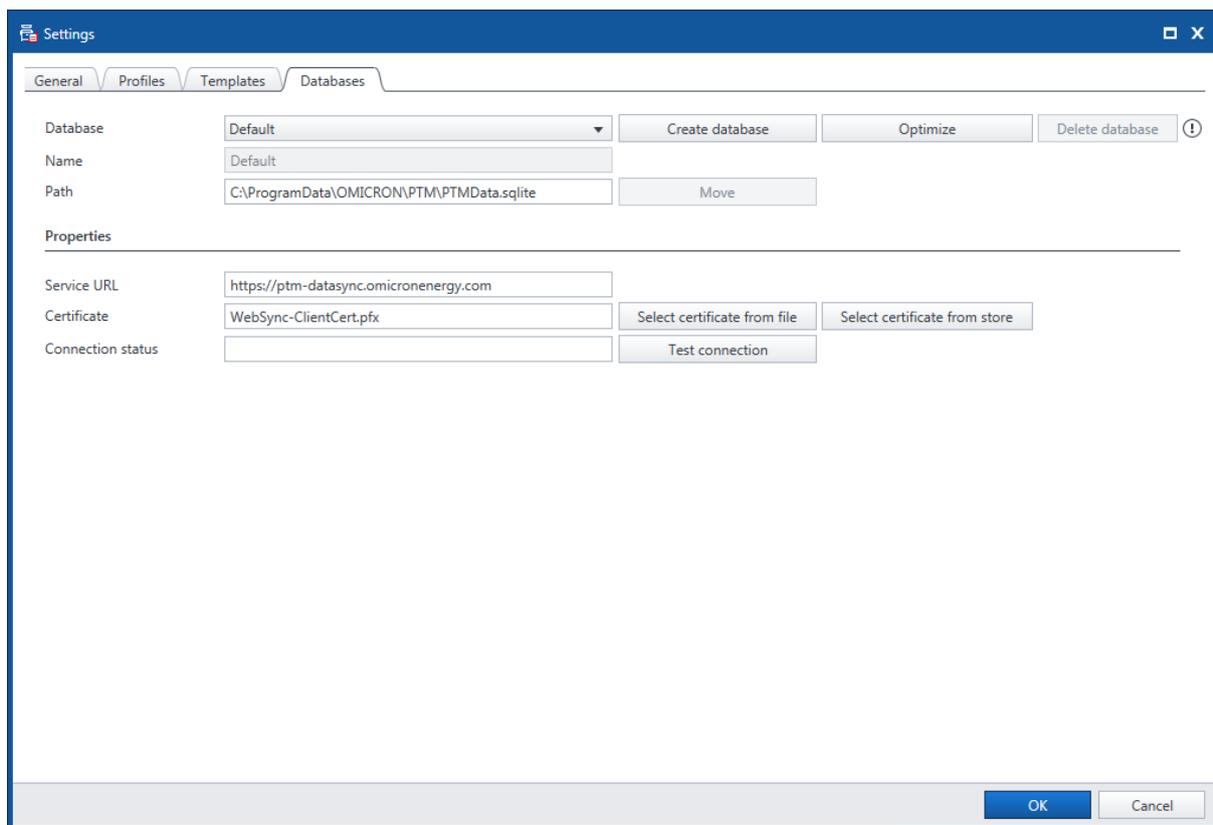
Figure 7-8: Databases tab

7.1.2   Send data to technical support

In the **Omicron Assist** dialog box, you can send system information and your data to OMIRON technical support.

1.   To open the **Omicron Assist** dialog box, click **Send data to Technical Support** in the title bar.

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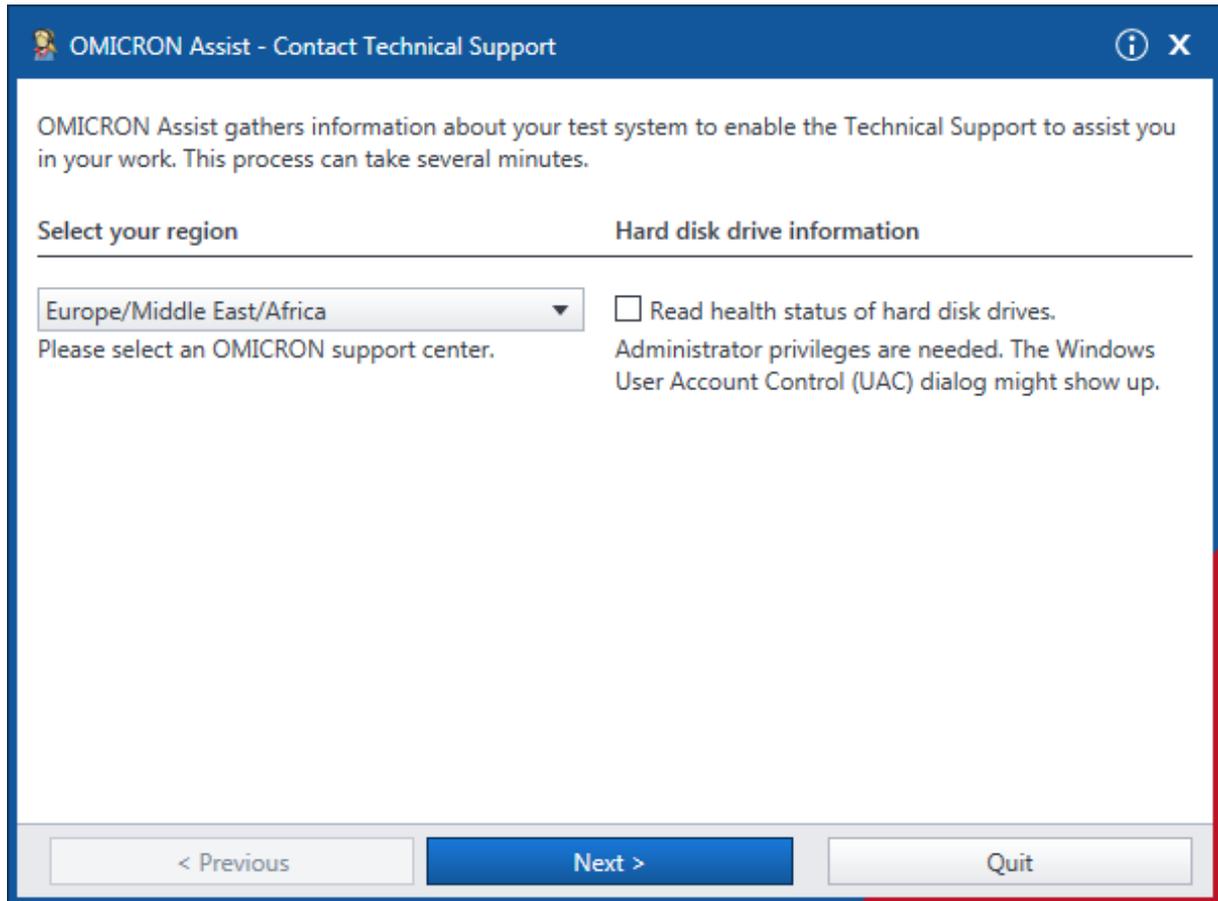
Figure 7-9: Contact technical support dialog box

2.   In the **Omicron Assist** dialog box, select your region, and then click **Next**.

3.   **Omicron Assist** will automatically collect your system information. Once this step is complete, click **Next**.

4.   Click **Add files**.

5.   Browse to the data you want to send, and then click **Next**.

6.   Click **Prepare e-mail**.

7.1.3   About

In the **About Primary Test Manager** dialog box, you can enter a license key 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.
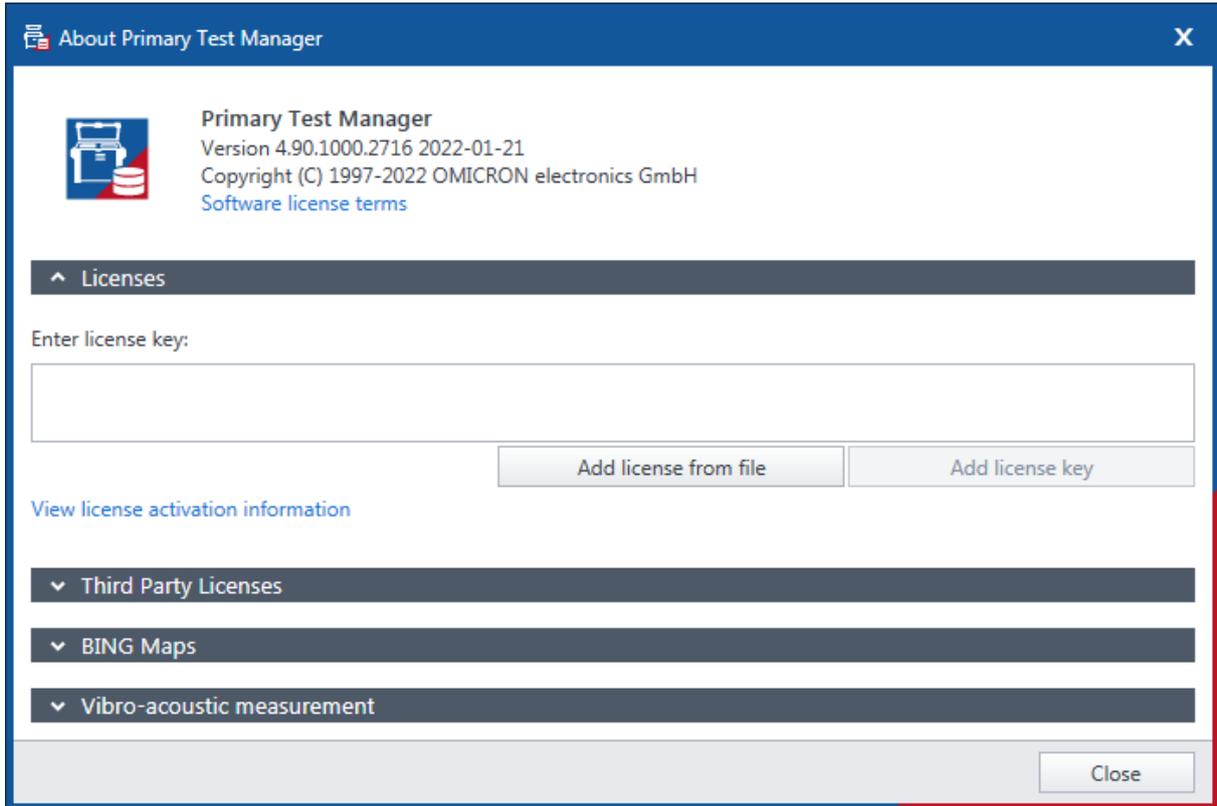
Figure 7-10: About Primary Test Manager dialog box

7.2 Manage connection to the test system

Under **Device**, you can connect to and disconnect from the test system.

▶ To connect to a *FRANEO 800* device, select the device from the list, and then click **Connect**.

Figure 7-11: Connecting to *FRANEO 800*

Alternatively, you can manage the connection to *FRANEO 800* in the *Primary Test Manager* status bar (see → Status bar on page 52).

7.3 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.

ⓘ 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.

7.3.1   Server settings

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

▶ 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.
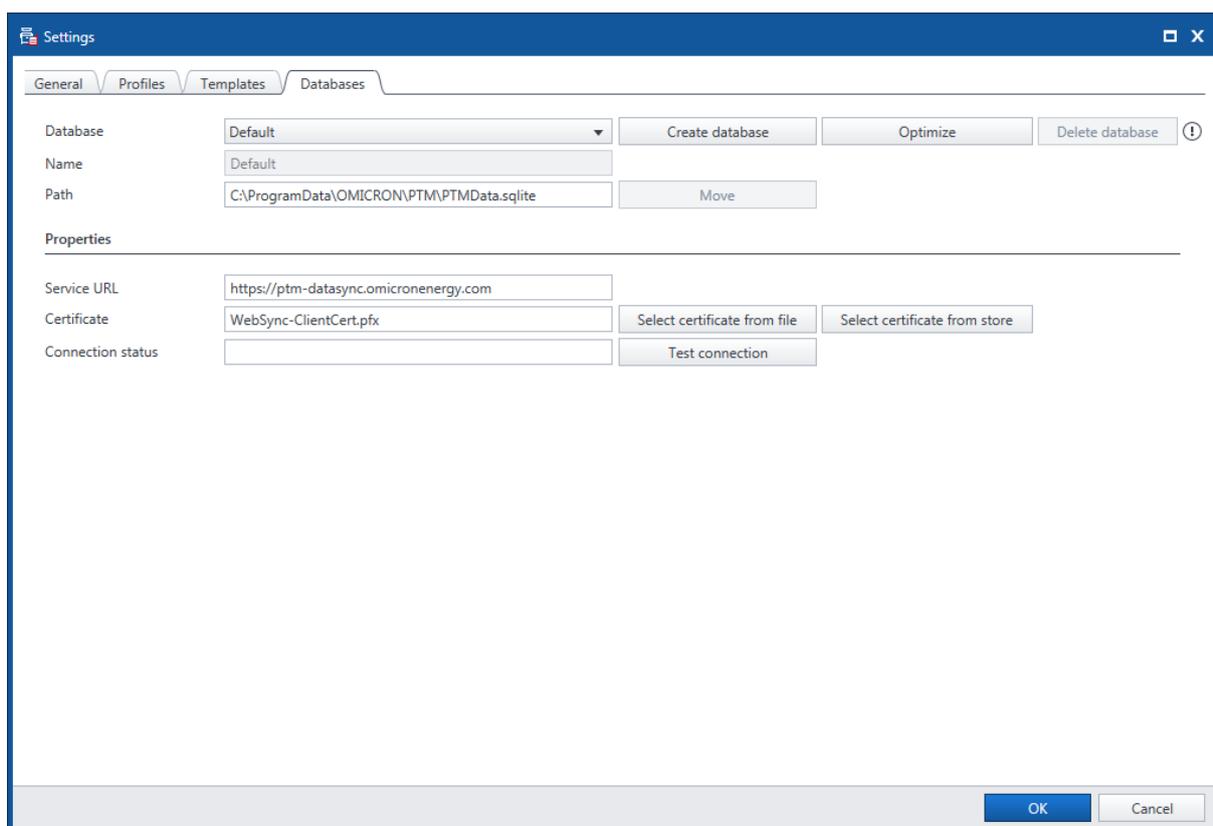
Figure 7-12: Server settings for DataSync

DataSync via web server

▶ For the service URL and certificate for DataSync via web server, contact your regional OMICRON Service Center.

DataSync on premises

▶ For the service URL and certificate for DataSync on premises, contact your system administrator.

1. In the **Databases** tab, enter the **Service URL** and upload the **Certificate**.
2. To test the connection to the server, click **Test** next to the **Connection status**.

7.3.2 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 click the **Manage** button.
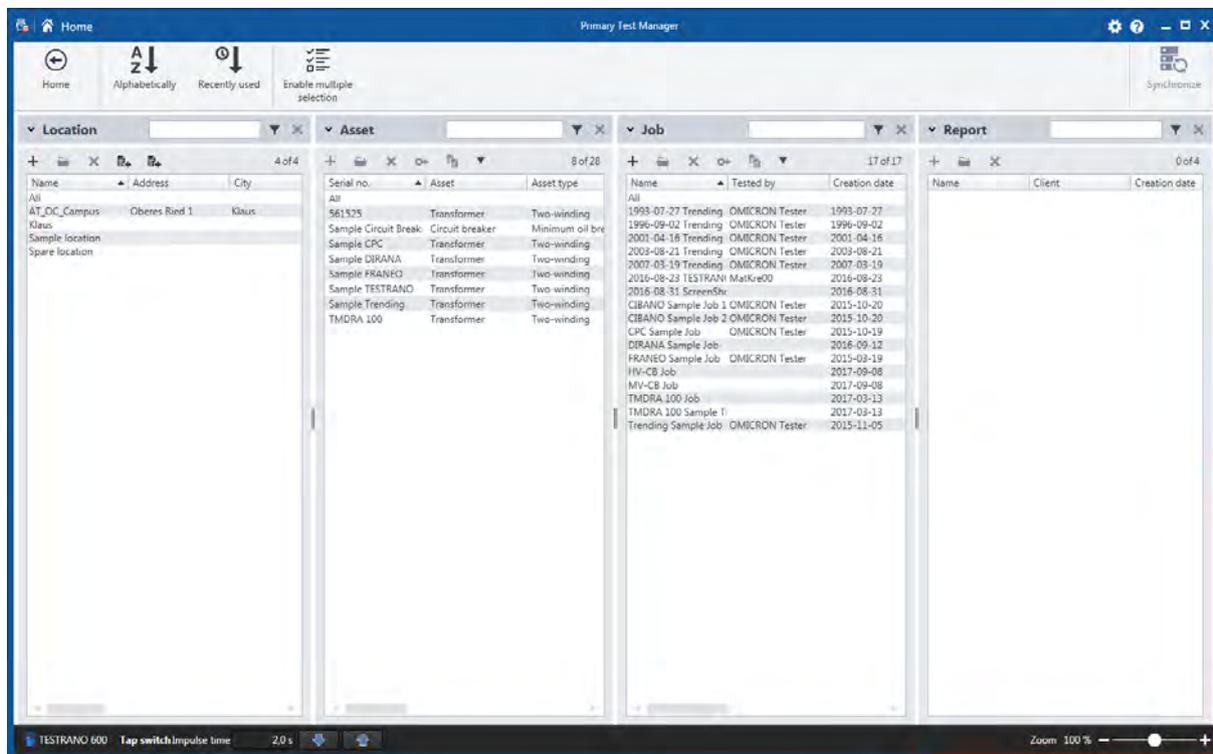
Figure 7-13: Manage View

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.
Primary Test Manager then displays the synchronization progress.

7.3.3 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.

ⓘ   You can synchronize databases at any time if 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.

7.4 Import data

In the home view you can import jobs.

To import a job:

1. Under **Data**, click **Import files**.
2. Browse to the file you want to import.

Primary Test Manager supports the following file import formats:

Table 7-5: Supported file import formats

File name extension	Description
.ptm	Primary Test Manager native exchange format
.ptma	Format for import of manual test data. **Note:** To import manual test data, you must select the corresponding asset in the manage view.

7.5 Data backup and restoring

We strongly recommend backing up your data in the *Primary Test Manager* database on a regular basis. *Primary Test Manager* will remind 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**.
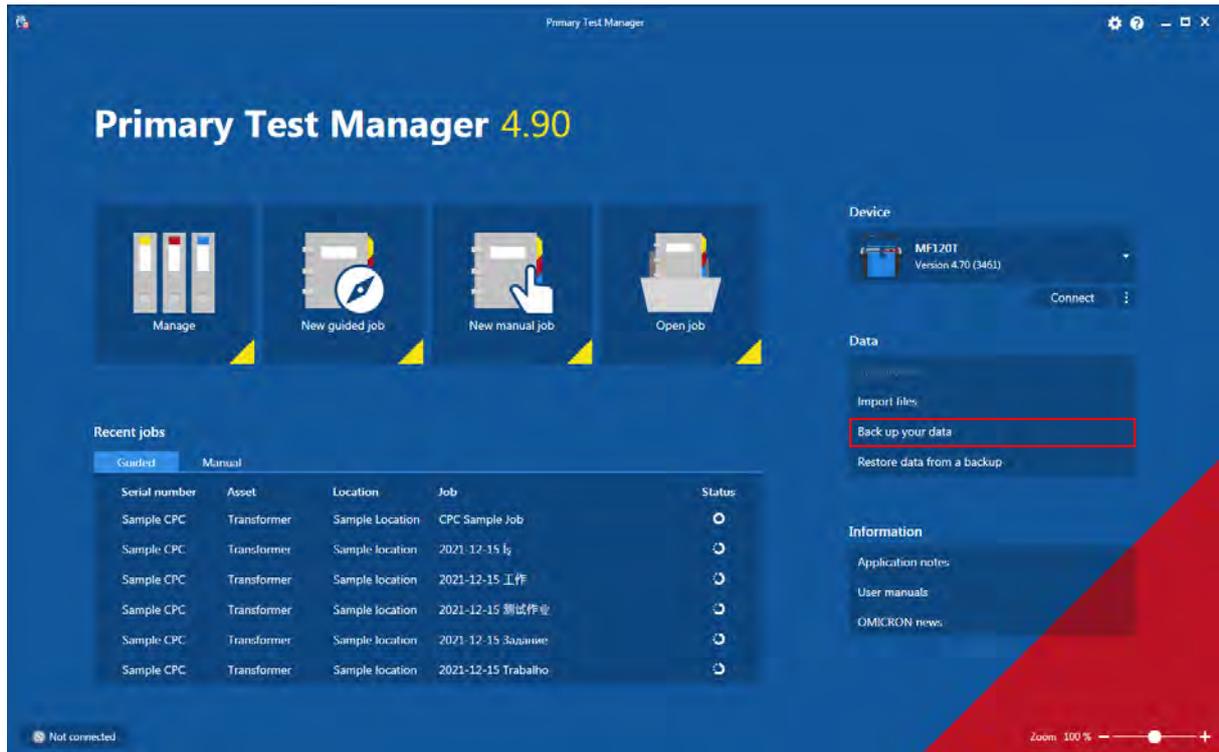
Figure 7-14: Backup data from home view

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.

7.6 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.

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

8 Create new guided jobs

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

▶ To open the new guided job view, click the **New guided job** button in the home view.
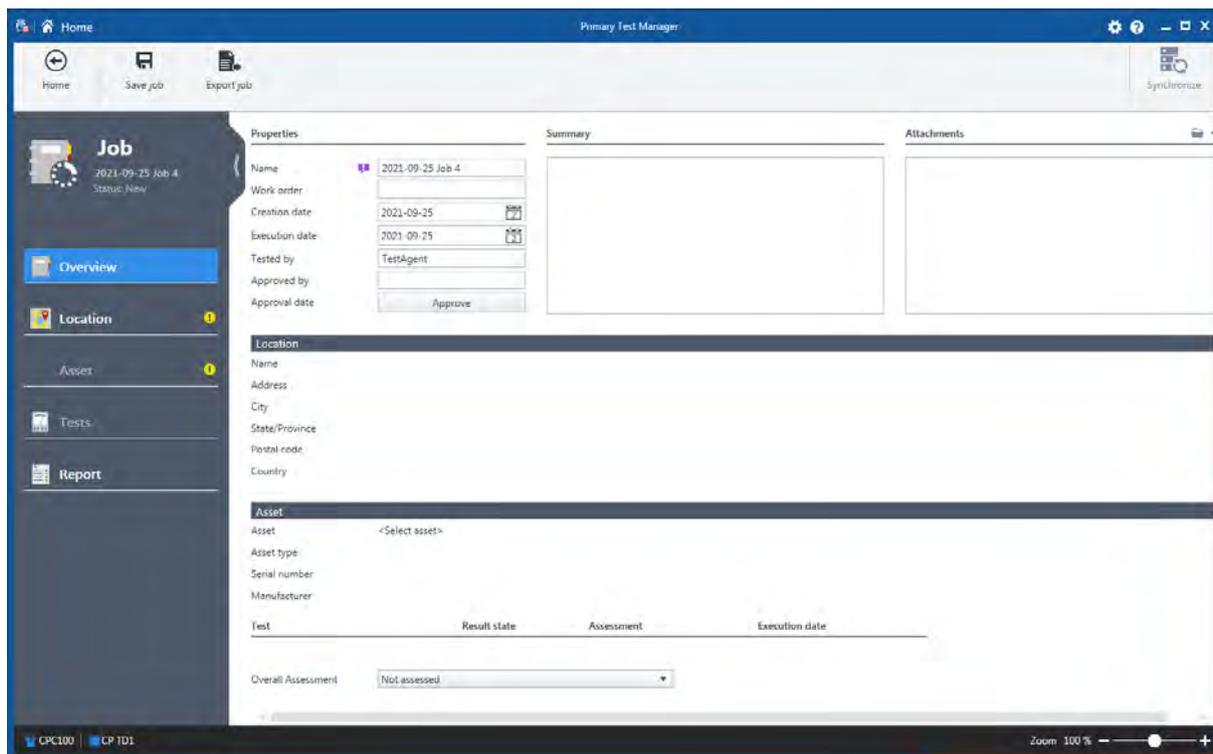
Figure 8-1: New guided job view

In the new guided job view, you can configure and execute 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. During the guided test workflow, the job status displayed in the left pane of the new guided job view changes. The following table describes the job statuses.

Table 8-1: 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.

8.1 Guided test workflow

The guided test workflow leads you through the following steps:

Enter the job data (see → Job overview on page 55).

Specify the location (see → Location view on page 57).

Specify the asset (see → Asset view on page 61).

Specify and perform the tests (see → Test view on page 69).

Generate the test reports (see → Generate test reports on page 90).

To navigate through the test workflow, click the navigation buttons in the left pane of the create new job view.
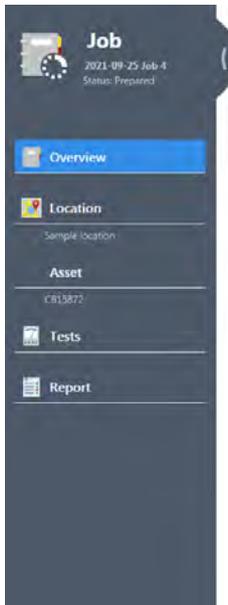
Figure 8-2: Navigation buttons

> You can interrupt the test workflow at any time and return to any view 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 8-2: Operations on the jobs

Command	Action
Home/Manage	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.
Export job	Exports the job displayed in the new guided job view into a Microsoft Excel spreadsheet.
Load existing location (Only available if the **Location** view is open and job has not been saved yet)	Load an existing location available in *Primary Test Manager*.

Command	Action
Load existing asset (Only available if the **Asset** view is open and job has not been saved yet)	Load an existing asset available in *Primary Test Manager*.
Copy test (available if a test is open)	Adds another test of the same kind and with the same settings to the test list. Results are not copied.
Delete test	Deletes a test
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.

For more information about operations on the jobs, see → Manage objects on page 79.

8.2　Job overview

In the job overview of the create new job view, you can enter the job data. In the course of the guided test workflow, *Primary Test Manager* sets some basic location, asset, and test data.

▶　To open the job overview, click the **New guided job** button in the home view.
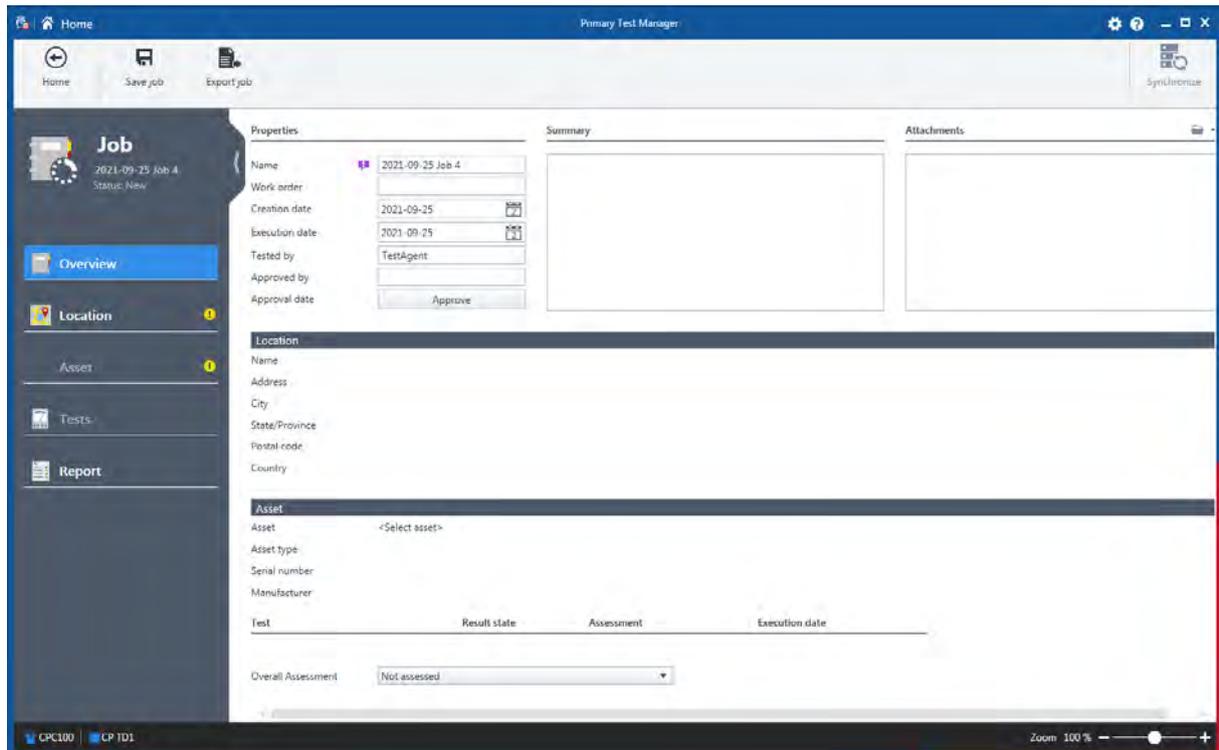
Figure 8-3: Job overview

8.2.1 Job data

The following table describes the job data.

Table 8-3: Job data

Data	Description
Name/WO (required)	Name of the job or work order (generated automatically 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 on page 56)
Summary	Text field to summarize the job data
Attachments	Attachments to the job (see → Managing attachments on page 57)

8.2.2 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**.

🛈   After approving a job, some settings can no longer be edited.

8.2.3 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** box to manually characterize the asset's condition for reporting purposes.

Table 8-4: Result state

Result state	Description
Not executed	No measurement of the test has been executed.
Partially executed	At least one measurement of the test has been executed.
Executed	All measurements of the test have been executed.

Table 8-5: Assessment

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*.

Status	Description
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*.

8.2.4   Managing attachments

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

To add an attachment:

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 ▬.

8.3   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.
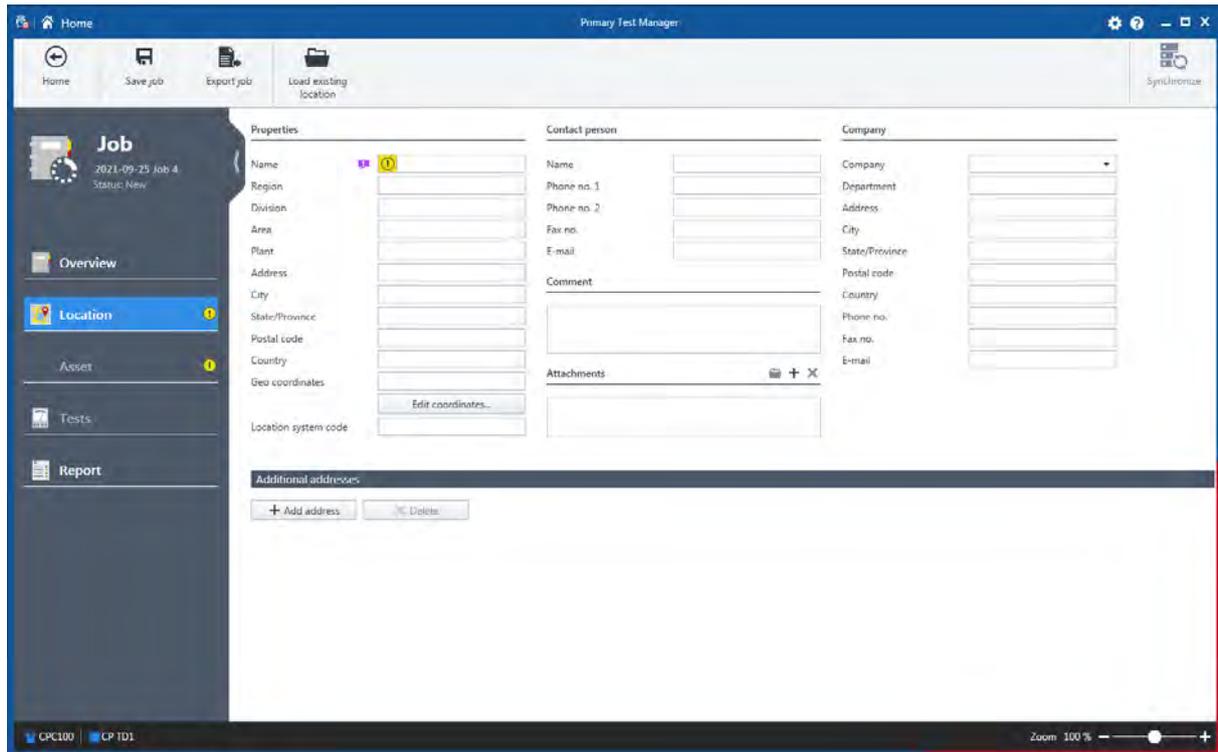
Figure 8-4: Location view

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 → Manage objects on page 79.

▶   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.
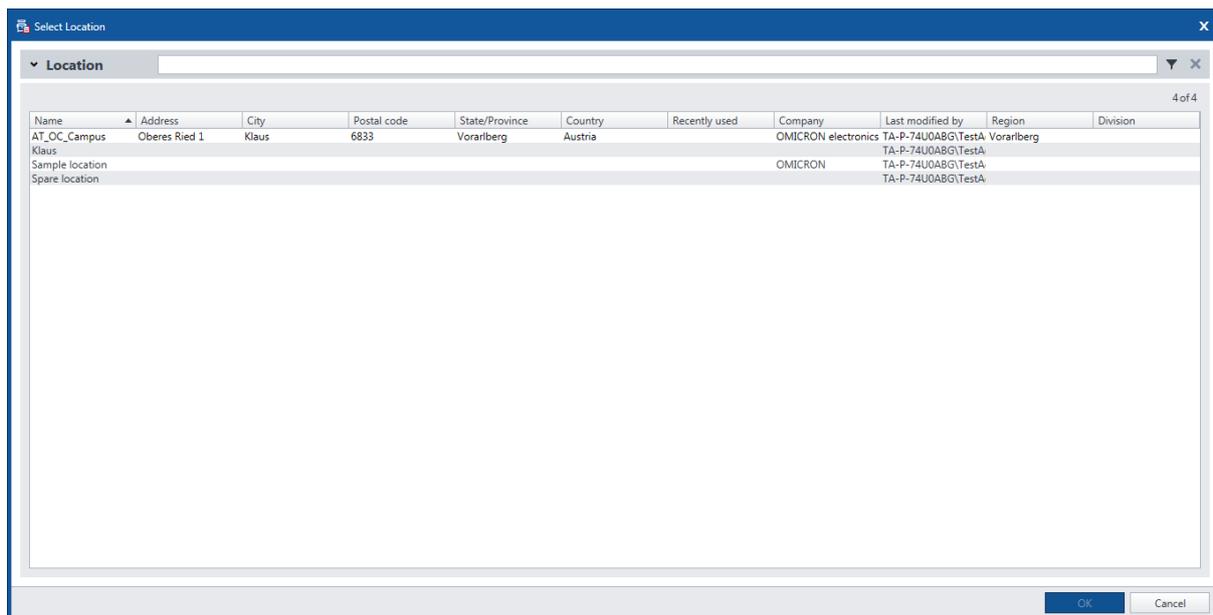
Figure 8-5: Select location dialog box

In the **Select Location** dialog box, you can search for locations (see → Search for objects on page 80).

8.3.1 Location data

The following table describes the location data.

Table 8-6: Location data

Data	Description
Name (required)	Name of the location
Region	Region where the asset is located
Division	Division where the asset is located
Area	Area where the asset is located
Plant	Plant where the asset is located
Address	Address of the location
City	City where the asset is located
State/Province	State or province where the asset is located
Postal code	Postal code of the location
Country	Country where the asset is located
Geo coordinates	Geo coordinates of the location(see → Setting the geo coordinates on page 60)
Location system code	Location code used by maintenance planning systems
Contact Person	
Name	Name of the contact person
Phone no. 1	Phone number of the contact person

Data	Description
Phone no. 2	Alternative phone number of the contact person
E-mail	E-mail address of the contact person
Company	
Company	Company where the asset is located
Department	Department of the company
Address	Address of the company
City	City where the company is located
State/Province	State or province where the company is located
Postal code	Postal code of the company
Country	Country where the company is located
Phone no.	Phone number of the contact person
Fax no.	Fax number of the contact person
E-mail	E-mail address of the contact person

In the location view, you can enter additional addresses of, for example, a client, owner or utility. To enter additional addresses, click **Add address** under **Additional addresses**.

8.3.2 Setting the geo coordinates

To set a location's geo coordinates:

1. In the location view, click **Edit coordinates**.
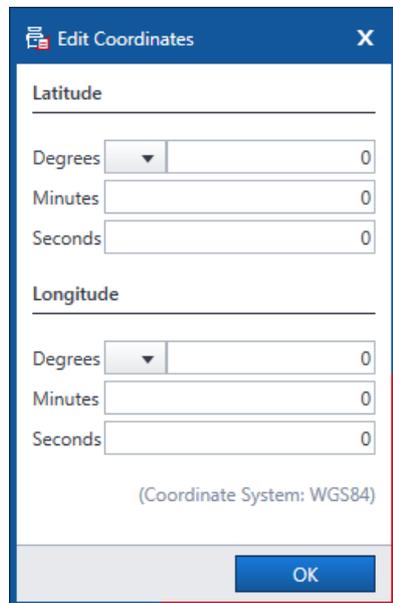
Figure 8-6: Edit coordinates dialog box

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

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ℹ️ If you have a smartphone running the *PTMate* app connected via Bluetooth to *Primary Test Manager*, you have the option to add coordinates through live location sharing by clicking the Geo coordinates button 🗺️.

8.3.3   Managing attachments

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

To add an attachment:

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 ▬.

8.4   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.
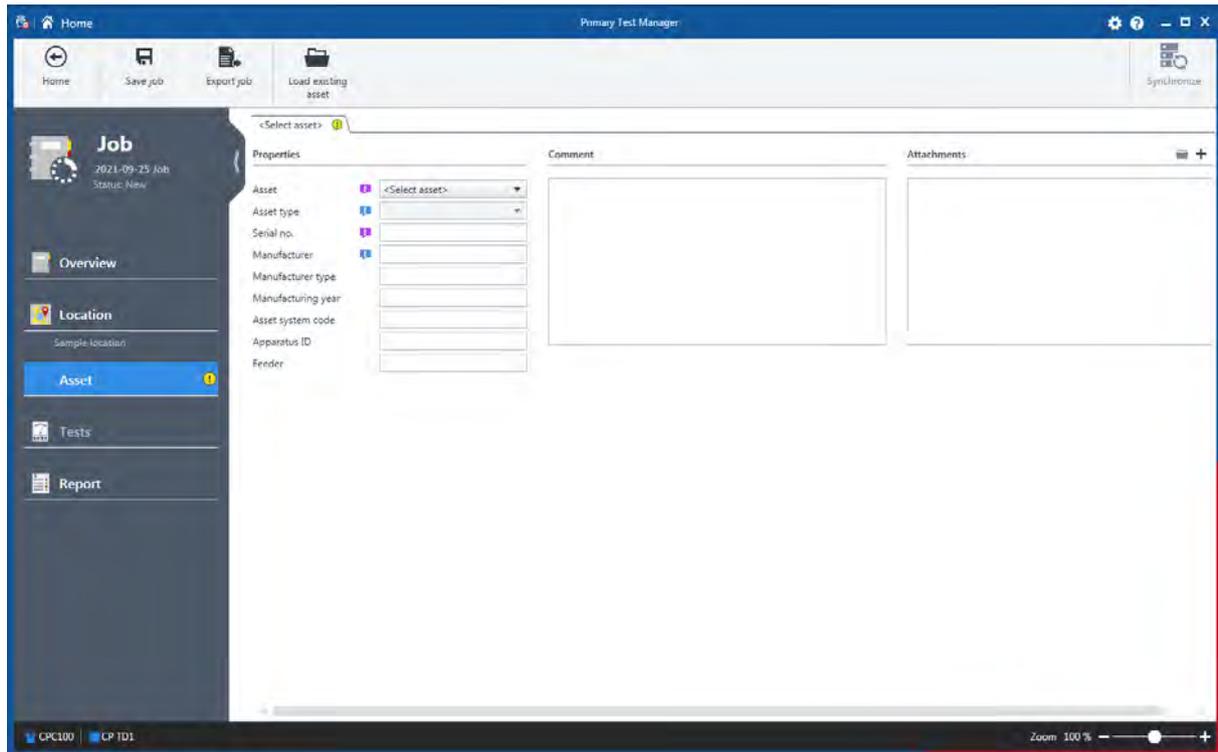
Figure 8-7: Asset View

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 63 and the asset-specific data described in → Asset data on page 92).

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 → Manage objects on page 79..

▶ 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.
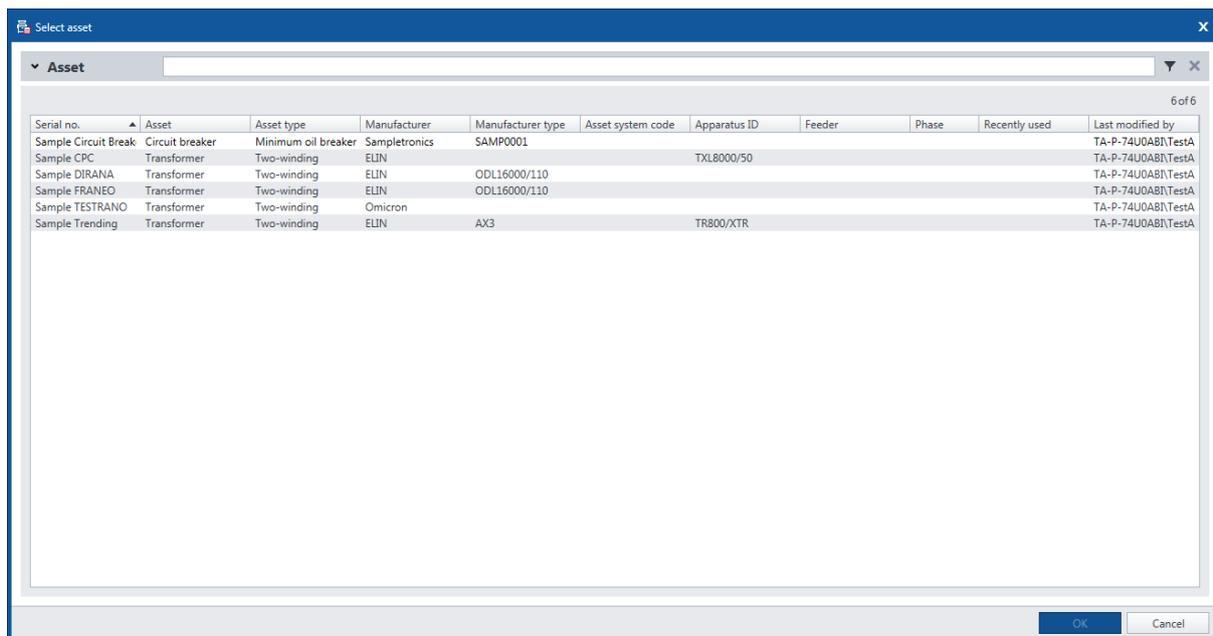
Figure 8-8: Select asset dialog box

In the **Select Asset** dialog box, you can search for assets (see → Search for objects on page 80) and sort them alphabetically or in the chronological order.

8.4.1 General asset data

The following table describes the general asset data.

Table 8-7: General asset data

Data	Description
Asset (required)	Asset under test
Asset type	Type of the asset
Serial no. (required)	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 to which the asset is connected
Phase (Only available for current transformers, voltage transformers and miscellaneous assets.)	Phase to which the asset is connected

8.4.2 Managing attachments

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

To add an attachment:

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 ▬.

8.4.3 Transformer view

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

To specify a transformer:

1. From the **Asset** list, select **Transformer**.

2. From the **Asset type** list, select the type of the transformer.
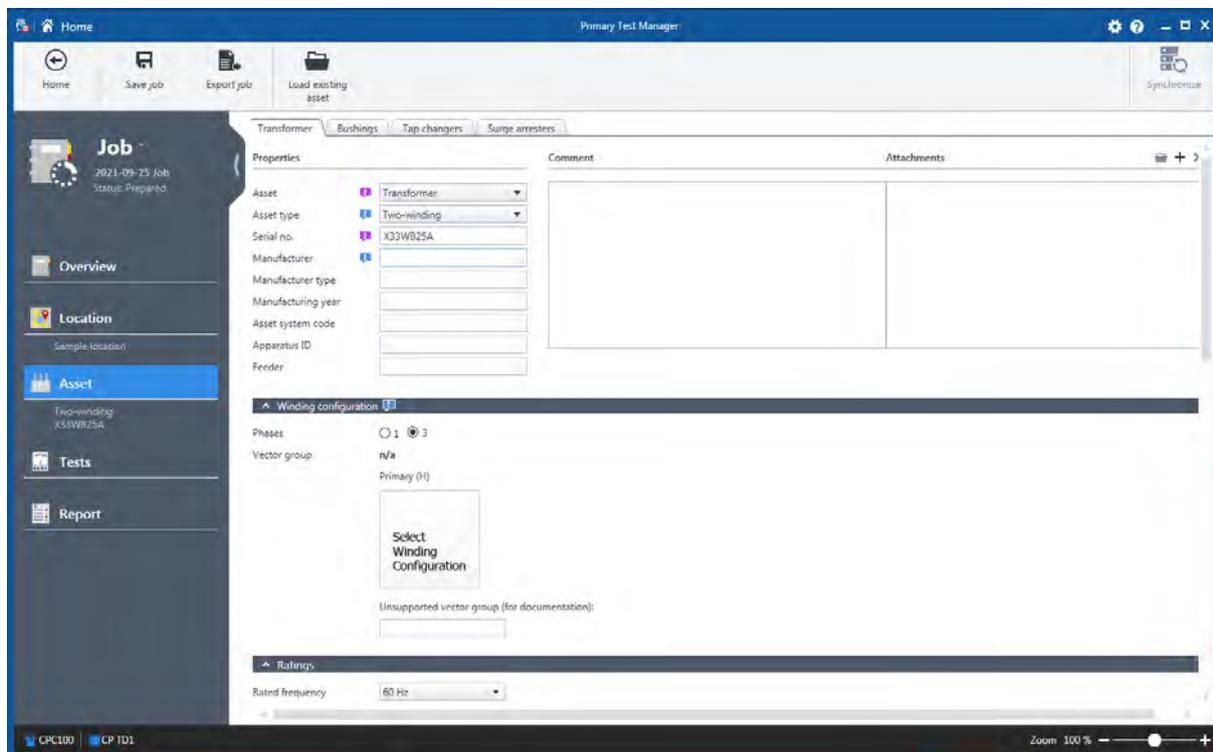
Figure 8-9: Transformer view

3. In the transformer view, enter the general asset data.

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4. Under **Winding configuration**, set the transformer's vector group.

5. Under **Ratings, Impedances and Others**, enter the transformer data (see → Transformer on page 92).

6. Optionally, specify the bushing mounted on the transformer.

7. Optionally, specify the tap changers of the transformer.

8. Optionally, specify the surge arresters mounted on the transformer.

Setting the vector group

1. To set the vector group of a transformer:

2. Select the number of transformer's phases.

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.
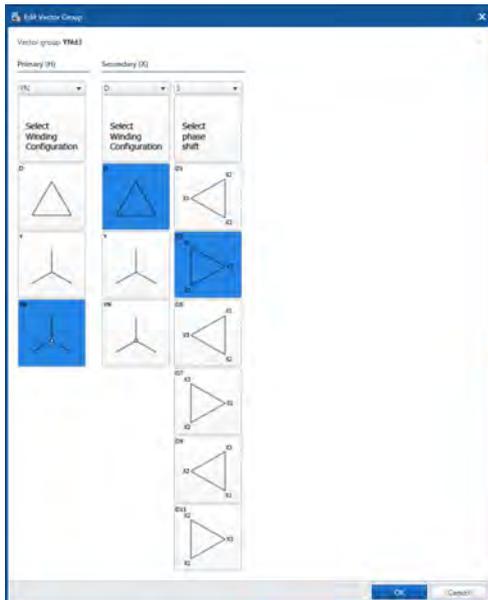
Figure 8-10: Edit vector group dialog box

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

Bushings tab (Transformer)

In the **Bushings** tab, you can specify the bushings mounted on the transformer.
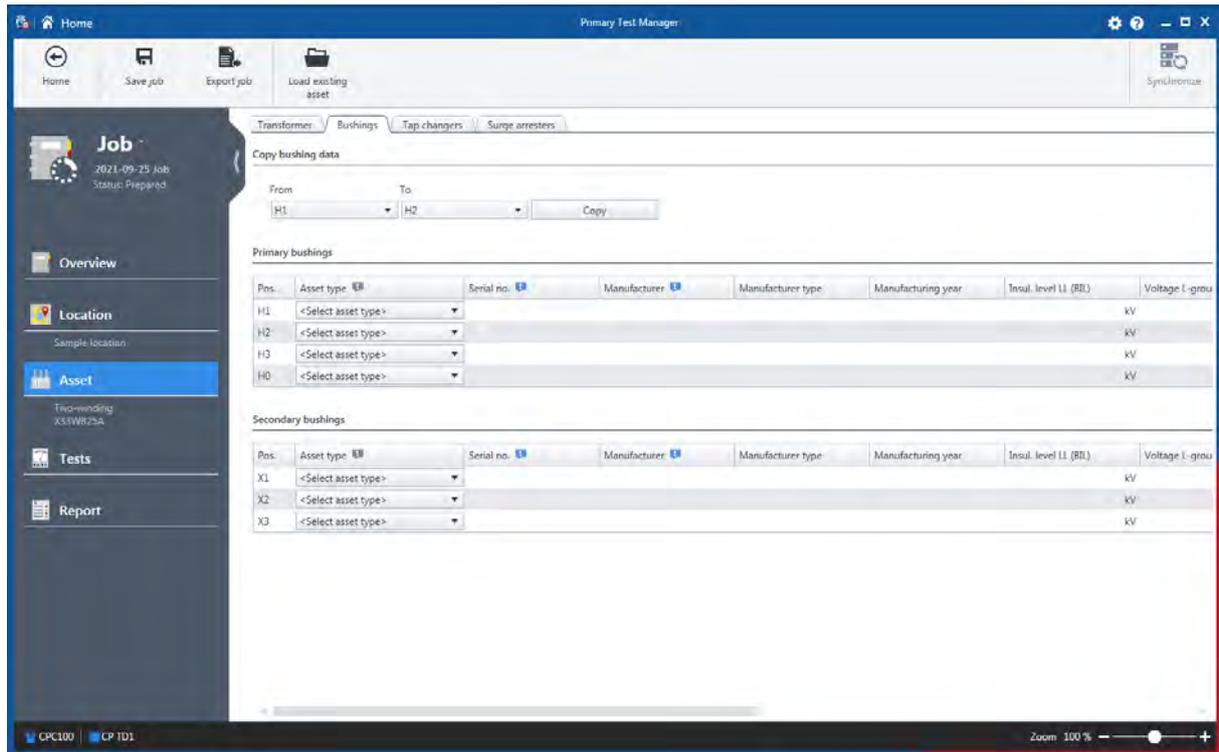
Figure 8-11: Transformer view: Bushings tab

Specifying a bushing

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

2. Enter the bushing data (see → Spare bushing on page 94).

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.
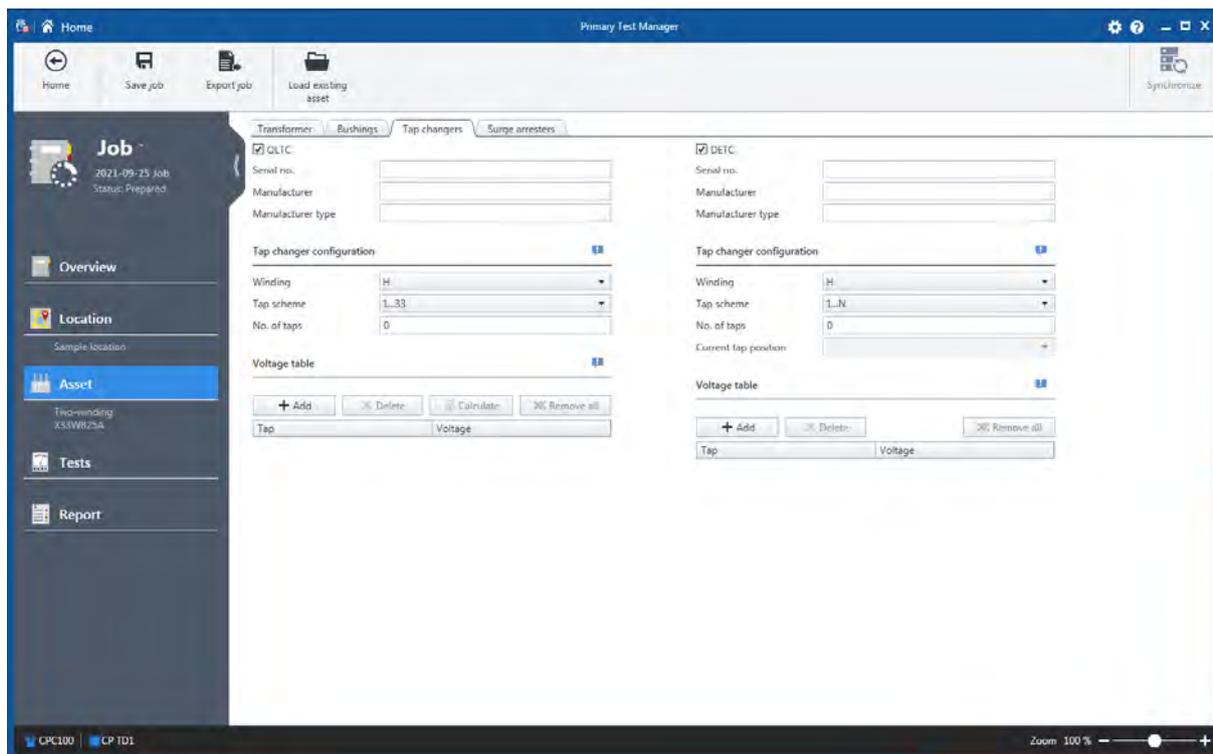
Figure 8-12: Transformer view: Tap changers tab

Specifying an on-load tap changer (OLTC)

1. Select the **OLTC** check box.

2. Enter the OLTC data (see → Tap changer on page 93).

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 automatically. 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, this value 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

ⓘ   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 → Tap changer on page 93).

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**.

🛈 The added taps match no tap scheme.

1. To delete a tap, select the tap you want to delete, and then click **Delete**.
2. 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.
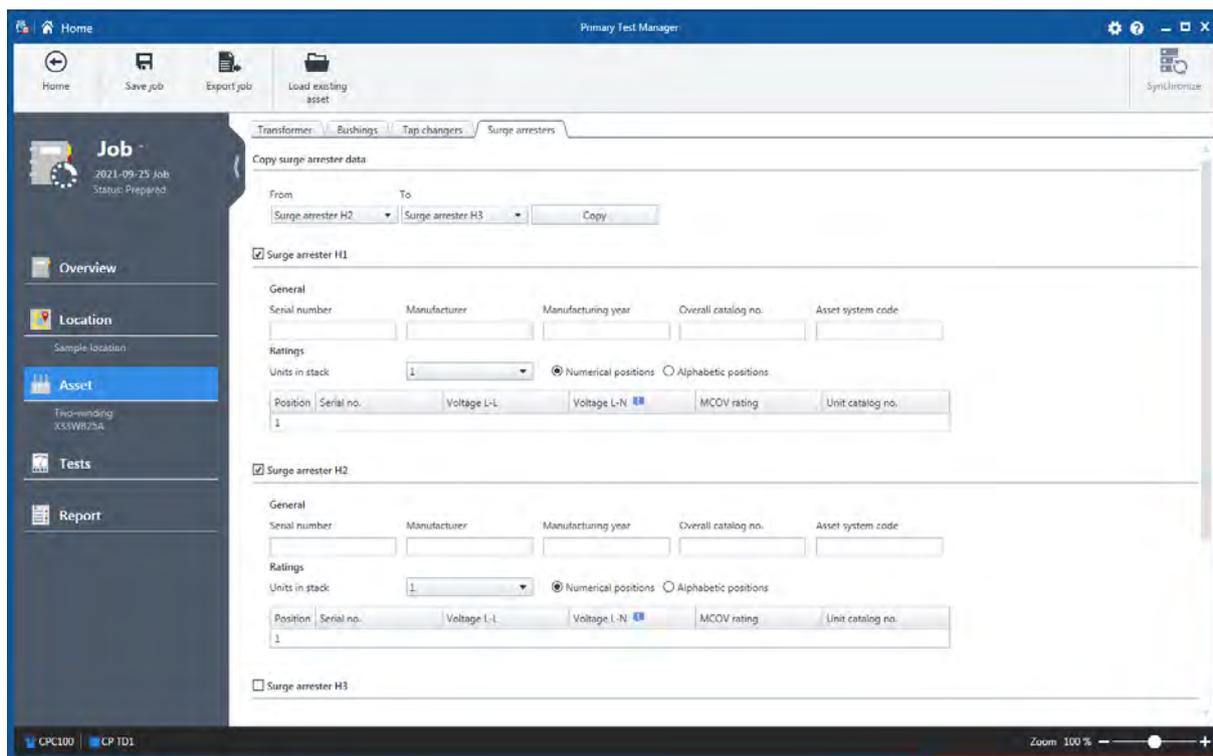
Figure 8-13: Transformer view: Surge arresters tab

Specifying a surge arrester

1. Select the respective **Surge arrester** check box.
2. Enter the surge arrester data (see → Surge arrester on page 94).

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 Oil Analysis for more detailed information on the Oil analysis test.

8.5   Test view

In the test view, you can select, import and perform tests.

▶   To open the test view, click the **Tests** navigation button [icon].
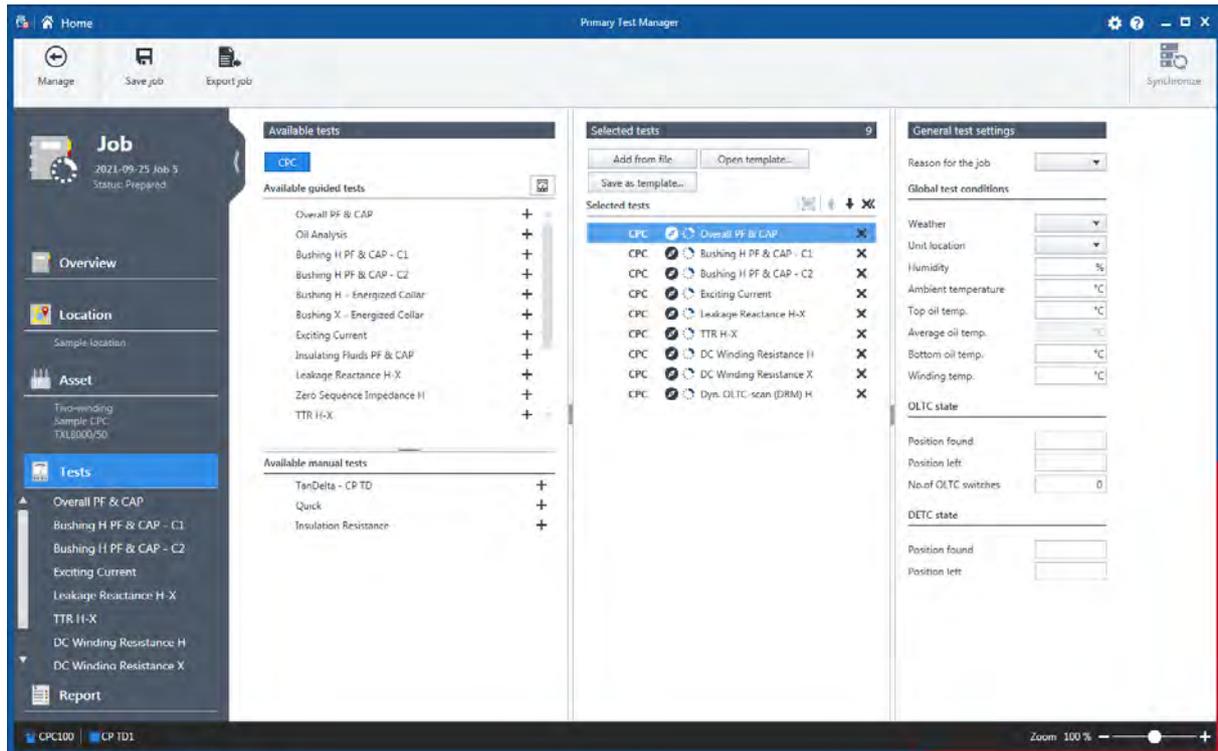
Figure 8-14: Test view

8.5.1   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. *Primary Test Manager* will then display 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 [icon].

You can select tests for different test systems supported by *Primary Test Manager* within the same job. The [icon] symbol indicates that the tests not available for the connected test system. You must connect another test system before proceeding to execute the job.
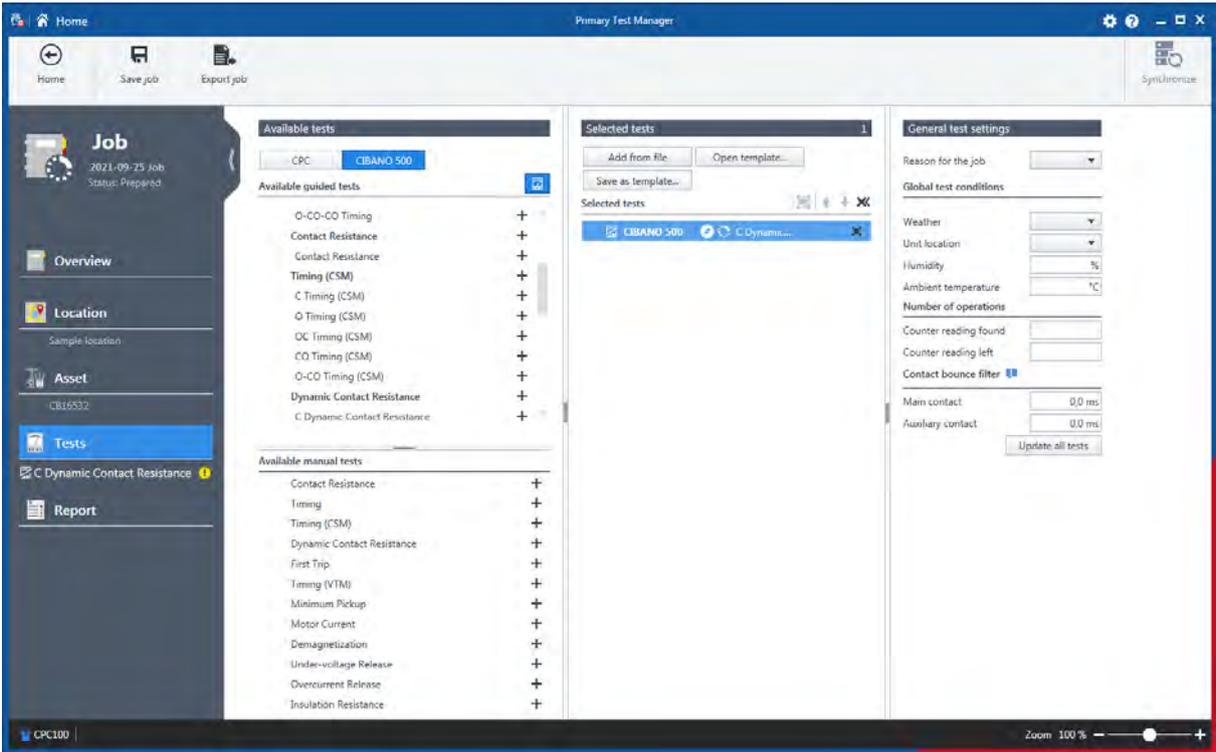
Figure 8-15: Job configured with test for the CPC 100 and the CIBANO 500 test systems

If you try to perform a *CIBANO 500* test with *CPC 100* connected, a warning message appears.
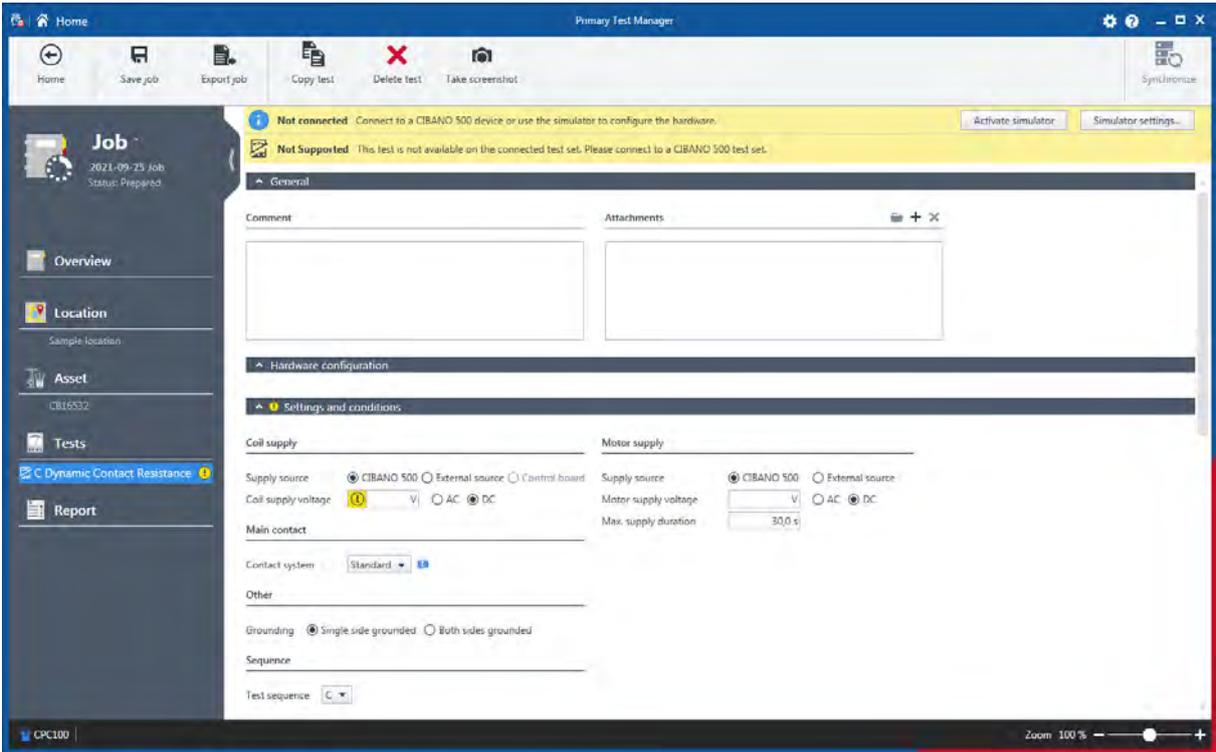
Figure 8-16: Warning message when trying to perform a test for the CIBANO 500

The optional manual tests are asset independent. You can perform the tests for any asset described in this User Manual, but *Primary Test Manager* will not guide you through the tests or provide any test settings data. These tests offer a large amount of flexibility to define test procedures and specify test settings according to your specific needs. For more information about the manual tests, see → Create new manual jobs on page 85.

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 ⬇ symbols. 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.

8.5.2   Grouping tests

You can group tests with *Primary Test Manager*. You are able to define the hardware configuration and certain settings and conditions for a test group. These settings are then applied to all tests in the test group.

To group tests:

1. In the **Selected tests** area, select the check boxes next to the tests you want to group.
2. Click the ▣ symbol.

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

▶   To rename a test group, click the test group name, and then type the name you want to use.

▶   To remove a test from the test group, click the ▣ symbol next to the test name.

▶   To remove a test group from the **Selected tests** area and from the left pane, click the ✖ symbol next to the test group name.

▶   To open a test group, click the test group name in the left pane of the test view.

After you have opened a test group, the workspace is split into the following areas:

*   **Hardware configuration**
    Display the test-specific controls of the test set.
*   **Settings and conditions**
    Display the test settings common to all tests of the test group.
*   **Test control**
    Display the test control buttons and the list of the tests with the execution and assessment status.

8.5.3   General test settings

The **General test settings** area displays the following data.

Table 8-8: General test settings

Data	Description
Reason for the job	Reason why the job has been created

Data	Description
Global test conditions	
Weather	Weather conditions on site
Unit location	Location of the unit under test
Humidity	Relative ambient humidity on site
Ambient temperature	Ambient temperature on site
Number of operations	
Counter reading found	Counter reading before starting the tests
Counter reading left	Counter reading after the tests has finished
Contact bounce filter	
Main contact	Threshold value of the time interval between two consequent bounces of the main contact. For time intervals equal or below the threshold, the contact is considered as closed. Setting the value to 0.0 ms deactivates the contact bounce filter.
Auxiliary contact	Threshold value of the time interval between two consequent bounces of the auxiliary contact. For time intervals equal or below the threshold, the contact is considered as closed. Setting the value to 0.0 ms deactivates the contact bounce filter.
Update all tests	Click **Update all tests** to set the contact bounce filter for all tests.

8.5.4   Importing tests

In the test view, you can import tests performed with *CPC 100,* as well as the test systems not currently supported by *Primary Test Manager*. *Primary Test Manager* supports import of tests of the following formats.

Table 8-9: Supported test formats

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

You can also import tests in .jpg, .pdf or 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.
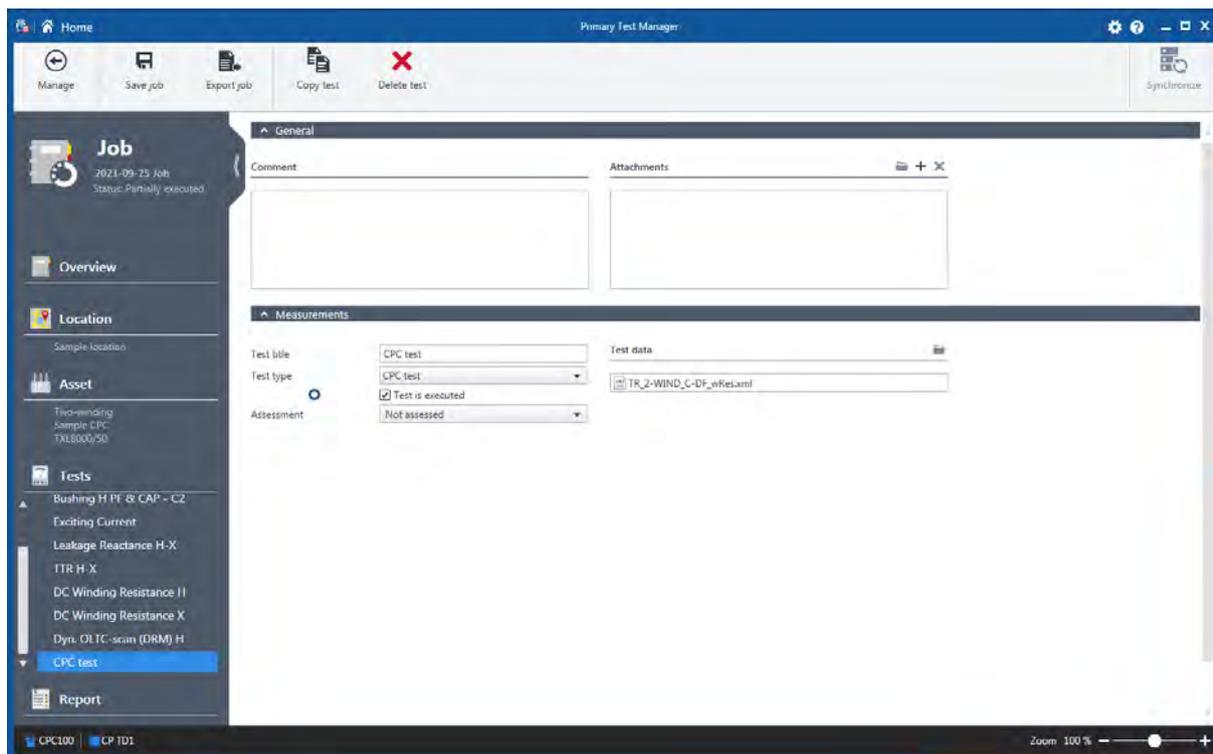
Figure 8-17: Test view after a test has been imported

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**.

ℹ️   To open a test, you must have installed the associated application software on your computer.

You can attach files and add comments to the test.

For information about importing and exporting jobs, see → Export and import jobs on page 83.

8.5.5   Performing tests

To perform and analyze the tests, you must know and understand the test settings and the measurement data. For detailed information about performing tests, see → Application on page 96.

8.5.6   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 select configure a job.

2. In the **Selected tests** area of the test view, click **Save as template**.

Figure 8-18: Save tests as new template dialog box

3. In the **Save Tests as New Template** dialog box:

    3.1   Select the **Asset type** and number of **Phases**.

    3.2   Enter a **Name** for the template.

4. Optionally, you can add a customized Microsoft Excel report template (see → Generate test reports on page 90) for the job template. To add a Microsoft Excel report template:

    4.1   Click **Select template**.

    4.2   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**.
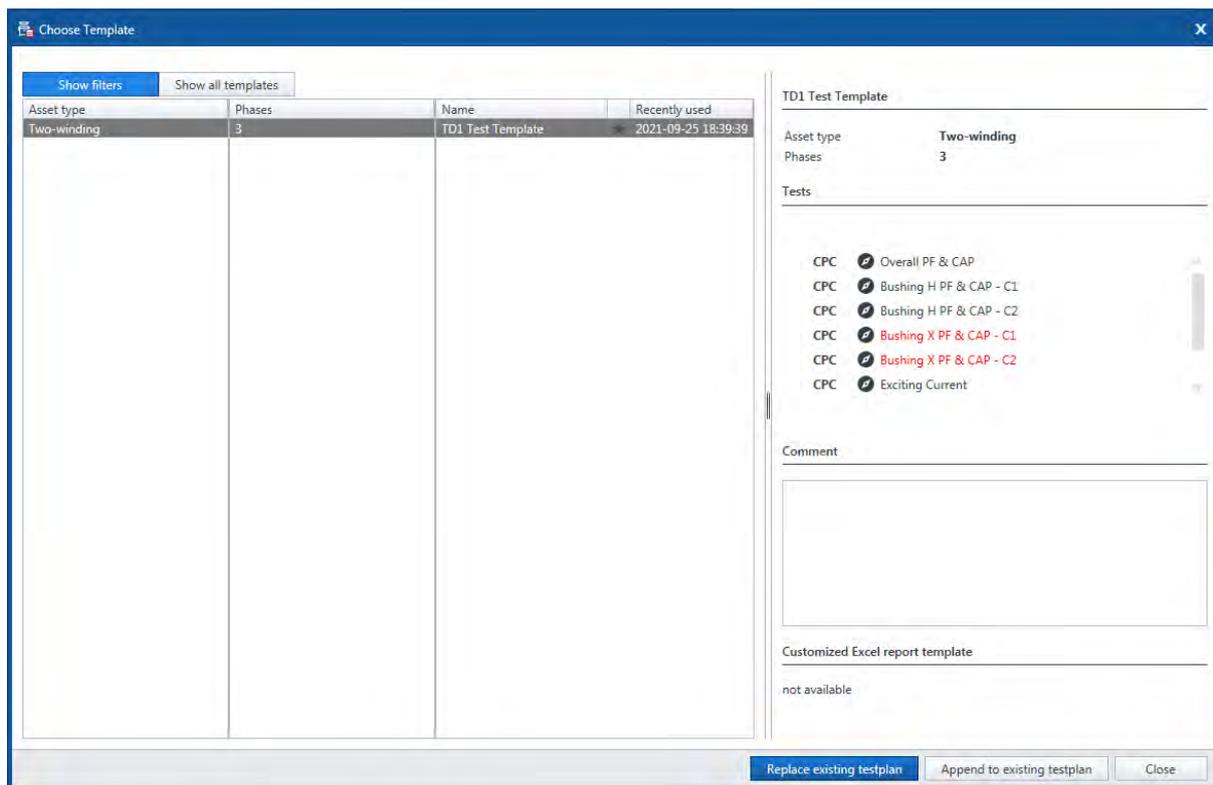
Figure 8-19: Choose Template dialog box

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

> 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.

> 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.

8.6 Handling results

8.6.1 Trending tab

The **Trending** tab displays measurement data from PF 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.).

Trending is available for the following tests:

Overall PF & CAP

Bushing PF & CAP – C1

Bushing PF & CAP – C2

Spare Bushing PF & CAP – C1

Spare Bushing PF & CAP – C2

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

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.

8.6.2   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 8-10: Assessment

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*.

8.6.3   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 during measurement:

1. In the home view (see → Home view on page 36), click the **New guided job** button .
2. In the **Create new job** view, configure a job as previously described in this chapter.
3. In the test view (see → Test view on page 69), select the test you want to perform.
4. In the Measurements pane, click the **+ Select comparison** button, if available.
5. In the **Select a test** window, select the test you want to compare with the current test.
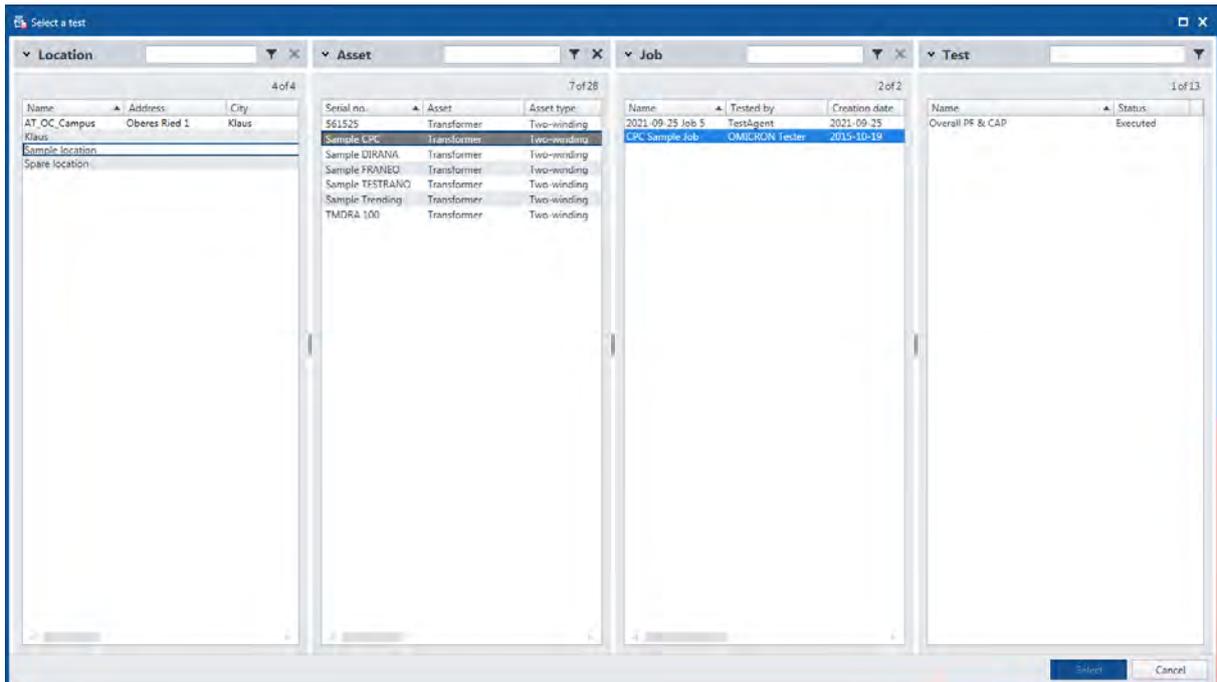
Figure 8-20: Select a test window

6.　The Measurements pane displays the measurement results of the selected test.
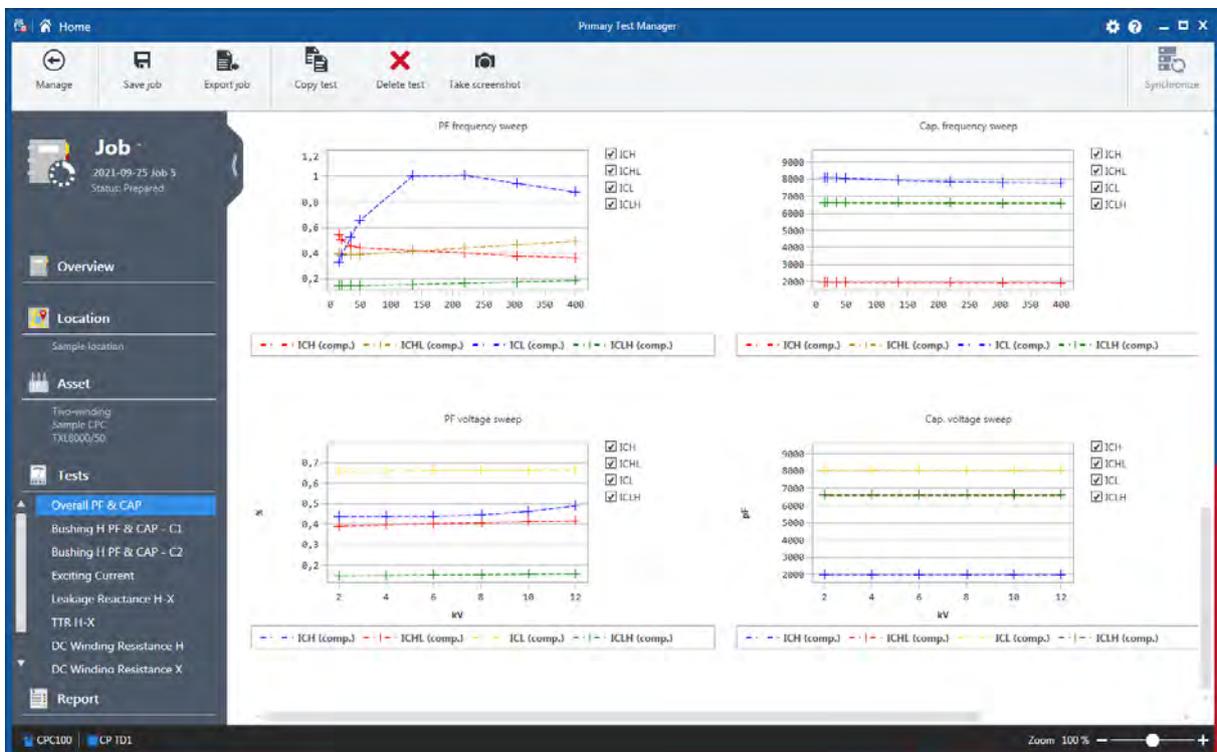
Figure 8-21: Test comparison: Measurement results of the first test

7.　Start the test (see Performing tests).

8. Click the **Plot** tab.

9. *Primary Test Manager* displays the measurement results of both tests in real time.
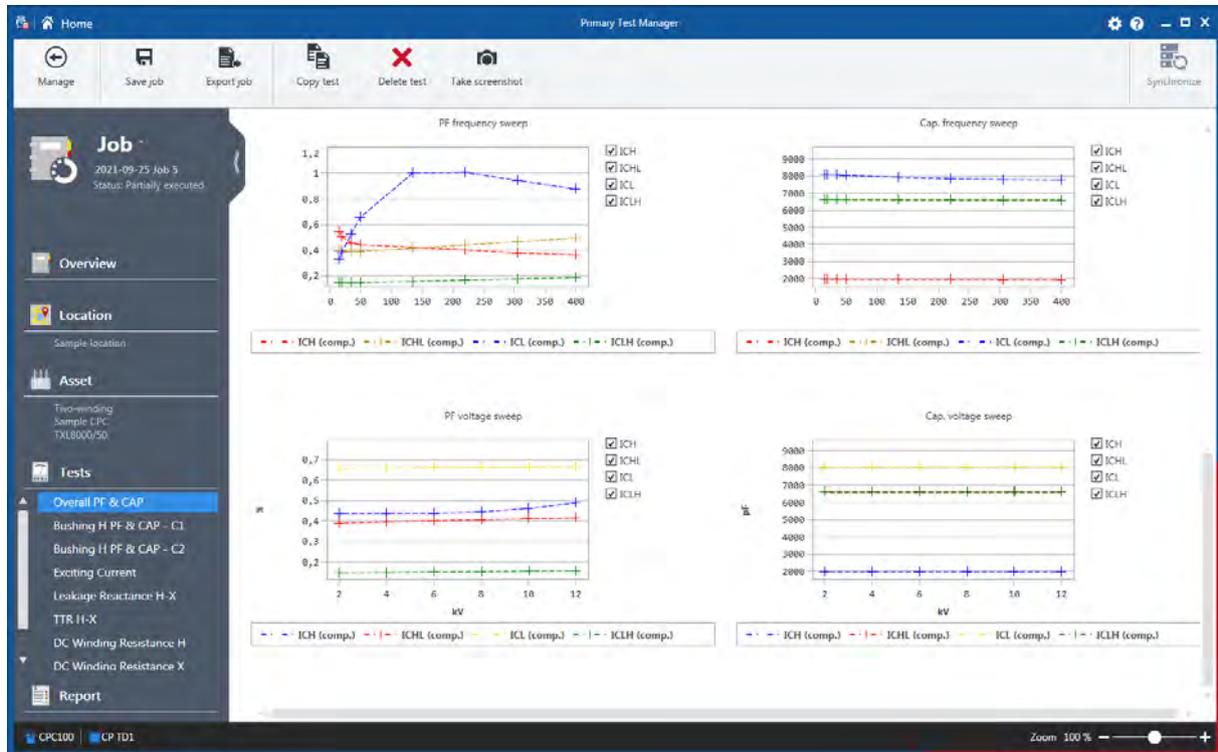
Figure 8-22: Test comparison: Measurement results of both tests

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

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

1. In the **Manage** view (see → Manage objects on page 79), 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 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 → Create new guided jobs on page 53).

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

ℹ In this chapter, the locations, assets, jobs, and reports are collectively called objects.
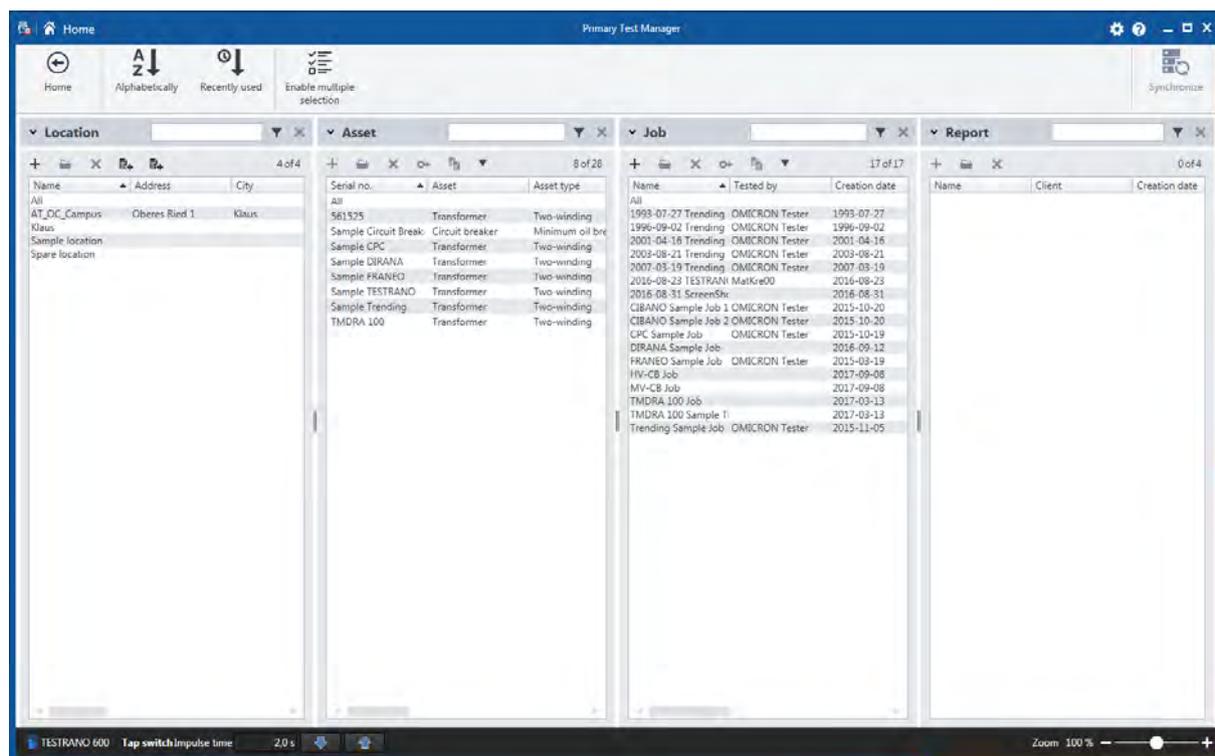
Figure 9-1: Manage view

ℹ 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:

▶ To sort the objects alphabetically, click **Alphabetically** on the ribbon.

▶ To sort the objects in the chronological order, click **Recently used** on the ribbon.

▶ To sort the objects according to the job status, click **Status** on the ribbon.

▶ To rearrange the columns, drag and drop the column headers.

In the manage view, you can:

• Search for objects (see → Search for objects on page 80)

• Perform operations on objects (see → Perform operations on objects on page 81)

• Relocate assets (see → Relocate assets on page 82)

• Export and import jobs (see → Export and import jobs on page 83)

9.1   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:

1. Expand the Search area by clicking the arrow next to **Search**.

2. Type the keyword(s) you search for in the respective object data box(es).

The following table describes the location search data.

Table 9-1: Location search data

Data	Description
Name	Name of the location
Address	Address of the location
City	City where the asset is located
State/Province	State or province where the asset is located
Postal code	Postal code of the location
Country	Country where the asset is located

The following table describes the asset search data.

Table 9-2: 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 9-3: 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 9-4: 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

9.2 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(s)** button ✖.

▶ To export multiple jobs, select the check boxes next to the jobs you want to export, and then click the **Export** button 📤.

9.3 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.

9.4   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 ![icon].

3.   In the asset view, type the serial number(s) of the new asset.
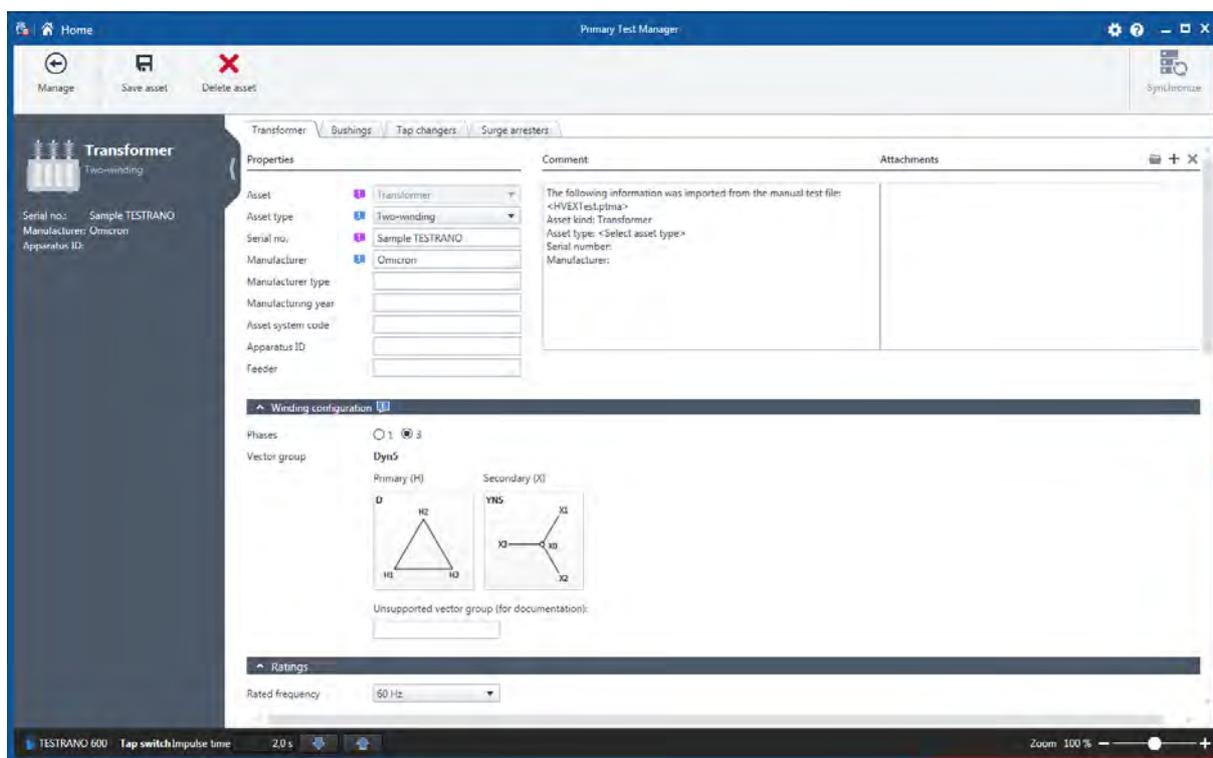
Figure 9-2: Asset view

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

ℹ   By default, the duplicated assets are linked to location of the original asset. For relocating the asset to a different location see → Relocate assets on page 82**.**

9.5   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 ![icon].
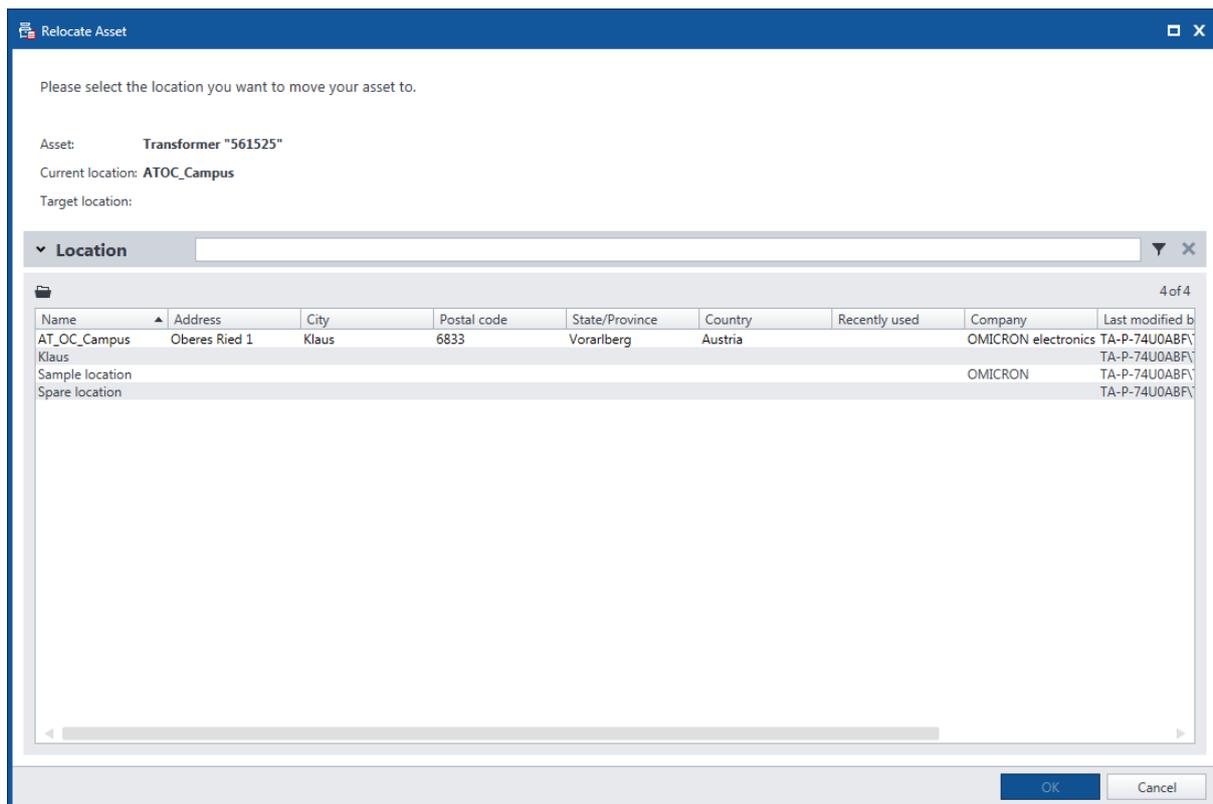
Figure 9-3: Relocate asset dialog box

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.

> ℹ️ You can filter the locations and assets by searching for keywords (see → Search for objects on page 80**).**

9.6   Export and import 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.

> ℹ️ 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 ![icon].
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.

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10 Create new manual jobs

Primary Test Manager assists you to create new manual jobs.

▶ To open the new manual job view, click the **New manual job** button .
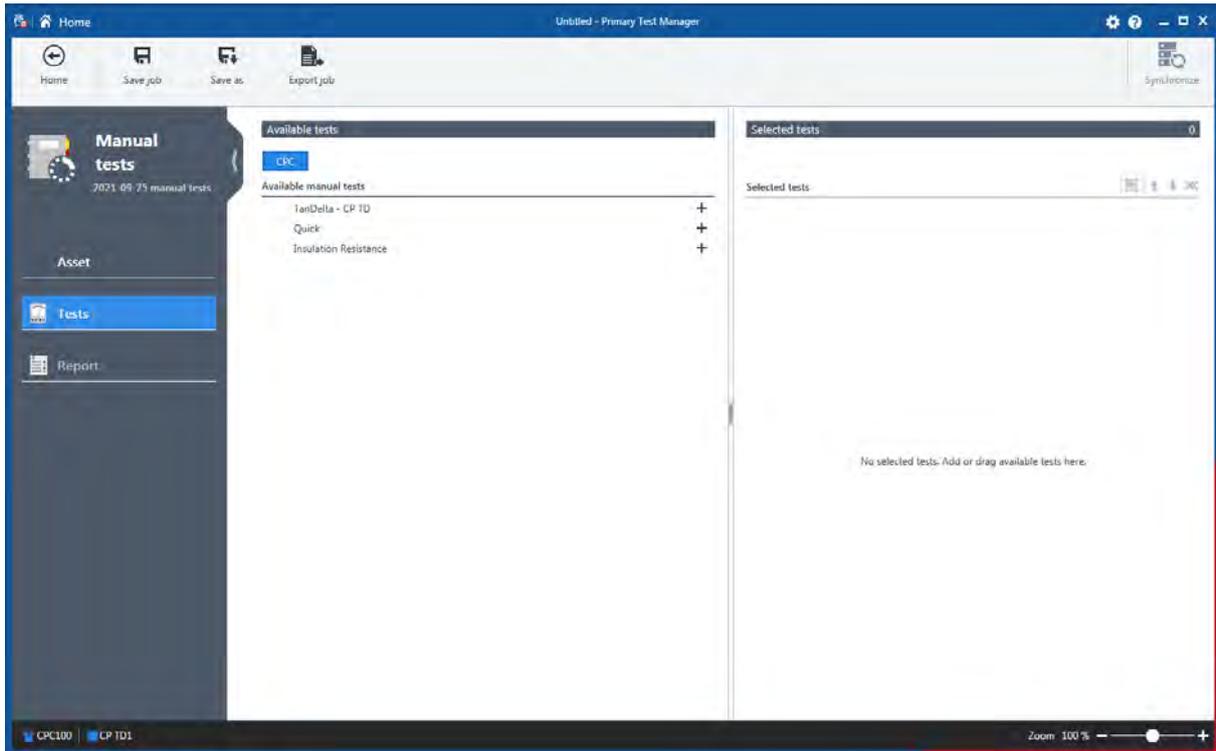
Figure 10-1: Create new manual tests view

The workspace of the new manual job view depends on the selected button in the left pane:

- Initially, the workspace is divided into the **Available tests** area and the **Selected tests** area.
- If you click the **Asset** button, *Primary Test Manager* displays the general asset data (see → General asset data on page 63).
- If you click the **Tests** button, *Primary Test Manager* displays the **Available tests** area and the **Selected tests** area. In this workspace, you can add tests to a job (see → Add tests to a job on page 86).

If you have added a test to a job and click the **Report** button, *Primary Test Manager* displays the report view. In the report view, you can configure and generate test reports.

If you click the **Tests** button, the workspace displays the **General** area and the **Tests** area again.

Figure 10-2: Left-pane buttons

ℹ 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.

10.1   Add tests to a job

To add a test to a job, click the test in the **Tests** area. The selected test opens in the workspace and a button with the test name appears in the left pane.

ℹ You can open a selected test at any time by clicking the corresponding button in the left pane.

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.

After you have opened a test, the workspace is split into the following areas:

*   **Hardware configuration**
    Displays the test-specific controls of the test set.
*   **Settings and conditions**
    Displays the basic test settings you typically need to configure the tests.
*   **Advanced settings**
    Displays the advanced settings for experienced users.
*   **Assessment**
    Provides access to setting the assessment limits. For the assessment limit description, see Assessment limits.
*   **Measurements**
    Displays the measurement results.

10.2 Processing tests

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

Table 10-1: Menu bar commands

Command	Action
Home	Closes the current job and leads you to the *Primary Test Manager* home view. Before closing the job, you can save the changes for all tests.
Save job	Saves the current job. When saving for the first time, you must specify the filename and directory of the job.
Save as	Saves the current job in a newly specified directory.
Export job	Exports the job displayed in the new manual job view into a Microsoft Excel spreadsheet.
Copy test (only available if a test is open)	Adds another test of the same kind and with the same settings to the test list. Results are not copied.
Delete test (only available if a test is open)	Deletes the currently open test.

ⓘ   Clicking **Home** in the title bar and **Close** in the menu bar have the same functionality.

11 Open jobs

With *Primary Test Manager*, you can open existing guided and manual jobs. To open a job:

1. Click the **Open job** button in the home view.
2. In the **Open** dialog box, browse to the file you want to open.
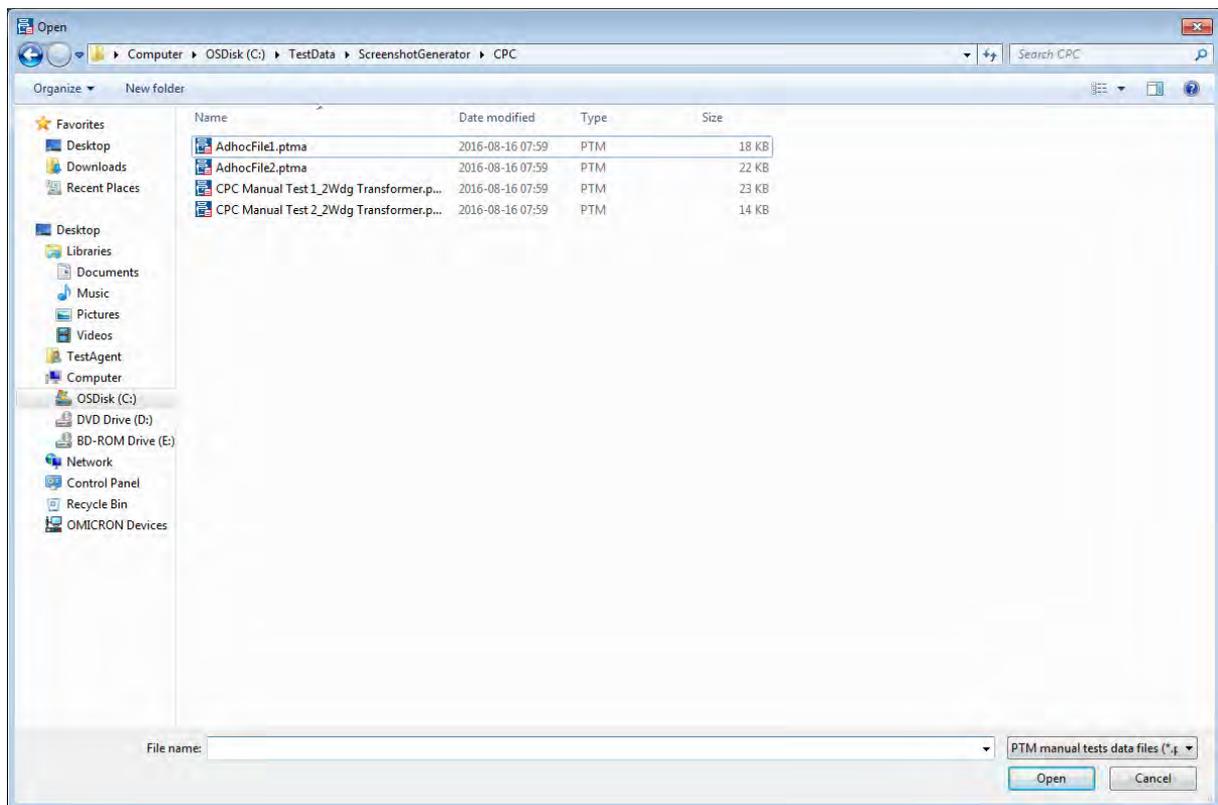
Figure 11-1: Open dialog box
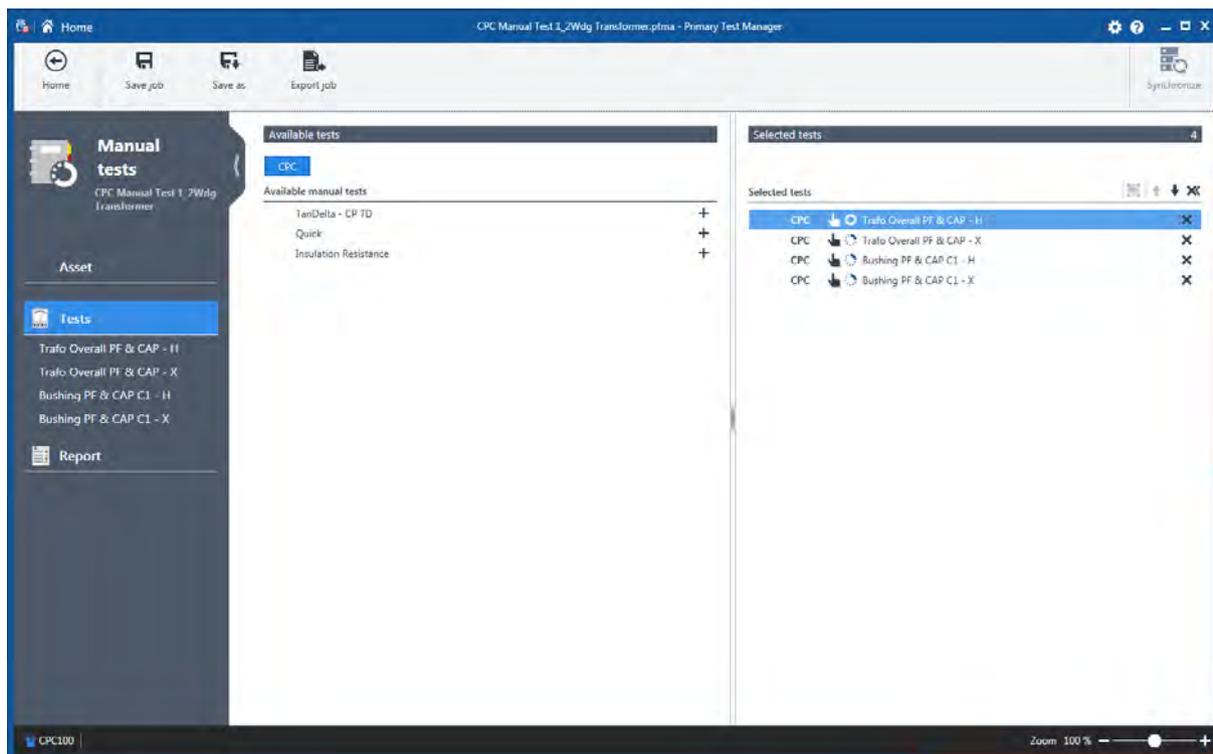
Figure 11-2: Open manual tests view

The open job view displays the tests in the left pane. To view the test results, click the corresponding test button. You can add new tests to the job and process tests as described in → Create new guided jobs on page 53 and → Create new manual jobs on page 85.

12 Generate test reports

In the report view, you can configure and generate test reports.

▶ To open the report view, click the **Report** button 📋.
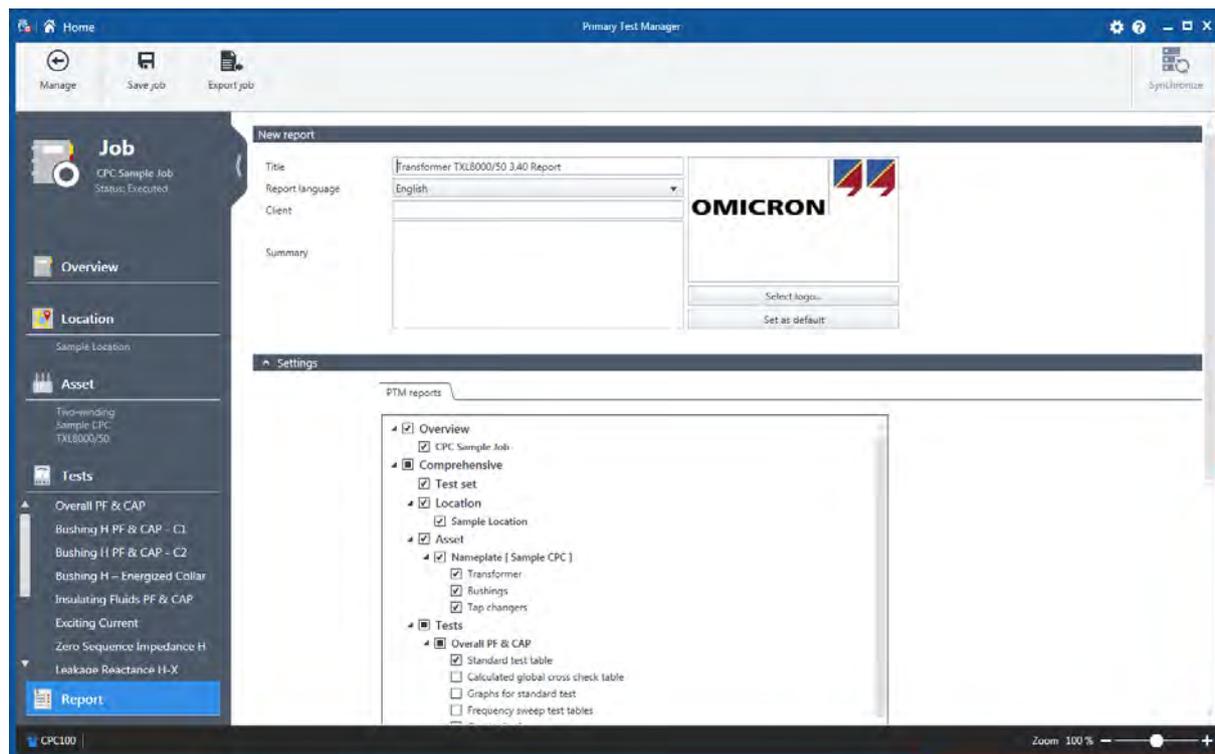
Figure 12-1: Report view

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 12-1: Report data

Data	Description
Title	Title of the report. Appears as the report header.
Report language	Language the report is created in
Report ID (automatically generated by *Primary Test Manager*)	Identifier of the report
Client	Customer for which the report is designated
Logo	Logo to appear in the report
Summary	Text field to summarize the content of the test report in own words.

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.

4. 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.

13 Asset data

This section describes the asset specific data.

13.1   Transformer

The following tables describe the transformer data.

Table 13-1: Winding configuration

Data	Description
Phases	Number of the transformer's phases
Vector group	Vector group of the transformer
Unsupported vector group (for documentation)	Vector group not supported by *Primary Test Manager* as text for documentation

Table 13-2: 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 (Set by the regional conventions, see → Settings on page 38)	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

Table 13-3: Impedances

Data	Description
Ref. temp.	Reference temperature

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Data	Description
Short-circuit impedances H - X, H - Y , X - Y	
Short-circuit impedance Z (%) (Set by the regional conventions, see → Settings on page 38)	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

Table 13-4: Others

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

13.1.1   Bushing

For the data of the transformer's bushings, see → Spare bushing on page 94.

13.1.2   Tap changer

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

Table 13-5: 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.

Data	Description
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 (only available for the DETC)	Current position of the tap
Voltage table	
Tap	Number of the tap
Voltage	Voltage on the tap

13.1.3 Surge arrester

The following table describes the surge arrester data.

Table 13-6: 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-LVoltage 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

13.2 Spare bushing

The following table describes the spare bushing data.

Table 13-7: Spare bushing data

Data	Description
Pos. (Only available for spare bushings mounted on another assets)	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

OMICRON ELECTRONICS GMBH

Data	Description
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) (Set by the regional conventions, see → Settings on page 38)	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) (Set by the regional conventions, see → Settings on page 38)	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
Other	
Insulation type	Insulation type of the spare bushing
Outer insulation type	Outer insulation type of the spare bushing

14 Application

This section describes testing of the power transformers with *FRANEO 800*. *Primary Test Manager* supports the following transformer tests:

Guided tests
→ SFRA test on page 96
→ Oil analysis on page 115

Manual tests
→ Manual SFRA test on page 121
→ Insulation Resistance test on page 133

14.1   SFRA test

14.1.1   Test traces

For testing with *FRANEO 800*, the test traces are of fundamental importance. The frequency response of a test trace strongly depends on the vector group of the transformer under test and the measurement type (for example, end-to-end or interwinding). When creating a new test, *Primary Test Manager* generates the default test traces automatically based on the selected template or according to IEC 60076-18 FRA testing recommendations. You can intentionally change the predefined test traces for your specific applications.

Typically, you do not need to change the default test traces. In well-founded cases, you can delete the default test traces and add new test traces. In particular, in typical *FRANEO 800* applications proceed as follows:

1. If you want to test a transformer for the first time, create a test with a standard measurement profile based on the FRA testing recommendations. Then the default test traces are likely the traces you want to test.

2. If you want to compare the current test results with reference test results, create a test with the same measurement template as used by the reference test. Then the default test traces are exactly the traces you want to test.

> We recommend organizing the reference tests and inspection tests into different jobs with descriptive names. For example, the reference tests executed at a manufacturer site should be organized in a job named **Reference tests**. The tests executed before transportation should be organized in a job named **Before transportation**, and the tests executed after transportation should be organized in a job named **After transportation**.

14.1.2   Primary Test Manager test view

After clicking the SFRA test in the left pane of the *Primary Test Manager* test view (→ Test view on page 69), the test view is split into the General area, the Settings and conditions area, and the Measurements area. You can expand and collapse the areas by clicking the arrows on the split bars.

The General area displays the wiring diagram for the selected test trace. In the Settings and conditions area, you can enter the SFRA test settings (→ Test settings on page 97). In the Measurements area, you can prepare (→ Prepare the SFRA test on page 101) and perform (→

14.1.3   Test settings

The following table describes the SFRA test settings.

Table 14-1: SFRA test – Settings and conditions

Setting	Description
Measurement settings	
Measurement template	Template underlying the test (see "Measurement template" later in this section)
Injection	Transformer's terminal in which the signal is injected
Output level	
Test voltage (V_{pp}) (For compatibility with the test results obtained with the previous versions of *FRANEO 800*, the maximum test voltage is 2.83 V_{pp})	Output voltage of the source channel
Sweep settings	
Sweep profile	Settings of the sweep (see "Sweep profile" later in this section)
Start frequency	Start sweep frequency
Stop frequency	Stop sweep frequency
Sweep mode	Distribution of the measurement points (see "Custom frequency ranges" later in this section)
Measurement points	Total number of measurement points
Custom frequency ranges	Click **Custom frequency ranges** to customize the measurement points (see "Custom frequency ranges" later in this section).
Receiver bandwidth	Bandwidth of the *FRANEO 800* receiver (see "Receiver bandwidth" later in this section)
Attenuator	Measurement channel attenuation (see "Attenuator" later in this section)
Measurement time	Estimated measurement time based on the test settings
Test conditions	
Oil filled	Transformer's insulation
Oil temperature	Temperature of the transformer's oil
Overwrite global test conditions	Select the **Overwrite global test conditions** check box to set the test conditions different from the global test conditions.
Ambient temperature	Ambient temperature
Humidity	Relative ambient humidity
Weather	Weather during the test

Setting	Description
DETC tap	Position of the DETC tap

Measurement template

The measurement template specifies the default test traces. *Primary Test Manager* provides standard measurement templates based on the FRA testing recommendations. Select the measurement template you want to use from the **Measurement template** list. The following table describes the available measurement templates.

Table 14-2: Measurement templates

Template	Description
IEC 60076-18	Generates default test traces according to IEC 60076-18 standard.
OMICRON default	OMICRON template based on IEC 60076-18 standard
OMICRON extended	Advanced OMICRON template based on IEC 60076-18 standard
IEEE C57.149-2012 default	Generates the minimum recommended test traces according to IEEE C57.149-2012 standard.
IEEE C57.149-2012 extended	Generates all recommended test traces according to IEEE C57.149-2012 standard.
No traces	Generates no test traces, leaving you the freedom to define them.

The measurement templates specify also the positions of the OLTC tap including the minimum (min) or maximum (max) number of effective turns of the transformer's winding. You can select the tap positions corresponding to the min and max values from the list next to **min** or **max**.

You can add all test traces related to the tap changer with a specific tap position to the available test traces with a single click. To add test traces with a specific tap position:

1. Select the position of the tap from the **Tap position** list.
2. Click **Add traces for selected tap**.

To remove the test traces with a specific tap position:

1. Select the position of the tap from the **Tap position** list.
2. Click **Remove traces for selected tap**.

You can adapt the selected measurement template by adding and removing test traces to match your requirements.

> Customizing the test traces is an expert feature which enables an expert to specify whatever he wants. The provided standard templates are rule-based templates that recognize the nameplate values and adapt to nameplate changes automatically. For example, if the asset type is changed from two-winding to three-winding, the SFRA test automatically generates additional test traces for the three- winding asset type. Changes to the vector group or tap changer update the SFRA test in a similar way. However, as soon you customize the test traces, the measurement lines are "decoupled" from the nameplate, that is, changes to the nameplate do not adapt the measurement lines.
>
> You can also add measurement lines having no sense with respect to the nameplate. For example, you can add measurement lines for the tertiary winding even though the transformer's vector group does not specify it.
>
> Moreover, you can use any possible tap name, therefore no drop-down list box with the currently set tap names is available for the customized templates.

To adapt a measurement template:

1. Select the measurement template from the **Measurement template** list.

2. In the Measurements area, click the **Preparation** tab.

3. Click **Customize traces**.

4. Click **Add trace** to add a trace, or select the trace you want to remove, and then click **Remove trace**.

5. Repeat step 4 for all traces you want to add and remove.

6. Configure the added test traces to meet your needs (→ Prepare the SFRA test on page 101).

7. To save the measurement template, click **Save** beneath the **Measurement template** list.

8. In the **Measurement template** list box, type the template name, and then click **OK**.

> ℹ️ For the **No traces** measurement template, steps 1 to 3 are done by default.

To delete a user-defined measurement template:

1. Select the measurement template from the **Measurement template** list.

2. Click **Delete** beneath the **Measurement template** list.

Sweep profile

The sweep profile specifies the default sweep settings. Select the sweep profile you want to use from the **Sweep profile** list. The following table describes the available sweep profiles.

Table 14-3: Sweep profiles

Profile	Description
OMICRON default	Default sweep profile for testing with *FRANEO 800*
FRAnalyzer 2.1	Compatible with the *FRAnalyzer* 2.1 software To view the distribution of the measurement points, click **Custom frequency ranges**.
FRAnalyzer 2.0	Compatible with the *FRAnalyzer* 2.0 software To view the distribution of the measurement points, click **Custom frequency ranges**.
FRAnalyzer 1.1	Compatible with the *FRAnalyzer* 1.1 software To view the distribution of the measurement points, click **Custom frequency ranges**.
QuickLin	Fast sweep with linearly distributed measurement points
QuickLog	Fast sweep with logarithmically distributed measurement points

You can adapt the selected sweep profile by changing any sweep settings.

To adapt a sweep profile:

1. Select the sweep profile from the **Sweep profile** list.

2. Change any sweep settings.

3. To save the sweep profile, click **Save** beneath the **Sweep profile** list.

4. In the **Sweep profile** list box, type the profile name, and then click **OK**.

To delete a user-defined sweep profile:

1. Select the sweep profile from the **Sweep profile** list.

2. Click **Delete** beneath the **Sweep profile** list.

Custom frequency ranges

The default measurement points are defined by the selected sweep profile. You can customize the measurement points to increase the measurement quality with respect to the resolution and measurement time. Typically, a higher resolution is necessary due to the enhanced information content at higher frequencies.

To customize the default measurement points:

1. Click **Custom frequency ranges**.

Figure 14-1: **Custom Frequency Ranges** dialog box

2. To change a default frequency range, click in the corresponding **Frequency** box, and then type the frequency.

3. To change the number of measurement points of a frequency range, select the number of measurements points you want to change, and then type the new number of measurement points.

ℹ️ The maximum number of measurement points for a frequency range is 3201.

4. To change the distribution of measurement points within a frequency range, select the distribution from the corresponding **Sweep mode** list.

5. To delete a frequency range, click the corresponding **Remove section** button ➖.

To add a frequency range:

1. Click **Custom frequency ranges**.

2. Under **Add new frequency range**, type the start frequency of the new frequency range. The stop frequency of the new frequency range is the stop frequency of the frequency range into which the new frequency range fits.

3. Type the number of measurement points.

4. Select the distribution of measurement points.

5. Click the **Add frequency range** button +.

6. Click **OK** to close the **Custom Frequency Ranges** dialog box.

Receiver bandwidth

The bandwidth of the *FRANEO 800* receiver affects the noise suppression and the sweep speed. A narrow receiver bandwidth suppresses the most noise interference but slows down the sweep. A broad receiver bandwidth results in fast measurements with a reduced noise immunity of *FRANEO 800*. We recommend using the option **<adapt automatically>** to adapt the receiver bandwidth during the measurement for the best signal-to-noise ratio.

Attenuator

With the measurement channel attenuation, you can balance the overload risk. The following attenuator settings are available: **0 dB, 10 dB, 20 dB, 30 dB**, and **<adapt automatically>**. We recommend using the setting **<adapt automatically>** to adapt the attenuation during the test for the best signal-to-noise ratio without risk of overload.

14.1.4   Prepare the SFRA test

To prepare the SFRA test:

1. In *Primary Test Manager*, do one of the following:

    1.1   In the home view, click the **New guided job** button 📝, and then create a guided job (→).

    1.2   In the home view, click the **Open job** button 📁, and then open an existing guided job.

2. In the test view, select the **SFRA test** (→).

3. In the left pane of the test view, click the **SFRA test**.
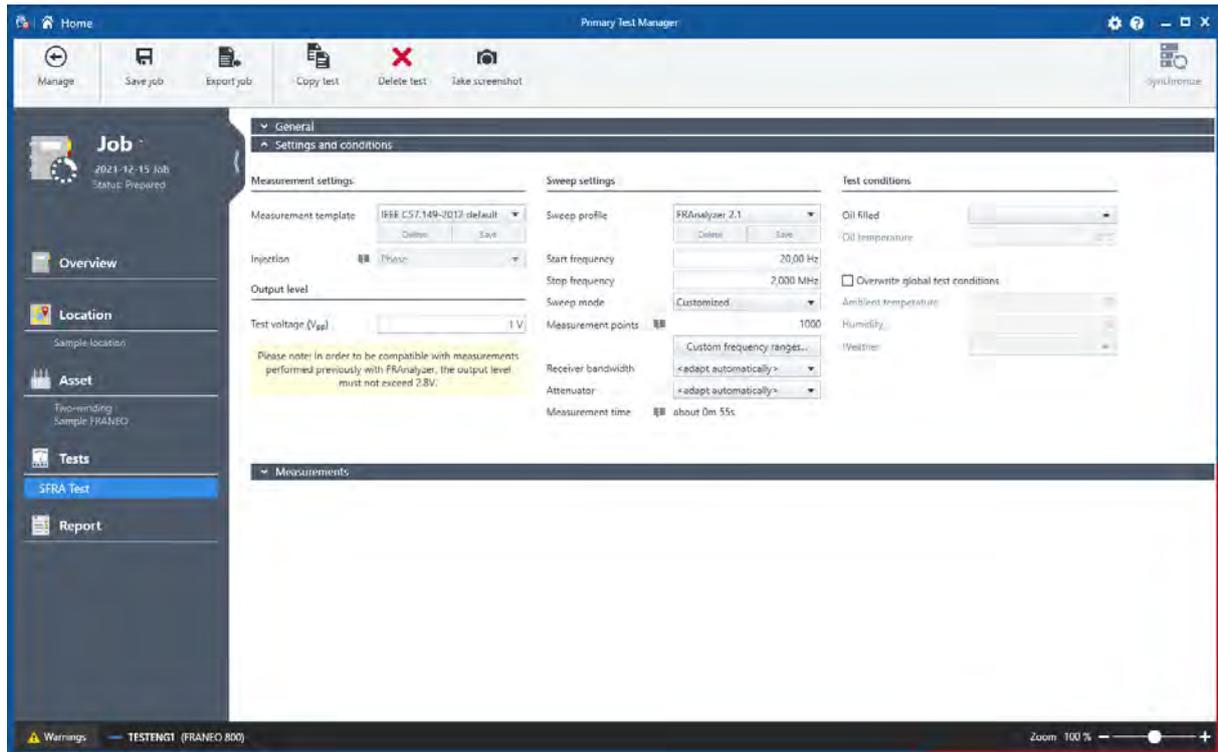
Figure 14-2: Settings and conditions area

ℹ️ For better handling of more tests, we recommend replacing the generic name of the SFRA test with a specific name. To rename the test, click the test name in the left pane of the test view, and then type a new name.

4. In the Settings and conditions area:

   4.1 Select a measurement template from the **Measurement template** list and, optionally, adapt the template to meet your needs (→ Test settings on page 97).

   4.2 Select a sweep profile from the Sweep profile list and, optionally, adapt the profile to meet your needs (→ Test settings on page 97).

   4.3 Enter other test settings (→ Test settings on page 97).
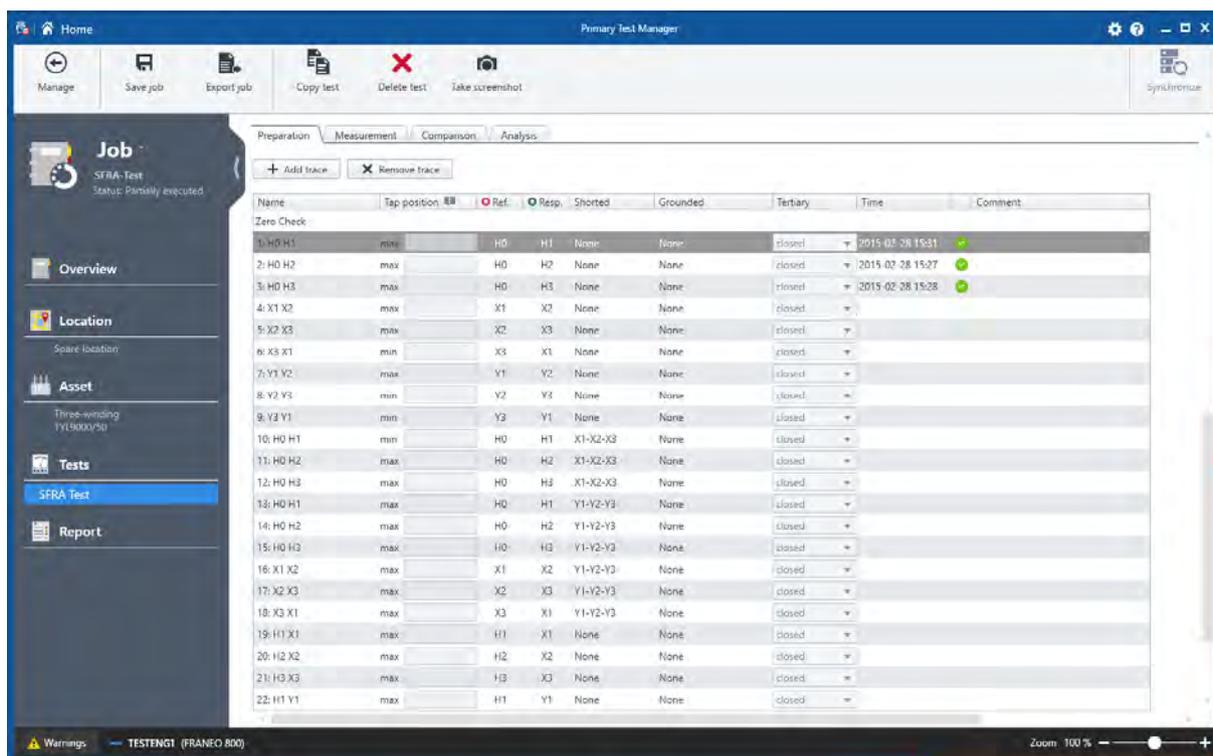
Figure 14-3: Measurements area: **Preparation** tab

The following table describes the SFRA measurement data.

Table 14-4: SFRA measurement data

Data	Description
Name (editable by the user)	Name of the test trace
Tap position (editable by the user)	Position of the transformer's tap defined by the measurement template: • min: tap positions including the minimum number of effective turns of the transformer's winding • max: tap positions including the maximum number of effective turns of the transformer's winding Optionally, you can select the tap position from the list next to min and max to document the tap changer's position corresponding to the minimum and the maximum number of effective turns included into the measurement circuit for the selected trace.
Ref.	Transformer's terminal to be connected to the *FRANEO 800* **REFERENCE** connector
Resp.	Transformer's terminal to be connected to the *FRANEO 800* **RESPONSE** connector
Shorted	Transformer's terminals connected together
Grounded	Transformer's terminals connected to ground
Tertiary winding	State of the transformer's tertiary winding
Time	Time the test was performed

Data	Description
Comment (editable by the user)	Comment on the measurement

14.1.5   Perform the SFRA test

You can perform the SFRA test in the **Measurement** tab workspace of *Primary Test Manager*.
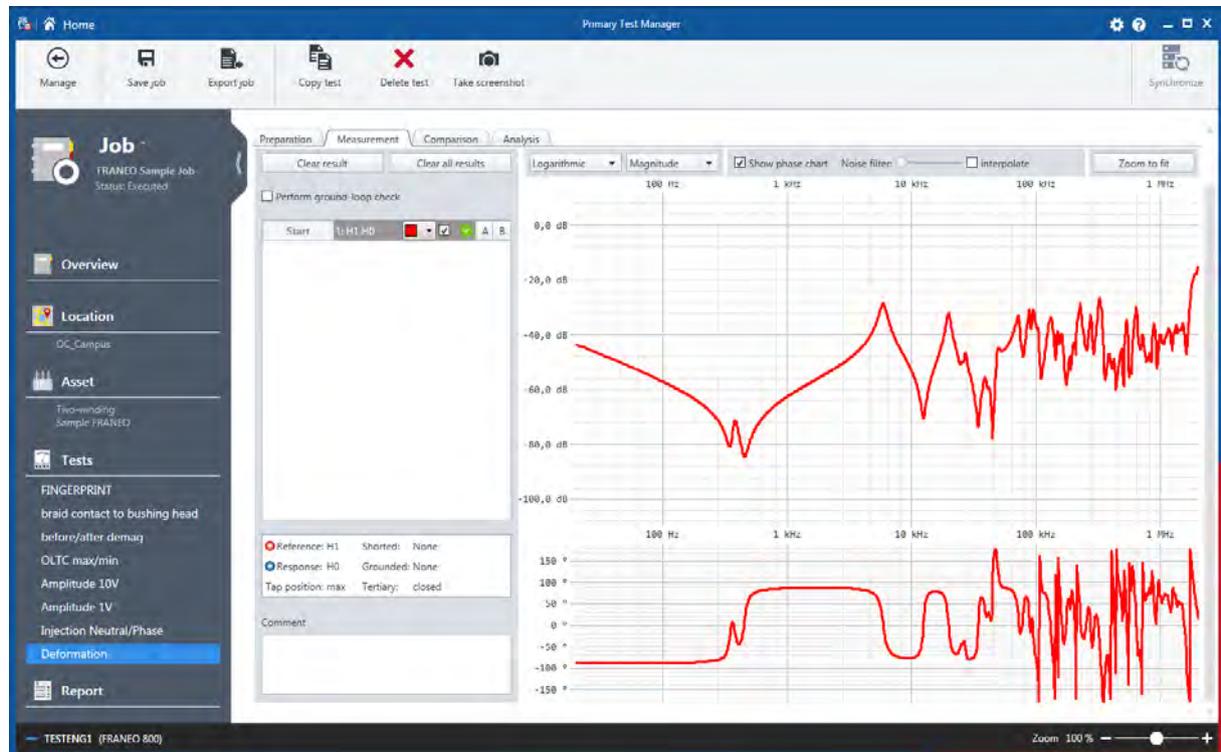
Figure 14-4: Measurements area: **Measurement** tab

The left area of the workspace displays a list of test traces generated during the test preparation with the following elements:

1. To change the test trace color, click the arrow next to the color box, and in the color palette, select your preferred color.

2. To display the measurement results for a test trace, select the check box corresponding to the test trace.

3. To clear the measurement results for a test trace, click the test trace, and then click **Clear result**.

4. To clear all measurement results, click **Clear all results**.

✅ Indicates available measurement results.

🗩 Indicates a comment on the test trace.

❌ Indicates a measurement error.

Ground-loop check

The ground-loop check measures the resistance of the conductor connection consisting of the grounding cable, connection between the transformer tank and the bushing clamp, and the shield of the coaxial cable. The ground-loop check measures the resistance for both bushing terminals. In this way, the ground-loop check proves whether the ground loop is not broken due to poor contacts between the transformer tank and the bushing clamp. Before checking the ground loop, connect the grounding cable to the equipotential ground terminal of *FRANEO 800* and to the transformer tank. The ground-loop check does not require any reconnection of the test setup. To perform the ground-loop check during the SFRA test, select the **Perform ground-loop check** check box.

Measurement results

The right area of the workspace displays the measurement results for the selected test traces with the following display control options:

1. To display the frequency response on the linear or logarithmic frequency axis, select **Linear** or **Logarithmic** from the list.
2. To display the magnitude, impedance or admittance of the frequency response, select **Magnitude**, **Impedance**, or **Admittance** from the list.
3. To display the phase frequency response, select the **Show phase chart** check box.
4. To filter the measurement noise, move the **Noise filter** slider to the right.
5. To add additional calculated values in the graph for analyzing purposes, select the **interpolate** check box.
6. To change the magnification of the whole diagram, click **Zoom to fit** or **Default Zoom**. To zoom into a specific part of the diagram, drag over the part you want to magnify.

To perform the SFRA test:

1. In the Measurements area, click the **Measurement** tab.
2. On the **Measurement** tab, click the test trace you want to test.
3. Connect *FRANEO 800* to the transformer under test according to the wiring diagram displayed in the General area (→ Connect FRANEO 800 to the power transformer on page 27).
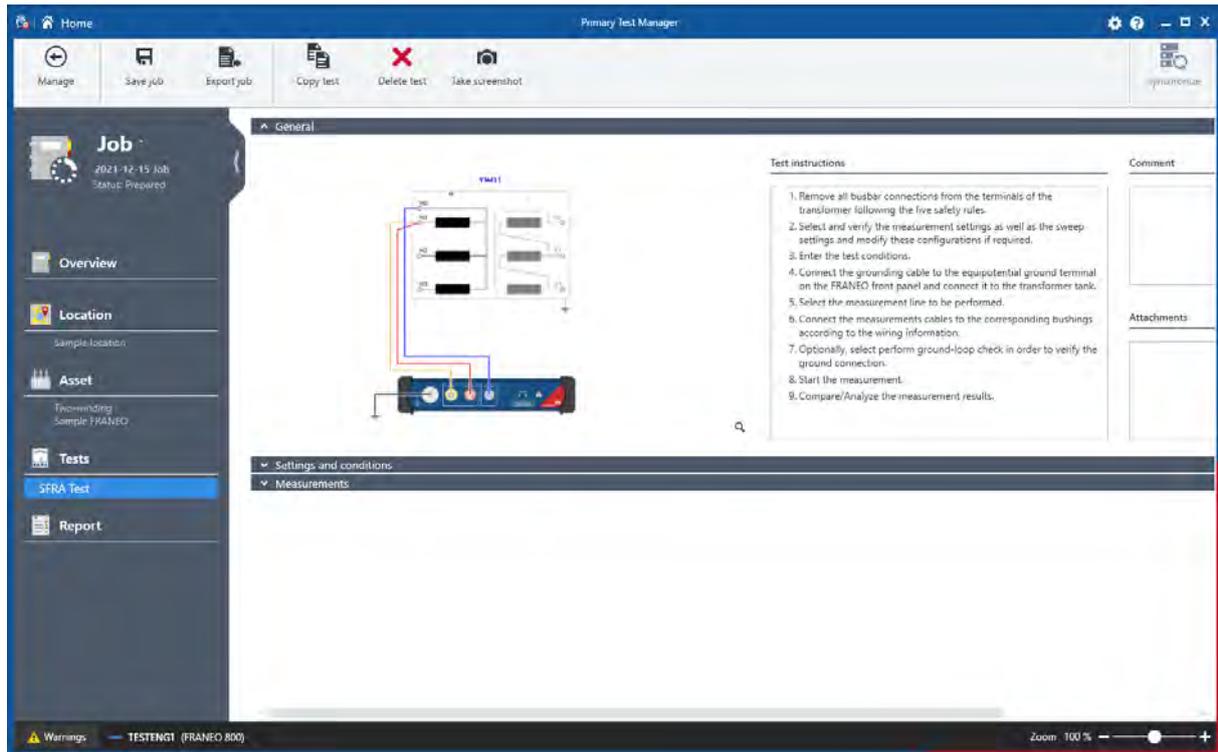
Figure 14-5: General area

4. Click **Start** next to the selected test trace.

5. Repeat steps 2 to 4 for all test traces.

14.1.6 Compare the test results

With *FRANEO 800*, you can diagnose defects in the transformer windings and magnetic core by comparing the SFRA test results. You can compare the test results in the **Comparison** tab workspace of *Primary Test Manager*.
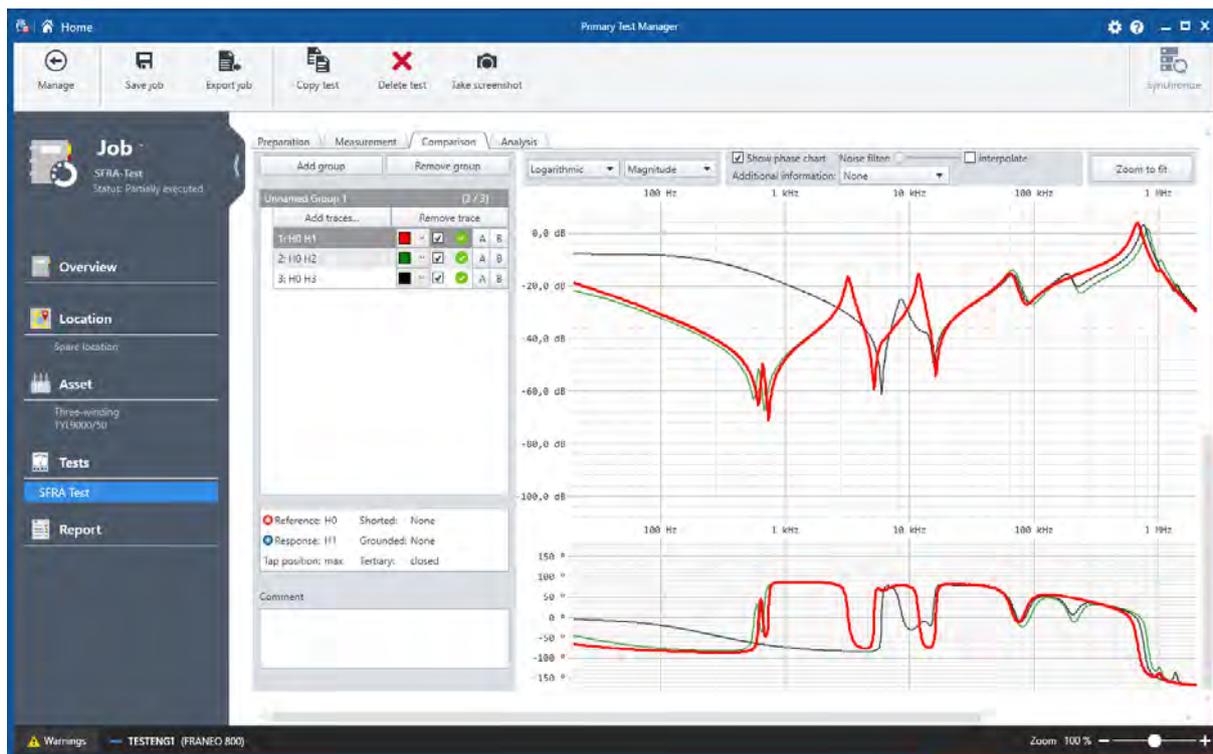
Figure 14-6: Measurements area: **Comparison** tab

In the left area of the workspace, you can configure groups of test traces for comparison.

1. To add a new group of test traces, click **Add group**.

2. To remove a group of test traces, select the group, and then click **Remove group**.

3. To rename a group, click **Unnamed Group x**.

You can group any test traces with available measurement results, and you can add as many groups as you want. You can add a test trace to multiple groups.

> **ⓘ** Groups are especially useful to individually compare the test traces on the high-voltage and low-voltage side.

The left area of the workspace displays a list of test traces of the selected group as described in → Perform the SFRA test on page 104. Additionally, two cursors are available. To set the cursors, click the buttons A and B in any trace of the group. After then, a table showing numerical results for the cursor positions displays in the right area of the workspace.

	Frequency	Magnitude	Phase	Impedance	Admittance	⊗ Close cursors table
▌Cursor A	60 Hz	-28,28 dB	-69 °	1,28 kΩ	781,59 µS	
▌Cursor B	250 Hz	-28,27 dB	-69 °	1,28 kΩ	782,27 µS	
Delta (B - A)	190 Hz	-12,61 dB	-13,5 °	4,25 kΩ	-600,69 µS	

Figure 14-7: Cursors Table

> **ⓘ** You can click the frequency column of a cursor to set or move the cursor to a specific frequency.

The right area of the workspace displays the measurement results for the selected group of test traces. For control display options, see → Perform the SFRA test on page 104. Here, the symbol ✅ indicates a test trace of the current test, while the symbol ⊘ indicates a test trace of a comparison test.

To compare the test results:

1. In the Measurements area, click the **Comparison** tab.

2. In the left area of the workspace, click **Add group**.

3. Under **Available traces**, all test traces with measurement results available in *Primary Test Manager* are displayed in a tree view.

4. Expand the tree view.

5. Click the Add button + next to a test to add all traces to the group, or click the Add button + next to a trace you want to add to the group.

6. Repeat steps 4 and 5 for all test traces you want to compare.

7. In the right area of the workspace, compare the measurement results for the group of test traces visually. You can set the following display control options:

Table 14-5: Display control options

Display control option	Description
Logarithmic/Linear	Select if you want to display the compared test traces on the linear or logarithmic frequency axis.
Magnitude/Impedance/Admittance	Select if you want to display the magnitude, impedance or admittance of the compared test traces.
Show phase chart	Select this check box to display the comparison of the phase frequency responses.
Noise filter	Move the slider to the right to filter the measurement noise.
Interpolate	Select this check box to add additional calculated values in the graph. This can be helpful for analyzing traces, especially when only a few measurement points were created.

Display control option	Description
Additional information	Select if you want to display additional information in the visual comparison. • **None** • **Typical influences** which indicate typical frequency ranges according to the influence of the different transformer parts. • **Frequency bands** which indicate different transformer characteristics, for example core, parallel capacitance, mutual coupling etc. • **Resonance points** • **Significant points** which indicate all minimum/maximum values and zero points. • **Noise** which indicates, for example, the power frequency noise and its harmonics.
Zoom to fit/Zoom to default	Change the zoom factor of the whole diagram. ▶ To zoom into a specific part of the diagram, drag over the part you want to magnify.

1. To rename a test trace group, click the group name, and then type a new name.
2. To remove a test trace from the group, select the test trace, and then click **Remove trace**.
3. To close the tree view, click **Close**, and to open the tree view again, click **Add traces**.

14.1.7 Analyze the transformer windings

With *FRANEO 800*, you can analyze the transformer windings by calculating the winding analysis factors of the frequency responses of two comparable test traces. You can calculate the winding analysis factors by using different algorithms (→ Analysis algorithms on page 112). You can perform the analysis in the **Analysis** tab workspace of *Primary Test Manager*.
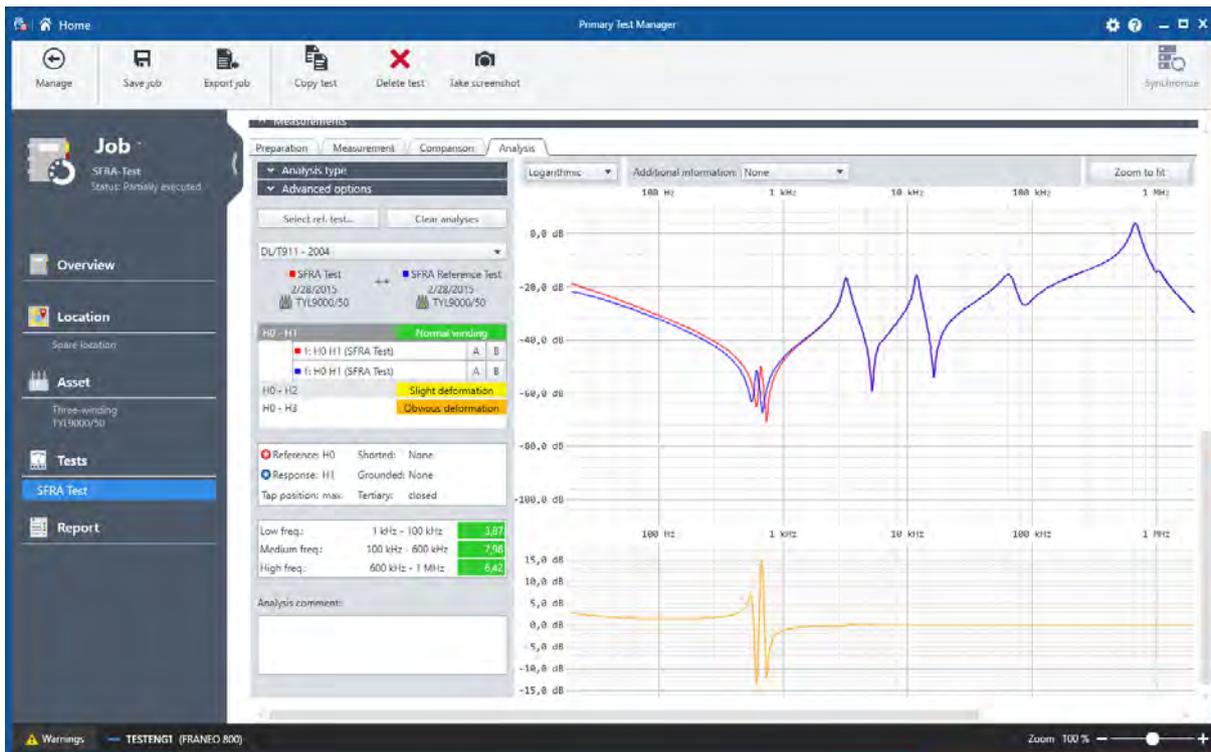
Figure 14-8: Measurements area: **Analysis** tab

In the left area of the workspace, you can configure the analysis of comparable test traces. The comparable test traces have:

- Measurement results on the same transformer
- Same measurement data Tap position (min or max), Ref., Resp., Shorted, Grounded, Tertiary winding (→ Prepare the SFRA test on page 101).

The right area of the workspace displays on the top the magnitude of the frequency responses of two comparable test traces, and on the bottom their difference. To perform an analysis of the transformer windings:

1. In the Measurements area, click the **Analysis** tab.
2. In the left area of the workspace under **Analysis type**, select one of the following analysis types which are commonly used to assess the measured SFRA traces:

Table 14-6: Analysis types

Analysis type	Description
Time-based (conforming to standard)	The SFRA result will be compared to previous results of the same asset.
Type-based (non-standard)	The SFRA result of one transformer will be compared to the results of another transformer of the same design and the same technical specifications (for example MVA rating, winding type etc.)

Analysis type	Description
Include phase-to-phase analyses	If you select this check box in addition to one of the above-mentioned analysis types, the SFRA result of one phase will be compared to the SFRA result of another phase.

1. If you use a **type-based (non-standard) analysis**, you can optionally select a check box under **Advanced options** to ignore certain settings that might differ from transformer to transformer, such as the tap position. By doing this, you are able to compare the test traces despite some minor differences in the settings of both transformers.

2. Click **Select ref. test**.

3. Under **Available tests**, all tests with measurement results available in *Primary Test Manager* are displayed.

4. Click the **Use as ref.** button next to the test you want to use for the analysis.

5. If the test contains test traces comparable with the test traces of the current test, the comparable test traces are displayed.

6. Select the analysis algorithm from the list.

7. On the top, the left area of the workspace displays the analysis next to the comparable test traces, and on the bottom the winding analysis factors.

8. Optionally, you can set the cursors as described earlier in this chapter.

9. In the right area of the workspace, you can examine the test traces visually and set the following display control options:

Table 14-7: Display control options

Display control option	Description
Logarithmic/Linear	Select if you want to display the compared test traces on the linear or logarithmic frequency axis.
Additional information	Select if you want to display additional information in the visual comparison: • **None** • **Analysis** indicates frequency rangers according to the selected analysis algorithm. • **Typical influences** indicate typical frequency ranges according to the influence of the different transformer parts. • **Frequency bands** indicate different transformer characteristics, for example core, parallel capacitance, mutual coupling etc. • **Resonance points** • **Significant points** indicate all minimum/maximum values and zero points. • **Noise** indicates, for example, power frequency noise and its harmonics.

Display control option	Description
Zoom to fit/Default zoom	Change the zoom factor of the whole diagram.
	▶ To zoom into a specific part of the diagram, drag over the part you want to magnify.

14.1.8   Analysis algorithms

The analysis of the transformer windings with *FRANEO 800* is based on two different algorithms described in this section.

DL/T911-2004 standard

DL/T911-2004 is a standard for the frequency response analysis widely used in the People's Republic of China. For detailed information, see the China Electric Power Publishing Co. website www.cepp.com.cn. The algorithm evaluates the similarity of the frequency responses of two transformer's test traces by calculating the factors R_{LF}, R_{MF} and R_{HF} (see Table "Winding analysis factors according to DL/T911-2004 standard" later in this section).

The basic underlying formulas of the DL/T911-2004 algorithm include:

$$D_x = \frac{1}{N} \sum_{k=0}^{N-1} \left[X(k) - \frac{1}{N} \sum_{k=0}^{N-1} X(k) \right]^2$$

Figure 14-9: Eq. 14-1

$$D_y = \frac{1}{N} \sum_{k=0}^{N-1} \left[Y(k) - \frac{1}{N} \sum_{k=0}^{N-1} Y(k) \right]^2$$

Figure 14-10: Eq. 14-2

$$C_{xy} = D_x \times D_y$$

Figure 14-11: Eq. 14-3

$$LR_{xy} = C_{xy} / (\sqrt{D_x D_y})$$

Figure 14-12: Eq. 14-4

$$R_{xy} = \begin{cases} 10 & \text{if } 1 - LR_{xy} < 10^{-10} \\ -\lg(1 - LR_{xy}) & \text{otherwise} \end{cases}$$

Figure 14-13: Eq. 14-5

where *X(k)*, *Y(k)* are comparable frequency response sequences of length *N*.

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The algorithm evaluates the factor R_{xy} at fixed frequencies within the frequency range 1 kHz…1 MHz. Consequently, the algorithm works only for frequency responses including measurement results within 1 kHz…1 MHz. Measurement results out of this range are not considered. The factor R_{xy} evaluated in different frequency ranges yields the winding analysis factors as given in the following table.

Table 14-8: Winding analysis factors according to DL/T911-2004 standard

Winding analysis factor	Frequency range
R_{LF}	1 kHz…100 kHz
R_{MF}	100 kHz…600 kHz
R_{HF}	600 kHz…1 MHz

By using the winding analysis factors described in the preceding table, the transformer winding deformation conditions are defined as follows.

The data in the following table applies to the power transformers with S > 1 MVA.

Table 14-9: Winding analysis according to DL/T911-2004 standard

Winding deformation degree	Winding analysis factors
Normal winding	$R_{LF} \geq 2.0$ AND $R_{MF} \geq 1.0$ AND $R_{HF} \geq 0.6$
Slight deformation	$2.0 > R_{LF} \geq 1.0$ OR $0.6 \leq R_{MF} < 1.0$
Obvious deformation	$1.0 > R_{LF} \geq 0.6$ OR $R_{MF} < 0.6$
Severe deformation	$R_{LF} < 0.6$

The algorithm according to the DL/T911-2004 standard analyzes only comparable test traces if the measurement results cover the frequency ranges required for the calculation of the winding analysis factors (see Table "Winding analysis factors according to DL/T911-2004 standard" earlier in this section). In all other cases, the calculated winding analysis factors have no meaning or cannot be calculated, and *Primary Test Manager* displays **Analysis Not Possible**.

As an example, the following figure shows the winding analysis of an intact transformer.
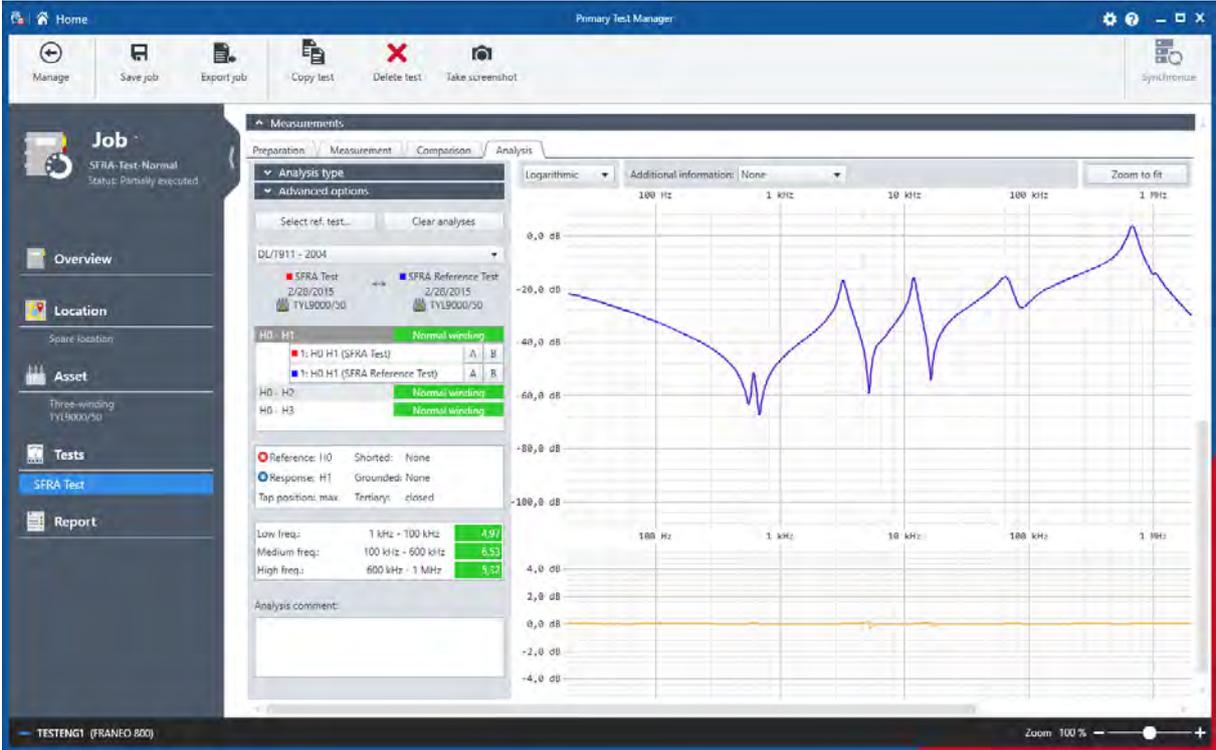
Figure 14-14: Winding analysis of an intact transformer

As an example, the following figure shows the winding analysis of a defective transformer.
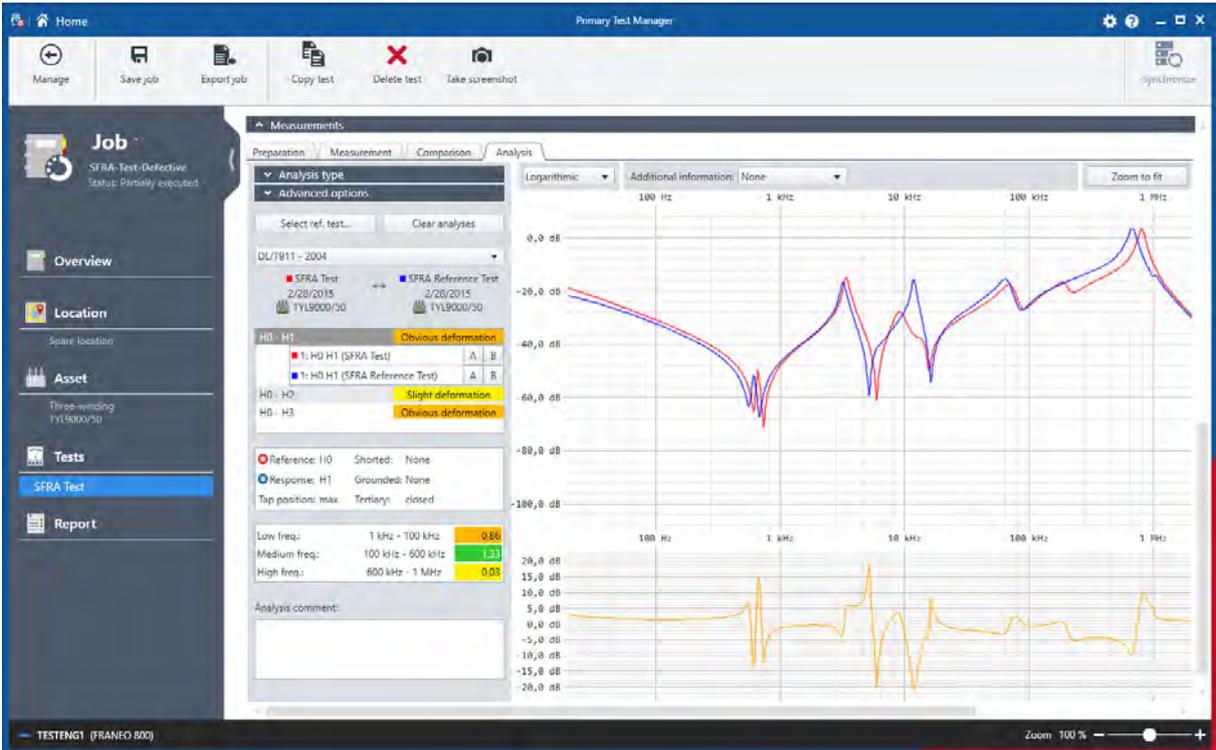
Figure 14-15: Winding analysis of a defective transformer

NCEPRI standard

NCEPRI is an alternative established method for the analysis of the transformer winding deformation. For detailed information, see the NCEPRI website www.ncepri.com. The algorithm evaluates the similarity of the frequency responses of two transformer's test traces by calculating their root mean-square deviation

$$E_{12} = \sqrt{\frac{\sum_{i=1}^{N} (F_{1i} - F_{2i})^2}{N}}$$

Figure 14-16: Eq. 14-6

where F_{1i}, F_{2i} are comparable frequency response sequences of length N in dB.

The winding analysis factor E_{12} is evaluated in different frequency ranges for the high-voltage, low-voltage and tertiary windings as shown in the following table.

Table 14-10: Frequency ranges according to NCEPRI standard

Winding	Frequency range
High-voltage	10 kHz…515 kHz
Low-voltage	10 kHz…600 kHz
Tertiary-voltage	10 kHz…700 kHz

By using the winding analysis factor E_{12}, the transformer winding deformation conditions are defined as follows.

Table 14-11: Winding analysis according to NCEPRI standard

Winding distortion level	Winding analysis factor in dB
Normal condition	$E_{12} < 3.5$
Slight distortion	$3.5 < E_{12} < 7.0$
Severe distortion	$E_{12} > 7.0$

The algorithm according to the NCEPRI standard analyzes only comparable test traces if the measurement results cover the frequency ranges required for the calculation of the winding analysis factor (see Table 14-10: "Frequency ranges according to NCEPRI standard" earlier in this section). In all other cases, the calculated winding analysis factor has no meaning or cannot be calculated, and *Primary Test Manager* displays **Analysis Not Possible**.

The overall winding analysis relies on the analysis algorithm with the levels for the winding analysis factors recommended by the respective standards and consequently cannot be guaranteed by OMICRON.

14.2   Oil analysis

The Oil analysis is used to add the results of oil analyses performed by an oil laboratory or by 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 settings.

Table 14-12: Oil analysis settings

Setting	Description
Asset	
Asset	Asset under test – set in the asset data (→ Transformer on page 92)
Tank type	Type of transformer tank
Insulation medium	Insulation medium of the transformer – set in the asset data (→ Transformer on page 92) **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
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 14-13: Gas-in-oil values

Data	Description
TDCG	Total dissolved combustible gas
TDG	Total dissolved gas

Data	Description
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 14-14: "Examples of result visualization in the section" later in this section)

• IEC basic gas ratios

• Roger's ratios

• Doernenburg's ratios

• Key gases according to IEEE C57.104 and IEC60599 (see Table 14-14: "Examples of result visualization in the Assessment Summary section" later in this section)

• MSS scheme

Table 14-14: 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	
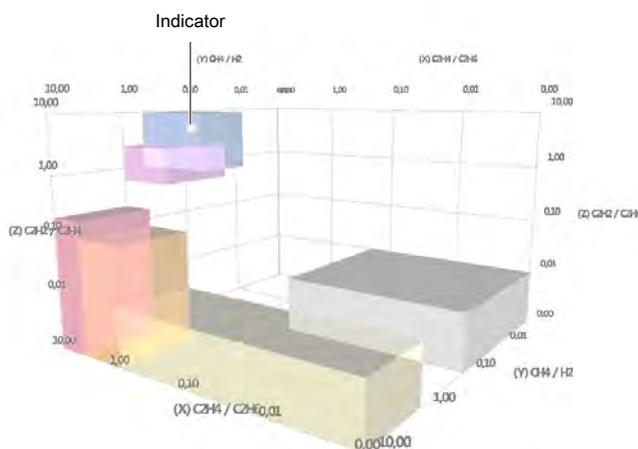
Assessment details

- 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 14-15: 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 14-14: "Examples of result visualization in the Assessment Summary section" earlier in this section).

- 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 14-16: Physico-chemical oil analysis data

Data	Description
Water content	
H_2O meas.	Measured water content in oil
H_2O @ 20°C	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**
Power factor (Term depends on the **Profile** selected in **Settings** (→ Settings on page 38).)	
Standard	Standard underlying the power factor analysis
Meas. value @ 25°C	Power factor/dissipation factor/Tanδ measured at 25°C
Meas. value @ 100°C	Power factor/dissipation factor/Tanδ measured at 100°C
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 that can be set in the **Oil Analysis**:

Table 14-17: Test status

Status	Description
Partially executed	At least one measurement of the test has been executed.
Executed	All measurements of the test have been executed.

ℹ The test status set in the **Oil Analysis** test is displayed in the job overview (→ Job overview on page 55) under **Tests**. If you do not set the test status to **Partially executed** or **Executed** in the **Oil Analysis** test, the test status **Not executed** is displayed in the job overview.

14.3 Manual SFRA test

With *FRANEO 800*, you can also perform a manual SFRA test of the transformer windings.

14.3.1 Test traces

The manual SFRA test can be used for various asset types and offers a more generic set of measurement templates (→ Test settings on page 121). Traces can also be added manually without using any measurement templates.

14.3.2 Primary Test Manager test view

After clicking the **SFRA test (manual)** in the left pane of the *Primary Test Manager* test view (→ Test view on page 69), the test view is split into the General area, the Settings and conditions area, and the Measurements area. You can expand and collapse the areas by clicking the arrows on the split bars.

The General area displays the wiring diagram for the selected test trace. In the Settings and conditions area, you can enter the SFRA test (manual) settings (→ Test settings on page 121). In the Measurements area, you can prepare (→ Prepare the manual SFRA test on page 126) and perform (→ Perform the manual SFRA test on page 128) the SFRA test, and compare the test results (→ Compare the test results on page 131).

14.3.3 Test settings

The following table describes the test settings of the manual SFRA test.

Table 14-18: Manual SFRA test – Settings and conditions

Setting	Description
Measurement settings	
Measurement template	Template underlying the test (see Table "Measurement templates" later in this section)
Output level	
Test voltage (V_{pp}) (For compatibility with the test results obtained with the previous versions of *FRANEO 800*, the maximum test voltage is 2.83 V_{pp}.)	Output voltage of the source channel
Sweep settings	
Sweep profile	Settings of the sweep (→ Test settings on page 121)
Start frequency	Start sweep frequency
Stop frequency	Stop sweep frequency
Sweep mode	Distribution of the measurement points (→ Test settings on page 121)
Measurement points	Total number of measurement points

Setting	Description
Custom frequency ranges	Click **Custom frequency ranges** to customize the measurement points (→ Test settings on page 121).
Receiver bandwidth	Bandwidth of the *FRANEO 800* receiver (→ Test settings on page 121)
Attenuator	Measurement channel attenuation (→ Test settings on page 121)
Measurement time	Estimated measurement time based on the test settings
Test conditions	
Oil filled	Transformer's insulation
Oil temperature	Temperature of the oil
Winding temperature	Temperature of the winding
Overwrite global test conditions	Select the **Overwrite global test conditions** check box to set the test conditions different from the global test conditions.
Ambient temperature	Ambient temperature
Humidity	Relative ambient humidity
Weather	Weather during the test
General settings	
Terminals naming scheme	Select your preferred terminals naming scheme. A specific terminals naming scheme is required when using measurement templates (see Table "Measurement templates" below).

Measurement template

The measurement template specifies the default test traces. *Primary Test Manager* provides standard measurement templates based on the FRA testing recommendations. Select the measurement template you want to use from the **Measurement template** list. The following table describes the available measurement templates.

Table 14-19: Measurement templates

Template	Description
Generic single phase (**IEEE**, **IEC**, **VDE** or **RST** has to be used as terminal naming scheme. A suitable terminal naming scheme is automatically set when selecting the measurement template.)	Measurement template for a single-phase asset (one trace)

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Template	Description
Generic 3 phase (phase to phase) (**IEEE**, **IEC**, **VDE** or **RST** has to be used as terminal naming scheme. A suitable terminal naming scheme is automatically set when selecting the measurement template.)	Phase-to-phase measurement template for a three-phase asset (three traces)
Generic 3 phase (phase to neutral) (**IEEE**, **IEC**, **VDE** or **RST** has to be used as terminal naming scheme. A suitable terminal naming scheme is automatically set when selecting the measurement template.)	Phase-to-neutral measurement template for a three-phase asset (three traces)
Rotating machine rotor measurement (**A1**/**A2** or **F1**/**F2** has to be used as terminal naming scheme. A suitable terminal naming scheme is automatically set when selecting the measurement template.)	Measurement template for a rotor of a rotating machine (one trace)

You can adapt the selected measurement template by adding and removing test traces to match your requirements.

To adapt a measurement template:

1. Select the measurement template from the **Measurement template** list.
2. In the Measurements area, click the **Preparation** tab.
3. Click **Add trace** to add a trace, or select the trace you want to remove, and then click **Remove trace**.
4. Configure the added test traces to meet your needs (→ Prepare the SFRA test on page 101).
5. To save the measurement template, click **Save** beneath the **Measurement template** list.
6. In the **Measurement template** list box, type the template name, and then click **OK**.

To delete a user-defined measurement template:

1. Select the measurement template from the **Measurement template** list.

2. Click **Delete** beneath the **Measurement template** list.

Sweep profile

The sweep profile specifies the default sweep settings. Select the sweep profile you want to use from the **Sweep profile** list. The following table describes the available sweep profiles.

Table 14-20: Sweep profiles

Profile	Description
OMIRCON default	Default sweep profile for testing with *FRANEO 800*
FRAnalyzer 2.1	Compatible with the *FRAnalyzer* 2.1 software To view the distribution of the measurement points, click **Custom frequency ranges**.
FRAnalyzer 2.0	Compatible with the *FRAnalyzer* 2.0 software To view the distribution of the measurement points, click **Custom frequency ranges**.
FRAnalyzer 1.1	Compatible with the *FRAnalyzer* 1.1 software To view the distribution of the measurement points, click **Custom frequency ranges**.
QuickLin	Fast sweep with linearly distributed measurement points
QuickLog	Fast sweep with logarithmically distributed measurement points

You can adapt the selected sweep profile by changing any sweep settings.

To adapt a sweep profile:

1. Select the sweep profile from the **Sweep profile** list.
2. Change any sweep settings.
3. To save the sweep profile, click **Save** beneath the **Sweep profile** list.
4. In the **Sweep profile** list box, type the profile name, and then click **OK**.

To delete a user-defined sweep profile:

1. Select the sweep profile from the **Sweep profile** list.
2. Click **Delete** beneath the **Sweep profile** list.

Custom frequency ranges

The default measurement points are defined by the selected sweep profile. You can customize the measurement points to increase the measurement quality with respect to the resolution and measurement time. Typically, a higher resolution is necessary due to the enhanced information content at higher frequencies.

To customize the default measurement points:

1. Click **Custom frequency ranges**.

Figure 14-17: **Custom Frequency Ranges** dialog box

2. To change a default frequency range, click in the corresponding **Frequency** box, and then type the frequency.

3. To change the number of measurement points of a frequency range, select the number of measurements points you want to change, and then type the new number of measurement points.

ⓘ The maximum number of measurement points for a frequency range is 3201.

4. To change the distribution of measurement points within a frequency range, select the distribution from the corresponding **Sweep mode** list.

5. To delete a frequency range, click the corresponding **Remove section** button ▬.

To add a frequency range:

1. Click **Custom frequency ranges**.

2. Under **Add new frequency range**, type the start frequency of the new frequency range. The stop frequency of the new frequency range is the stop frequency of the frequency range into which the new frequency range fits.

3. Type the number of measurement points.

4. Select the distribution of measurement points.

5. Click the **Add frequency range** button +.

6. Click **OK** to close the **Custom Frequency Ranges** dialog box.

Receiver bandwidth

The bandwidth of the *FRANEO 800* receiver affects the noise suppression and the sweep speed. A narrow receiver bandwidth suppresses the most noise interference but slows down the sweep. A broad receiver bandwidth results in fast measurements with a reduced noise immunity of *FRANEO 800*. We recommend using the option **<adapt automatically>** to adapt the receiver bandwidth during the measurement for the best signal-to-noise ratio.

Attenuator

With the measurement channel attenuation, you can balance the overload risk. The following attenuator settings are available: **0 dB**, **10 dB**, **20 dB**, **30 dB**, and **<adapt automatically>**. We recommend using the setting <adapt automatically> to adapt the attenuation during the test for the best signal-to-noise ratio without risk of overload.

14.3.4   Prepare the manual SFRA test

To prepare the manual SFRA test:

1. In *Primary Test Manager*, do one of the following:

    1.1   In the home view of *Primary Test Manager*, click the **New manual job** button 🖫, and then create a manual job (→ Create new manual jobs on page 85).

    1.2   In the home view, click the **Open job** button 🖫, and then open an existing manual job

2. In the test view, select the **SFRA test (manual)** (→ Selecting tests on page 69).

3. In the left pane of the test view, click the **SFRA test (manual)**.
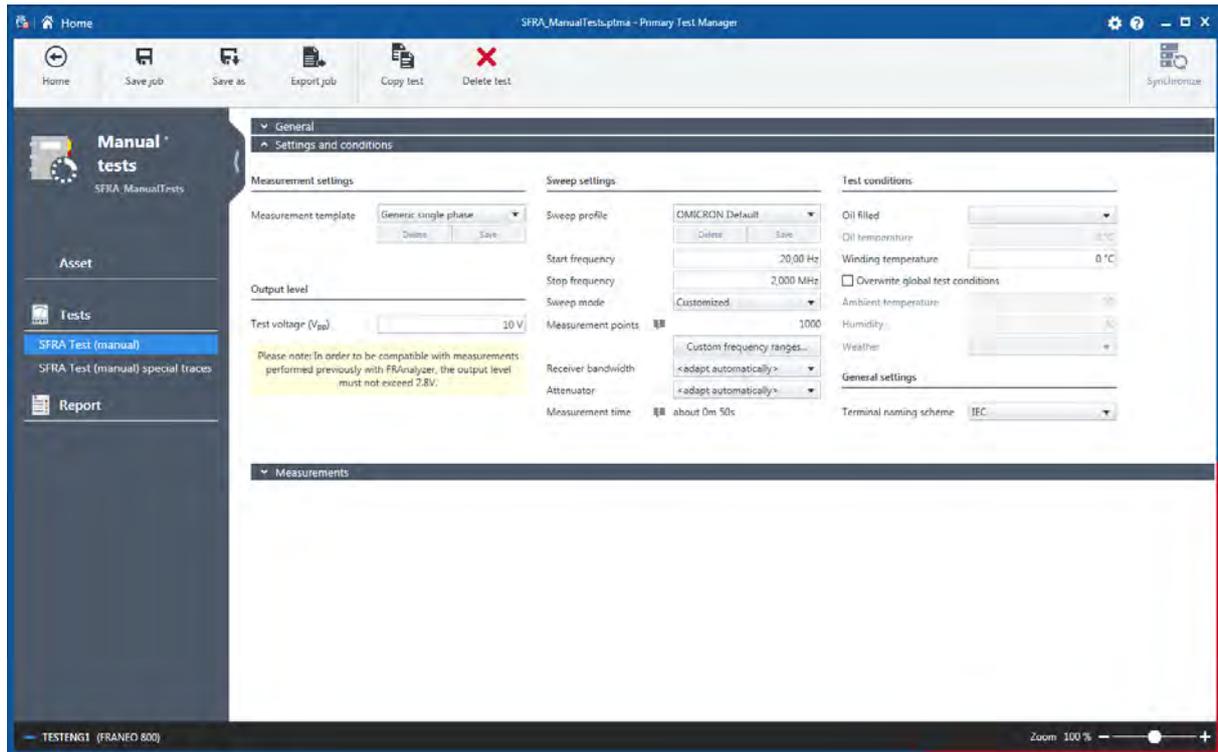
Figure 14-18: Settings and conditions area

> For better handling of more tests, we recommend replacing the generic name of the manual SFRA test with a specific name. To rename the test, click the test name in the left pane of the test view, and then type a new name.

4. In the Settings and conditions area:

    4.1 Select a measurement template from the **Measurement template** list and, optionally, adapt the template to meet your needs (see Table 14-19: "Measurement templates" earlier in this section).

    4.2 Select a sweep profile from the **Sweep profile** list and, optionally, adapt the profile to meet your needs (→ Test settings on page 97).

    4.3 Enter other test settings (→ Test settings on page 97).
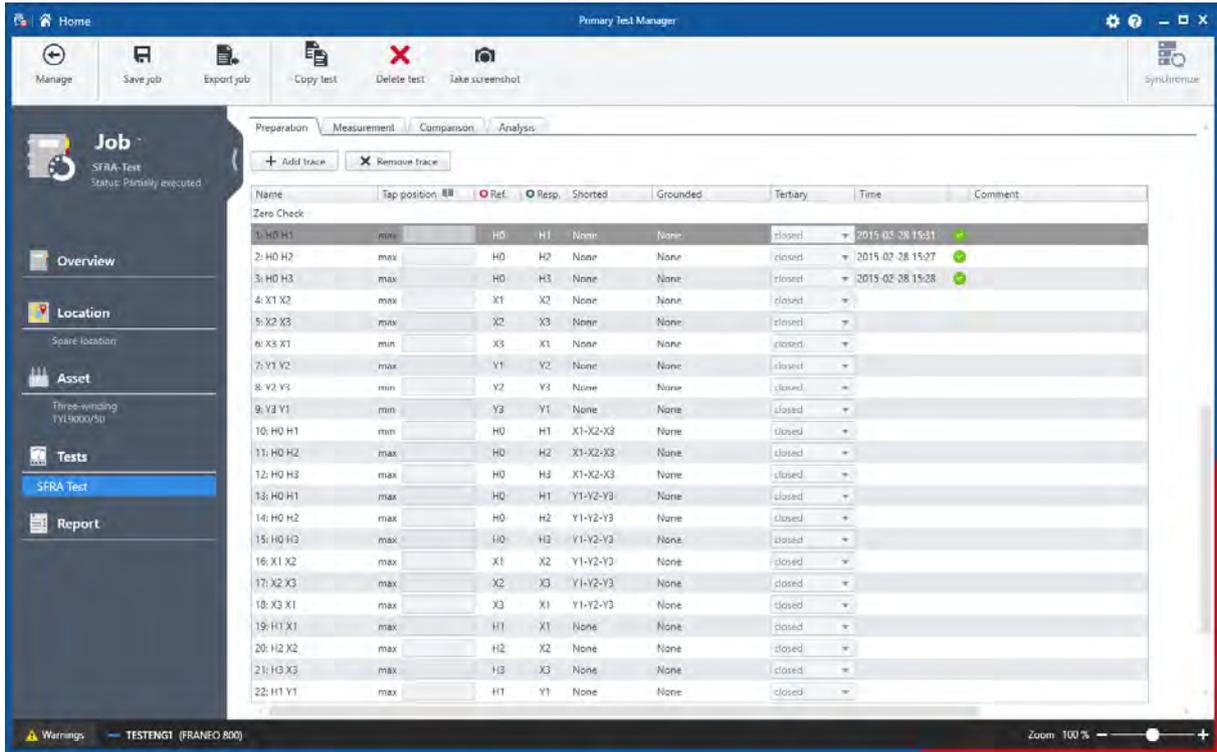
Figure 14-19: Measurements area: **Preparation** tab

The following table describes the SFRA measurement data.

Table 14-21: SFRA measurement data

Data	Description
Name (editable by the user)	Name of the test trace
Tap position (editable by the user)	For manual testing, several assets are supported. Therefore, enter the tap changer position or rotor pole number to be tested.
Ref.	Terminal to be connected to the *FRANEO 800* **REFERENCE** connector
Resp.	Terminal to be connected to the *FRANEO 800* **RESPONSE** connector
Shorted	Terminals connected together
Grounded	Terminals connected to ground
Time	Time the test was performed
Comment (editable by the user)	Comment on the measurement

14.3.5 Perform the manual SFRA test

You can perform the manual SFRA test in the **Measurement** tab workspace of *Primary Test Manager*.

Figure 14-20: Measurements area: **Measurement** tab

The left area of the workspace displays a list of test traces generated during the test preparation with the following elements:
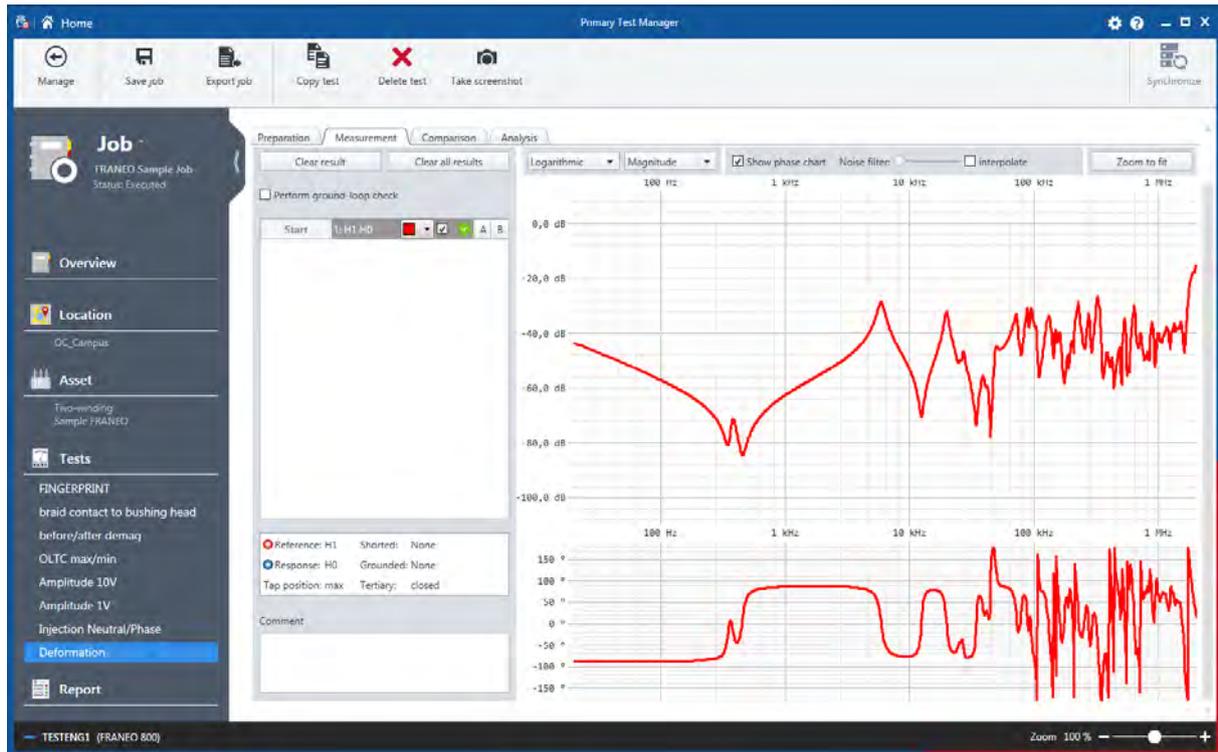
1. To change the test trace color, click the arrow next to the color box, and in the color palette, select your preferred color.

2. To display the measurement results for a test trace, select the check box corresponding to the test trace.

3. To clear the measurement results for a test trace, click the test trace, and then click **Clear result**.

4. To clear all measurement results, click **Clear all results**.

⬤ Indicates available measurement results.

🗩 Indicates a comment on the test trace.

❌ Indicates a measurement error.

Ground-loop check

The ground-loop check measures the resistance of the conductor connection consisting of the grounding cable, connection between the transformer tank and the bushing clamp, and the shield of the coaxial cable. The ground-loop check measures the resistance for both bushing terminals. In this way, the ground-loop check proves whether the ground loop is not broken due to poor contacts between the transformer tank and the bushing clamp. Before checking the ground loop, connect the grounding cable to the equipotential ground terminal of *FRANEO 800* and to the transformer tank. The ground-loop check does not require any reconnection of the test setup.

▶ To perform the ground-loop check during the SFRA test, select the **Perform ground-loop check** check box.

Measurement results

The right area of the workspace displays the measurement results for the selected test traces with the following display control options:

1. To display the frequency response on the linear or logarithmic frequency axis, select **Linear** or **Logarithmic** from the list.

2. To display the magnitude, impedance or admittance of the frequency response, select **Magnitude**, **Impedance**, or **Admittance** from the list.

3. To display the phase frequency response, select the **Show phase chart** check box.

4. To filter the measurement noise, move the **Noise filter** slider to the right.

5. To add additional calculated values in the graph for analyzing purposes, select the **interpolate** check box.

6. To change the magnification of the whole diagram, click **Zoom to fit** or **Default Zoom**. To zoom into a specific part of the diagram, drag over the part you want to magnify.

To perform the SFRA test:

1. In the Measurements area, click the **Measurement** tab.

2. On the **Measurement** tab, click the test trace you want to test.

3. Connect *FRANEO 800* to the device under test according to the wiring diagram displayed in the General area (→ Connect FRANEO 800 to the power transformer on page 27).
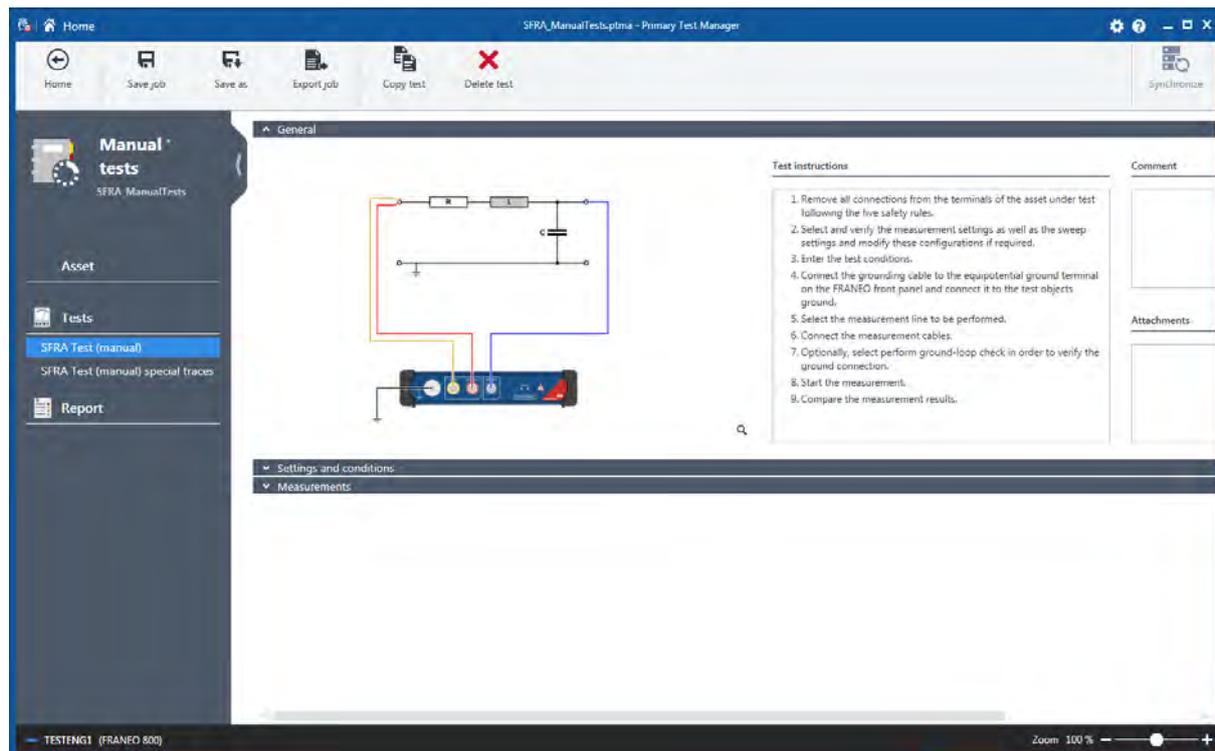

Figure 14-21: General area

4. Click **Start** next to the selected test trace.

5. Repeat steps 2 to 4 for all test traces.

14.3.6 Compare the test results

With *FRANEO 800*, you can compare the test results in the **Comparison** tab workspace of *Primary Test Manager*.
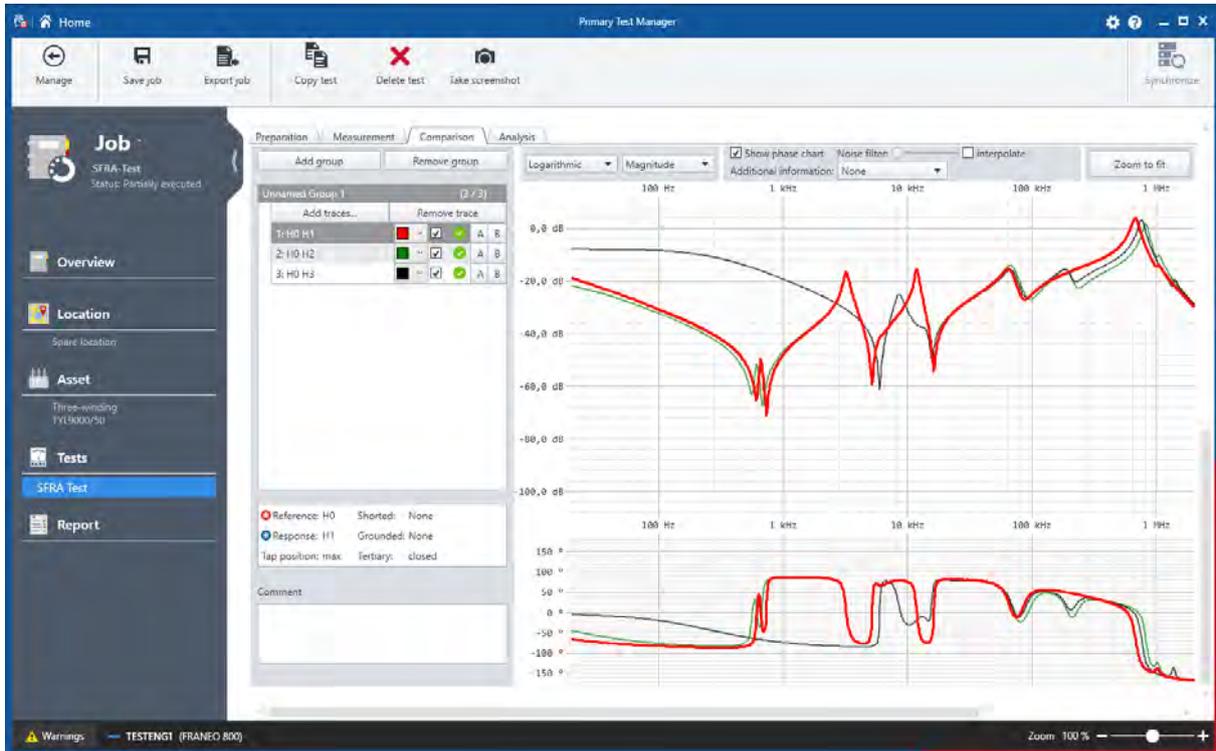
Figure 14-22: Measurements area: **Comparison** tab

In the left area of the workspace, you can configure groups of test traces for comparison.

1. To add a new group of test traces, click **Add group**.

2. To remove a group of test traces, select the group, and then click **Remove group**.

3. To rename a group, click **Unnamed Group x**.

You can group any test traces with available measurement results, and you can add as many groups as you want. You can add a test trace to multiple groups.

> Groups are especially useful to individually compare the test traces on the high-voltage and low-voltage side.

The left area of the workspace displays a list of test traces of the selected group as described in → Perform the SFRA test on page 104. Additionally, two cursors are available. To set the cursors, click the buttons **A** and **B** in any trace of the group. After then, a table showing numerical results for the cursor positions displays in the right area of the workspace.

	Frequency	Magnitude	Phase	Impedance	Admittance	⊗ Close cursors table
▌Cursor A	60 Hz	-28,28 dB	-69 °	1,28 kΩ	781,59 µS	
▌Cursor B	250 Hz	-28,27 dB	-69 °	1,28 kΩ	782,27 µS	
Delta (B - A)	190 Hz	-12,61 dB	-13,5 °	4,25 kΩ	-600,69 µS	

Figure 14-23: Cursors table

> You can click the frequency column of a cursor to set or move the cursor to a specific frequency.

The right area of the workspace displays the measurement results for the selected group of test traces. For control display options, see → Perform the SFRA test on page 104. Here, the symbol ✅ indicates a test trace of the current test, while the symbol ⊘ indicates a test trace of a comparison test.

To compare the test results:

1. In the Measurements area, click the **Comparison** tab.

2. In the left area of the workspace, click **Add group**.

3. Under **Available traces**, all test traces with measurement results available in *Primary Test Manager* are displayed in a tree view.

4. Expand the tree view.

5. Click the Add button + next to a test to add all traces to the group or click the Add button next to a trace you want to add to the group.

6. Repeat steps 4 and 5 for all test traces you want to compare.

7. In the right area of the workspace, compare the measurement results for the group of test traces visually. You can set the following display control options:

Table 14-22: Display control options

Display control option	Description
Logarithmic/Linear	Select if you want to display the compared test traces on the linear or logarithmic frequency axis.
Magnitude/ Impedance/ Admittance	Select if you want to display the magnitude, impedance or admittance of the compared test traces.
Show phase chart	Select this check box to display the comparison of the phase frequency responses.
Noise filter	Move the slider to the right to filter the measurement noise.
Interpolate	Select this check box to add additional calculated values in the graph. This can be helpful for analyzing traces, especially when only a few measurement points were created.

Display control option	Description
Additional information	Select if you want to display additional information in the visual comparison. • **None** • **Resonance points** • **Significant points** which indicate all minimum/maximum values and zero points. • **Noise** which indicates, for example, the power frequency noise and its harmonics.

1. To rename a test trace group, click the group name, and then type a new name.
2. To remove a test trace from the group, select the test trace, and then click **Remove trace**.
3. To close the tree view, click **Close**, and to open the tree view again, click **Add traces**.

14.4   Insulation Resistance test

The Insulation Resistance test is used to import or enter data from an insulation testing device.

Table 14-23: 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 Time 2	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: $$PI = \frac{R_{600}}{R_{60}}$$
DAR calculation	Calculation of dielectric absorption ratio
Time 1 Time 2	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: $$DAR = \frac{R_{60}}{R_{30}}$$

Setting	Description
Correction factors	
Temperature correction	Select the **Temperature correction** check box to activate temperature correction.
Correction temp.	Temperature correction factor

Table 14-24: Insulation Resistance – Measurements

Setting	Description
Test data	To import a file containing test data: ▶ Click the **Add** button to browse your PC and add data from a file. To directly import data from a measurement file: 1. Open the file on your computer. 2. In the file press CTRL+A to mark all content, then press CTRL+C to copy. 3. 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	

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15 Technical data

15.1 Calibration interval of FRANEO 800

All input/output values are guaranteed for one year within an ambient temperature of 23 °C ± 5 °C/73 °F ± 10 °F and a warm-up time longer than 25 min. Technical data is subject to change without notice.

15.2 FRANEO 800 specifications

Table 15-1: General specifications

Characteristic	Rating
Frequency range	1 Hz…30 MHz
Source output	
Output impedance (In the frequency range 20 Hz…2 MHz.)	50 Ω ± 2%
Connector	BNC
Wave form	Sinusoidal signal
Amplitude	10 V_{pp} at 50 Ω load
Reference and measurement inputs	
Input impedance (In the frequency range 20 Hz…2 MHz.)	50 Ω ± 2%
Connectors	BNC
Input sensitivity	10 V_{pp}
Dynamic range (In the frequency range 20 Hz…2 MHz.)	>150 dB (+10 dB…< −140 dB noise $floor_{RMS}$)

Table 15-2: Accuracy (in the frequency range 20 Hz…2 MHz)

Attenuation	Typical	Guaranteed
0 dB…−50 dB	±0.1 dB	±0.3 dB
−50 dB…−100 dB	±0.3 dB	±0.5 dB

Table 15-3: Frequency accuracy

Frequency Range	Guaranteed
1 Hz…3 Hz	0.3%
3 Hz…20 Hz	0.1%
20 Hz…30 MHz	0.02%

The *FRANEO 800* is equipped with a 25 MHz frequency oscillator which has an accuracy of ±30 ppm.

Table 15-4: Phase accuracy (in the frequency range 20 Hz…2 MHz)

Phase accuracy	Rating
±10 dB… –80 dB	±1º
–80 dB…–100 dB	±5º

15.3   Power supply specifications

Table 15-5: AC power supply specifications

Characteristic	Rating
Input	100 V…240 V AC/50…60 Hz/700…350 mA
Output	18 V DC/1.33 A

15.4   Environmental conditions

Table 15-6: Climate

Characteristic		Rating
Temperature	Operating	–10 °C…+55 °C/+14 °F…+131 °F
	Storage (For the reduction of the battery's lifetime with the storage temperature, see Table 15-7: "Aging speed" later in this section.)	–35 °C…+55 °C/–31 °F…+131 °F
Max. altitude	Operating	5 000 m/16 400 ft
	Storage	12 000 m/40 000 ft

Storing the battery at higher temperatures reduces the battery's lifetime as shown in the following table.

Table 15-7: Aging speed

Storage temperature	Aging speed
+25 °C/+77 °F	Normal
+45 °C/+113 °F	4 times faster
+55 °C/+131 °F	12 times faster

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15.5   Mechanical data

Table 15-8: Mechanical data

Characteristic	Rating
Dimensions (w × h × d)	25.2 cm × 5.5 cm × 26.9 cm/ 9.9 inch × 2.2 inch × 10.6 inch
Weight	1.82 kg/4.0 lb (without measuring cables)

15.6   Standards

Table 15-9: Standards conformity

EMC, safety		
EMC	IEC/EN 61326-1 (industrial electromagnetic environment) FCC subpart B of part 15, class A	CE TÜV SUD
Safety	IEC/EN/UL 61010-1	
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	
Application Relevant		
	IEC 60076 Edition 1.0 2012-07	
	IEEE C57.149™-2012	
	DL/T911-2004	
	NCEPRI	
	CIGRE A2.26 - 342	

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