

TRAX

Transformer and Substation Test System

User's Manual



Megger

WWW.MEGGER.COM

TRAX

Transformer and Substation Test System

User's Manual

NOTICE OF COPYRIGHT & PROPRIETARY RIGHTS

© 2016, Megger Sweden AB. All rights reserved.

The contents of this manual are the property of Megger Sweden AB. No part of this work may be reproduced or transmitted in any form or by any means, except as permitted in written license agreement with Megger Sweden AB. Megger Sweden AB has made every reasonable attempt to ensure the completeness and accuracy of this document. However, the information contained in this manual is subject to change without notice, and does not represent a commitment on the part of Megger Sweden AB. Any attached hardware schematics and technical descriptions, or software listings that disclose source code, are for informational purposes only. Reproduction in whole or in part to create working hardware or software for other than Megger Sweden AB products is strictly prohibited, except as permitted by written license agreement with Megger Sweden AB.

This device contains software that is licensed under the General Public License (GPL). If requested, a copy of the source code licensed under the GPL can be sent to you. Please e-mail your request to se-gplrequest@megger.com. Please note that no questions regarding the content of the source code can be answered. You may be charged a fee covering the costs of sending you the source code.

TRADEMARK NOTICES

Megger® and Programma® are trademarks registered in the U.S. and other countries. All other brand and product names mentioned in this document are trademarks or registered trademarks of their respective companies.

Megger Sweden AB is certified according to ISO 9001 and 14001.

Postal address:

Megger Sweden AB
Box 724
SE-182 17 DANDERYD
SWEDEN

Visiting address:

Megger Sweden AB
Rinkebyvägen 19
SE-182 36 DANDERYD
SWEDEN

T +46 8 510 195 00 seinfo@megger.com
F +46 8 510 195 95 www.megger.com



Contents

1 Introduction

.....	6
1.1 Product description	6
1.2 Features and benefits	6
User interface.....	6
1.3 Warranty	7
Receiving Instructions.....	7
Warranty repair.....	7

2 Safety

.....	8
2.1 General.....	8
Symbols	8
Warning and Caution Notices	8
Open ground detection.....	8
Instrument safety	8
2.2 Safety instructions.....	9
Maintenance.....	10

3 Controls, indicators and connectors .. 12

3.1 Side panel.....	12
3.2 Top panel.....	13
Screen and control knob	13
Communication and safety	14

4 Basic operating description

.....	16
4.1 General.....	16
Manual and configured tests.....	16
Test object information (nameplate)	16
Create a test session in advance	16
Use measurement as template	17

5 Operating instructions

.....	18
5.1 Main menu	18
Turn off TRAX	18
Global settings.....	18
GUI Settings	19
5.2 Manual Control	21
Buttons in the apps	21
Control knob	22
Generator settings	22
App settings.....	23
5.3 Manual control application examples	26
Resistance measurements.....	26
Excitation current (impedance) measurements.....	26

Zero-sequence impedance measurements	27
Power transformer turns-ratio measurements.....	28
CT excitation current.....	28
CT ratio with voltage.....	28
CT ratio with current.....	29
Voltage withstand measurements.....	29
5.4 Contact resistance	30
Settings.....	30
Connection for measurement.....	31
5.5 Winding resistance	32
Transformer configuration (Vector diagram)	33
Connection for measurement.....	34
5.6 Demagnetization	36
Step-by-step instructions.....	37
5.7 Turns ratio	37
Transformer configuration.....	37
Step-by-step instructions.....	38
5.8 Excitation current	39
Step-by-step instructions.....	40
5.9 Short-circuit impedance / Leakage reac- tance	41
Transformer configuration.....	41
Step-by-step instructions.....	42

6 Data handling and reporting 44

6.1 General.....	44
6.2 Test object configuration.....	44
No configuration – Manual test.....	44
Test configuration	44
6.3 Save and report	45
Action buttons.....	45
Save a test in a report file.....	45
6.4 Load file.....	46
Delete files.....	47
6.5 Load Template	47
6.6 TRAX logfile.....	48

7 Remote control and communication ports 50

7.1 Communication ports	50
7.2 Remote control	50
Connecting a device to TRAX.....	50
Off-line (simulation) mode.....	51

8 Update TRAX **52**
8.1 Upgrading 52
 Upgrading via Internet 52
 Upgrading via USB 52
 Getting a TRAX (USB) upgrade via PC..... 52
9 Specifications **54**
Specifications TRAX 54
Index **56**

1 Introduction

1.1 Product description

TRAX™ is a unique testing instrument designed to accomplish routine and advanced diagnostics on power, distribution and instrument transformers as well as on many other substation components.

A wide range of AC DC current and voltage sources together with high precision metering instrumentation allow TRAX to be used in a wide range of applications such as resistance, ratio, excitation, impedance and primary measurements of power system components.

TRAX is a unique test system for testing power transformers, CTs, VTs, and a variety of other power components. TRAX is capable of providing up to 800 A and 2200 V (up to 2000 A and 12000 V with optional accessories) with a frequency range of 5-505 Hz (1-505 for insulation testing) and can be controlled via integrated touch-screen or an external computer device with a web browser. The compact design weighs in at only 26 kg (TRAX220) and can be shipped in its transportation case within the limits of check-in luggage (< 32 kg).

1.2 Features and benefits

- Multi-function system for transformer/substation testing
- Flexible AC / DC current and voltage sources for a variety of tests.
- State of the art measurement methods for advanced diagnostic testing
- Variable output frequency for accurate measurements in high interference environments
- Compact and lightweight

User interface

TRAX user interface architecture is based on a number of individual test setups/"instruments", in this manual called "Apps", where only the necessary functionality is displayed by default. All Apps are "ready to go" in manual test mode without doing any specific settings. Just select the amplitude of the test signal and press start/play. If you prefer guidance from TRAX on how to perform the measurement, enter the configuration and TRAX will provide connection diagrams and a table with the order of measurements. And if a specific non-standardized measurement is needed, the "Manual Control" instrument can be used to generate any voltage or current test signal and measure the necessary parameters.

All results can be stored and reported as a specific report containing test object information and all tests or as data to be imported in e.g. Excel. When testing a certain substation component, e.g. a power transformer, all measurements from different Apps can be collected in one report/file. It is also possible to use a former measurement as a template for a new test session.

Applications

A wide range of voltage and current levels can be achieved and measured with high precision which allows the test system to be used for a wide range of applications such as ratio, excitation current, winding and contact resistance, impedance, tan delta/power factor testing and various other measurements of power system components.

- Examples are:
- Power transformer
- Current transformer
- Voltage transformer
- Resistance testing
- Primary injection testing

1.3 Warranty

Products supplied by Megger are warranted against defects in material and workmanship for a period of one year following shipment.

Our liability is specifically limited to replacing or repairing, at our option, defective equipment.

This warranty does not include batteries, lamps or other expendable items, where the original manufacturer's warranty shall apply.

We make no other warranty. The warranty is void in the event of negligence and/or abuse (failure to follow recommended operating procedures) or failure by the customer to perform specific maintenance as indicated in this manual.

Receiving Instructions

- Check the equipment received against the packing list to ensure that all materials are present. Notify Megger of any shortage.
- Examine the instrument for damage occurred in transit. If damage is identified, file a claim with the carrier at once and notify Megger giving a detailed description of the damage.
- The instrument has been thoroughly tested, calibrated and inspected to meet rigid specifications before being shipped. It is ready for use when set up as indicated in this user manual.

Warranty repair

Equipment returned to the factory for repair must be shipped prepaid and insured.


Contact your Megger representative for instructions and a return authorization (RA) number.


Please indicate all pertinent information, including problem symptoms.

Also specify the serial number and the catalog number of the unit.






2 Safety

2.1 General

 **Important**
 Read and comply with the following instructions.
 Always comply with local safety regulations.


 **Caution**
 Caution, as used in this manual, is defined as a condition or practice which could result in damage to or destruction of the equipment or apparatus under test.

Symbols

	Caution, refer to accompanying documents.
	Protective conductor terminal/test ground.
	Ground For connecting an additional ground between the main unit and accessories or to ground external objects e.g. optional trolley.
	Open ground = the ground Loop Detector will indicate that the separate "Test Ground" on the side panel is not connected to safety/chassis ground.
	WEEE, Waste Electrical and Electronic Equipment. Please utilize your local WEEE collection facilities in the disposition of this product and otherwise observe all applicable requirements.

Warning and Caution Notices

Warning and caution notices are used throughout this manual where applicable and should be strictly observed. These notices appear in the format shown below and are defined as follows:

 **Warning**
 Warning, as used in this manual, is defined as a condition or practice which could result in personal injury or loss of life.

Open ground detection

- The unit has an open ground detection circuit which gives alarm if the mains outlet ground is missing or different from the station/test specimen ground. The alarm can be configured by the user to give an alarm only or actually lock the unit and prohibit any test signal generation.
- The mains outlet must have a PE, protective earth (ground) connected to station ground. Normally mains outlet PE is connected to station ground. If that is not the case there are two alternatives:
 - In compliance with local safety regulations and permits, use an isolation transformer where the secondary side Earth/Ground is to be connected to station ground using a separate ground cable (not via TRAX unit!)
 - In compliance with local safety regulations and permits, use a temporary grounding connection by connecting mains outlet ground with station ground.

Instrument safety

- This instrument operates from a single-phase power source. It has two-pole terminal with ground connector and requires a two-pole, 16A, three-terminal, voltage and ground type connector. The voltage of the power source must be within the following rated operating voltage: 100-240 V ± 10 %, 47/63 Hz.
- Before making connection to the power source, determine that the instrument rating matches the voltage of the power source and has a suitable two-pole terminal with ground connector.

-
3. The power input plug must be inserted only into a mating receptacle with a ground contact. Do not bypass the grounding connection. Any interruption of the grounding connection can create an electric shock hazard. Determine that the receptacle is properly wired before inserting the plug.

2.2 Safety instructions

1. It is not possible to eliminate all potential hazards from, and in using, electrical test equipment. For this reason, every effort has been made to point out in this instruction manual the proper procedures and precautions to be followed by the user in operating this equipment and to mark the equipment itself with precautionary warnings where appropriate. It is not possible to foresee every hazard which may occur in the various applications of this equipment. It is therefore essential that the user, in addition to following the safety rules in this manual, also carefully consider all safety aspects of the test before proceeding.
 2. The test set and the specimen to which it is connected are a possible source of high-voltage electrical energy and all persons making or assisting in tests must use all safety practice precautions to prevent contact with energized parts of the test equipment and related circuits.
 3. Persons actually engaged in the test must stand clear of all parts of the complete high-voltage circuit, including all connections, unless the test set is de-energized and all parts of the test circuit are grounded. Persons not directly involved with the work must be kept away from test activities by suitable barriers, barricades, or warnings.
 4. Treat all terminals of high-voltage power equipment as a potential electric shock hazard. There is always the potential of voltages being induced at these terminals because of proximity to energized high-voltage lines or equipment.
 5. Always ground connection points of the test specimen before connecting any leads from the test set. Whenever possible, always keep one side of the test specimen grounded at all times. Always use a safety ground stick to ground any high-voltage conductor.
 6. The ground connection on the test set must be the first made and the last removed. Any interruption of the grounding connection can create an electric shock hazard.
 7. Make sure that the instrument is properly grounded, both through its AC power cord and through the ground connector. The AC power cord is the disconnecting device.
 8. Always disconnect test leads from test specimen before attempting to disconnect them at the test set.
-

9.	High-voltage discharges and other sources of strong electric or magnetic fields may interfere with the proper functioning of heart pacemakers. Persons with heart pacemakers should obtain expert advice on the possible risks before operating this equipment or being close to the equipment during operation.	3.	Read and understand Safety in the User Manual before performing any service.
10.	All persons making or assisting in tests must use all practical safety precautions to prevent contact with energized parts of the test equipment and related circuits. Also follow all local and company safety requirements. Persons actually engaged in the test must stand clear of all parts of the complete high-voltage circuit, including all connections, unless the test set is de-energized and all parts of the test circuit are grounded. Persons not directly involved with the work must be kept away from test activities by suitable barriers, barricades, or warnings.	4.	Routine maintenance is all that is required for these test sets. The cables and connector panel should be inspected frequently to be sure all connections are tight and all ground connections intact.
11.	Safety is the responsibility of the user.	5.	The appearance of the test set can be maintained by occasional cleaning of the case, panel and cable assemblies. The outside of the carrying case can be cleaned with detergent and water. Dry with a clean, dry cloth. The control panel can be cleaned with a cloth dampened with detergent and water. Do not allow water to penetrate panel holes, because damage to components on the underside may occur. A household all-purpose spray cleaner can be used to clean the panel. Polish with a soft, dry cloth, taking care not to scratch the display screen cover. The cables and mating panel receptacles can be cleaned with isopropyl or denatured alcohol applied with a clean cloth.
12.	Misuse of this high-voltage equipment can be extremely dangerous.		
13.	The purpose of this equipment is limited to use as described in this manual. Do not use the equipment or its accessories with any device other than specifically described.		
14.	Before making any connections, make sure that the instrument is de-energized and that all parts of the test circuit are properly grounded.		
15.	Never connect more than one output at the time. All outputs are energized by the same amplifier and therefore all outputs are energized simultaneously.		
16.	Operation is prohibited in rain or snow.		
17.	Do not use the test set in an explosive atmosphere.		
18.	A qualified operator should be in attendance at all times while the test equipment is in operation.		
19.	Observe all safety warnings marked on the equipment.		
20.	Corrective maintenance must only be performed by qualified personnel who are familiar with the design and operation of the test set and the hazards involved.		

Maintenance

1. DISCONNECT the MAINS plug before any cleaning or maintenance.
2. Maintenance should be performed only by qualified personnel familiar with the hazards involved with high-voltage test equipment.

3 Controls, indicators and connectors

3.1 Side panel



- 1. 0-2200 V AC**
1 A (max 1 minute). The output is additionally disconnected with a relay and the output is "live" only when this generator is selected.

- 2. 0-250 V AC / 0-10 A**
10 A (max 1 min)

- 3. 0-16 A DC**
0-1 or 0-16 A continuous

- 4. 0-300 V DC**
Rectified AC, max 10 A for 1 minute


- 5. 0-100 A DC**
100 A (max 2 minutes, continuous 70 A)

- 6. 0-200 A AC / 0-800 A AC**
TRAX 220: 0-200 A (6 V), TRAX 280: 0-800 A (6 V)

- 7. AUX CONTROL**
Ethernet communication and power (54 V DC) to accessories.


- 8. F1 F2**
Main fuses 25 A

- 9. POWER**
Output 0-235 V AC directly from power amplifier for powering accessories, TRAX TDX and TRAX TCX.

- 10.  Test Ground**
To be connected to the test object ground before connecting any other cables to the unit.

- 11. Mains >265 V AC**
LED is lit if mains voltage exceeds 265 V. An electronic protection switches off the generation.

- 12. MAINS INPUT 100-240 V AC, 16 A, 50/60 Hz**
Single phase + Ground.

- 13.  Ground**
For connecting an additional ground between the main unit and accessories or to ground external objects e.g. optional trolley.



WARNING

The outputs 1, 2, 4 and 6 are connected internally to the same output transformer and should be considered "live" when one of the outputs is activated. Never connect more than one output at a time.

Test objects should be grounded at one end to minimize risk for high voltage interference entering the instrument.

3.2 Top panel



Screen and control knob

1. Capacitive touch screen.
2. Control knob for controlling selected output generator. Press to change value for the incremental steps (e.g. 1V, 2V, 5V, 0.1V). Used as pairing device when connecting TRAX for external control via Ethernet or Wifi cursor up/down when reading reports.

Communication and safety



1. Ethernet port for running the instrument from an external PC or connect it to an external network.
2. Three USB ports for multipurpose use: USB memory stick, external mouse or keyboard.
3. **INTERLOCK 2**
Manual interlock. If activated, the power amplifier shuts off when the interlock is open.
Note *Interlock 2 can not be deactivated for 2.2 kV output and when using the TDX120 accessory.*
4. Ground Loop Indicator
This yellow LED will indicate if the GROUND connector on the side panel is not connected to the same external ground as the mains outlet. See section "Safety" for details.
5. **INTERLOCK 1**
Fixed interlock with key switch. If the key is in the OFF position, or is not in the unit, the power amplifier is OFF.
6. Connector for Wifi antenna, making it possible to run the instrument wireless from a PC or tablet (option).
7. Communication Speaker
Beeper under the panel for sound indicator.
8. **ON / OFF**
Press button for 1 second and the instrument will start.
Press for 3 seconds and the instrument will shut off.
9. **STROBE**
External strobe is optional, but when connected, it will flash while generating voltage/current.

10. SAFE

Green LED indicates that the instrument is in a safe state for connecting and disconnecting of cables.

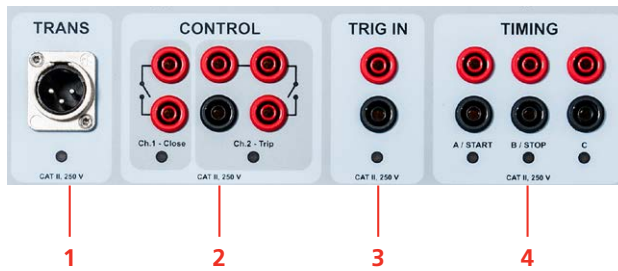
11. ACTIVE Indicator

Red LED continuous light – Instrument is ready for generating voltage/current (armed).
Red LED flashes – Instrument is generating a voltage or current or discharging an inductive circuit after a DC test (winding resistance measurements).

12. EMERGENCY

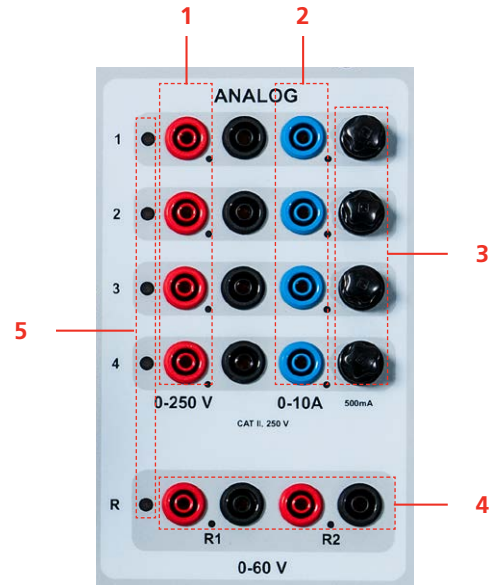
ESD – Emergency shut down button.

Transducer, binary outputs and timing



- 1. TRANS**
General input for analog transducers and low level analog signals e.g. motion transducers, Rogowski coils etc.
- 2. CONTROL**
close/open contacts for OLTC and circuit-breaker control (up-down, close-trip)
- 3. TRIG IN**
External trig input for starting measurements or recording based on external event.
- 4. TIMING**
Binary inputs for timing measurements in timer and relay testing applications when used as a timer. A and B inputs dedicated for Start and Stop.

Analog inputs



- 1. VOLTAGE INPUTS**
Four channels 0-250 V AC, 0-350 V DC
- 2. CURRENT INPUTS**
Four channels 0-10 A AC, 0-10 A DC

Note *Voltage and current cannot be measured on the same channel simultaneously.*

- 3. FUSES**
4 x 500 mA/25 V AC fast, can be changed from the outside, protects the low current gain shunt. Inside the top panel, there are 4 x 15 A/250 V AC fast fuses for the high current gain step
- 4. DC INPUTS**
These two channels (R1 & R2) are designed for measuring low DC voltage when measuring contact and winding resistance, using the 100 A or 1 to 16 A DC current outputs. If the channels are used for measuring AC, max input is 40 V RMS.
- 5. LED INDICATORS**
Red LED's indicate which channel to connect to depending on what App is used.

4 Basic operating description

4.1 General

TRAX measurements are collected together in tests and test sessions. A test is often containing several individual measurements and a TRAX test session/file/report often contains several tests performed with different apps.

Manual and configured tests

Manual Control

Manual tests can be done by using Manual Control where you define exactly what generator to use, type of test signal, how results are measured and how parameters are calculated. This gives unlimited possibilities to perform almost any AC or DC test on any electrical component within the limits of TRAX generating capabilities.

Results from Manual Control measurements for a certain setup are collected in a result table. If the test setup is modified due to change of measurement channels and/or calculated parameters, the new results are collected in a new test/results table.

Manual test

It is also possible to use TRAX as a manual standard instrument. This operation mode is defined as "Manual Test/No configuration" and is available in all the transformer testing apps. Compared to Manual Control, this operation mode is locked to a certain application. As an example, winding resistance measurements in manual mode is limited to using any of the three DC current generators and one or two DC measurement inputs.

Results from Manual Test measurements for a certain setup are collected in a results table. If the test setup is changed by e.g. changing from single to dual channels (simultaneous winding magnetization) winding resistance, the new results are collected in a new test/result table.

Configured test

Configured tests are defined by entering information about the test object, as is the case of vector group and configuration of a power transformer, if there is a tap-changer or not and if so on what winding and

how many taps. From that the TRAX app is mastering the test and you have to perform the test following the connections described by the unit to get the automatic assessment of the test.

Also here the app measures one setup at a time. As an example, if the test object is a three-winding transformer, TTR measurements may be performed for three setups, HV-LV, HV-tertiary and LV-tertiary. Each of these is done as a separate test with a separate test table, collected together in the same test session.

Test object information (nameplate)

Test object/nameplate information must be entered for any configured test and will be part of the test report. The mandatory information needed for a certain app is asked for and added to the report. The next app will have the same information automatically but may need some additional information to be added. After all tests you can go to the report and add any information that is still missing.

Create a test session in advance

If a test session needs to be defined before the test is actually performed, the workflow is the following:

- 1] Open the first app and define the test object, define parameters such as: transformer vector group.
- 2] Name and save (the empty) test.
- 3] Go to the report and fill in all necessary information for the test object and all planned tests.
- 4] Open the next app to create a test table
- 5] Save and go to the next app. Continue as above for all desired apps.
- 6] Finally check the report once again to see that all the needed data is entered and that all planned tests are there.
- 7] Confirm/save and close.

At the site


- 1] Load the report that was created for the test object.
- 2] Go from report to a certain app to perform the specific measurements as guided by TRAX.
- 3] Save and go to the next app. Continue as above for all desired apps.

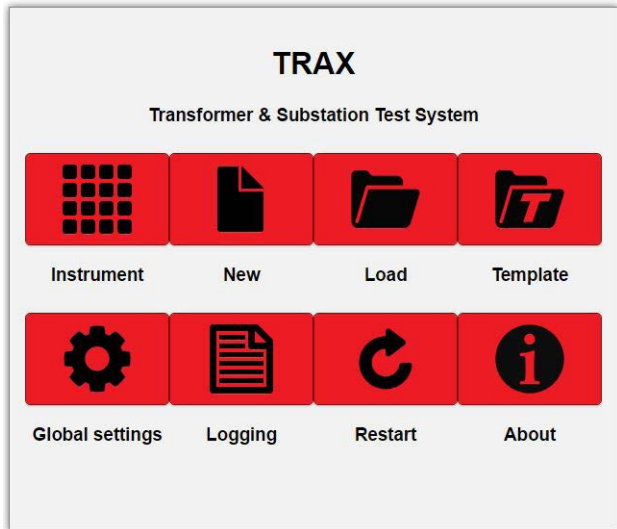
Use measurement as template

If a new test object is very similar to an already existing test object, the old test session can be used as template for the new test. By selecting "Load template" in the home view, the old test will open with a new date and no results. By copying the test under a new name it will be stored and can be used as template with any necessary changes.

5 Operating instructions

5.1 Main menu

1] Press  for one second to turn on TRAX.



	<p>App</p> <p>Selecting app. If this is the first app selected after starting the unit, TRAX prepares itself for a new test session. If previous tests are performed, TRAX continues with the same session (see section "Data handling and reporting")</p>
	<p>New</p> <p>New test file/session/report</p>
	<p>Load</p> <p>Load a saved test session/report</p>
	<p>Template</p> <p>Load a saved test as template for a new test session</p>
	<p>Global settings</p> <p>Global settings for all apps</p>

	<p>Logging</p> <p>Opens the dialog for reading and downloading TRAX logfiles with single measurements (see section "Data handling and reporting")</p>
	<p>Restart</p> <p>Restart the TRAX SW (but not the HW)</p> <p>Note <i>When TRAX is operated from a PC, shortcut key F5 can also be used for restart</i></p>
	<p>About</p> <p>Information; SW version, serial number, internal temperatures etc.</p>


Top menu buttons

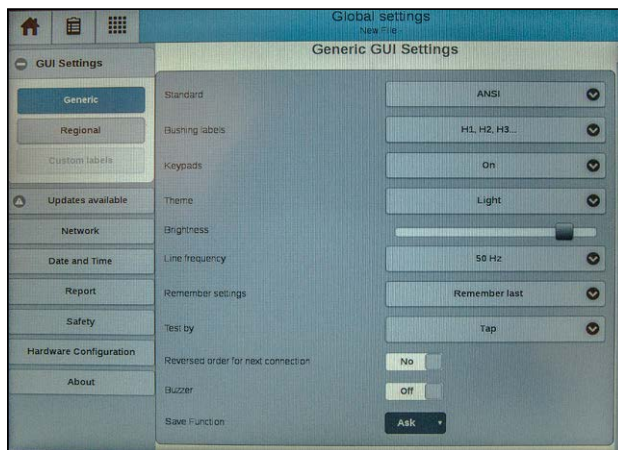
	Home screen
	Report view
	For selecting apps to be shown under corresponding menu tab.
	Safe eject of all USB drives connected to the TRAX

Turn off TRAX

1] Press  for 3 seconds to turn off TRAX.

Global settings

- 1] Press  for the global settings.
- 2] Press the button "+ GUI Settings"
A window with the following fields opens.



GUI Settings

Generic	
Standards	ANSI or IEC
Bushing labels	ANSI/IEC standard or user defined
Keypads	Virtual keyboard can be turned on or off (e.g. when using external computer).
Theme	Change GUI color scheme
Brightness	Adjustment for the screen brightness
Line frequency	60, 50, 25 or 16 2/3 Hz
Remember settings	Remember last means that TRAX starts with settings and configuration as in the last performed individual measurements and configuration. In default setting, TRAX starts with factory settings. (Not visible in offline mode).
Test by	Transformer test tables are organized by tap or winding.
Reversed order for next tap	Transformer test tables are organized with mid-phase in reversed tap order. Note: It is also possible to change tap order in a specific test by clicking on "Tap" in the test table
Buzzer	On/Off

Save Function

- **Auto:** TRAX will create a file directly when the first (new) app is opened and ask for name and location for saving. After this, every measurement and/or change will be automatically saved.
- **Ask:** Upon closing an app or a test session without manual saving, TRAX checks if anything has changed in the test or session and if so, will ask the user to save changes or not
- **Never/Manual:** The user decide when and what to save manually. TRAX will not give any save reminder messages ("multimeter mode").
Note: Even in manual ("never") save mode, TRAX will collect tests in a "temporary" report/file which makes it possible to save all or some of the collected results

Regional

Language	Select language
Keyboard	Select language for on-screen keyboard
Decimal separator	Select point or comma
Time format	Hours:minutes:seconds in 24 or 12 hour format
Date format	Select date format

Custom labels

Define specific terminal naming

Updates (Remote)

Note For details on TRAX updates see chapter "8 Update TRAX" on page 52

Release track	TRAX main SW version
Download	Get the available file
Create	Copy the update file to USB (remote PC only)

Updates TRAX stand-alone, direct connect

Release track	TRAX main SW version
Download	Get the available file
Install	Selected update is installed

Updates TRAX stand-alone via USB

Insert a USB stick with a valid TRAX update (from remote update)

Source	Select USB
Download	Get the available file from USB
Install	Selected update is installed

Network

Settings for TRAX remote operation. Not available in offline mode.

Report

Test Object	Define naming for the first ID fields in the report.
Header Fields	Select fields to be used for identification in TRAX.

Safety

Interlock	Interlock 2 can be selected as mandatory for all TRAX generators/outputs. If turned off, interlock 2 is only mandatory for 2 kV and 12 kV* generator. *TDX120 optional accessory
Ground loop detector	Can be turned on/off for all generators except 2 kV

Note:
Settings are not available in offline mode


Hardware Configuration

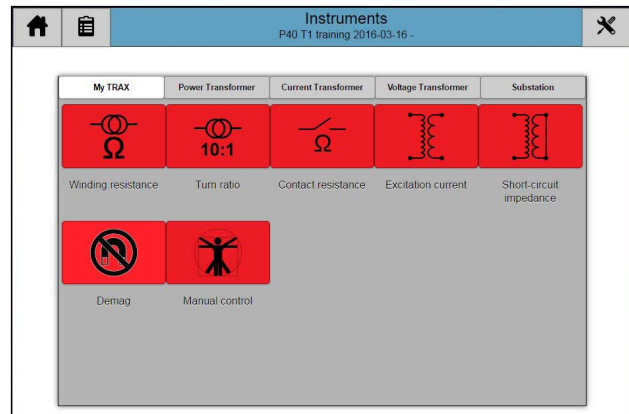
Internal Transformer size

About

About	HW and SW version information
Temperature	Temperatures in TRAX internal parts
Legal Notices	Legal information





Apps




1] Press  to access the different apps.



My TRAX	In "My TRAX" you can place your favourite apps for easy access by opening the "Tools" screen and activate a certain app.
Power Transformer	Apps suitable for testing power transformers.
Current Transformer	Apps suitable for testing current transformers.
Voltage transformer	Apps suitable for testing voltage transformers.
Substation	Apps suitable for general testing in substations.

Short description

	The winding resistance app is used for measuring DC resistance in transformer windings and other objects with high inductance.
	Turns ratio measurements on transformer windings (TTR).
	Contact resistance app is used for DC low resistance measurements on resistive loads.
	Excitation current app is used for measuring current and impedance on one side of a transformer with the opposite windings open.

 <p>Short circuit impedance</p>	<p>Short-circuit Impedance/Leakage Reactance app is intended for impedance measurements on the HV side of the transformer with the LV side shorted.</p>
 <p>Demag</p>	<p>Demagnetization of transformer core, recommended before and after testing a transformer and in particular before excitation current and/or SFRA measurements.</p>
 <p>Manual Control</p>	<p>Manual Control is used to operate TRAX in manual mode.</p>

5.2 Manual Control



Important

Read and comply with the safety instructions "2 Safety" on page 8. Always comply with local safety regulations.

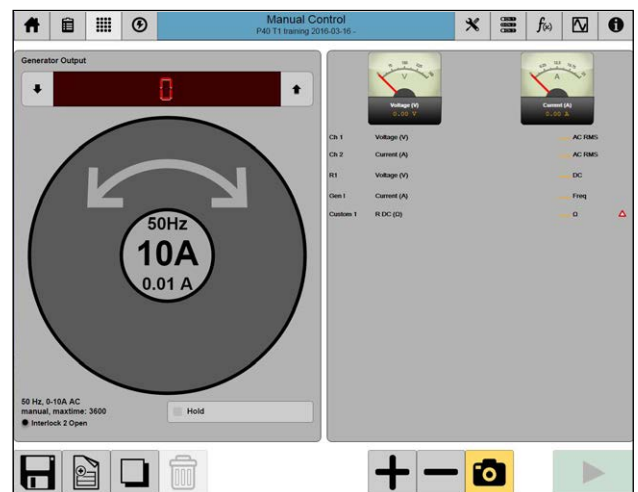
1] Press

Output generators and input channels can be selected to perform a variety of measurements.








TIP














All generators and analog measurement channels except transducer input and timing channels can be accessed from Manual Control.








Buttons in the apps

Buttons described below are common to most of the apps.

	Home
	Report
	Return
	Apps
	Generator settings

	App settings
	Measurement channel selection
	Calculated parameters
	Oscilloscope
	Information; SW version, internal temperatures etc. The icon changes color depending on the internal temperature: Green = OK Yellow = Attention Red = Warning
	Help on app screen wiring diagrams. Note: Not in Manual Control.
	Saves the test results to report/file. If it is the first test TRAX will ask for filename and location.
	Starts a new test for the same test session. The new test will be reported as a new table if Manual Control is used for various tests that you want to save and report as separate tests.
	Shows result as a diagram Note: Not in Manual Control.
	Displays the individual measurements in the test in a table format. Click one more time to return to the control view.
	Delete
	Notes Note: Not in Manual Control.
	Demagnetization Note: Not in Manual Control.
<input type="checkbox"/> Hold	Click the checkbox to hold / freeze values for reading without capture data to the test.

	The + button operate the output contact Ch 1.
	The - button operate the output contact Ch 2.
	Activating + or - buttons closes the contact for about 500 ms. After one operation the contacts are blocked for about 2 seconds before the next operation is possible.
	When the button is pressed, TRAX performs a measurement while the test signal continues.
	Start and stop the generator.
	Output signals and selected measurement signals are continuously displayed and updated on the analog meters and in the results. When the generator is stopped, measurement data and calculated parameters are (setting, can be selected on or off) automatically captured and displayed and added to the test.


Control knob



The on screen control knob is used in a similar way as the control knob on panel.

- 1] Press to change value for the incremental steps (0.1 V, 1 V, 2 V, 5 V).
- 2] Press and drag according to the arrows to increase/decrease the value.
- 3] Sensitivity/scaling can be adjusted by pressing in the middle of the control knob

Generator settings

- 1] Press  to make the generator settings.
- 2] Press the "Output" button to select generator output.

Output: 0.250 V AC

Manual

Frequency (Hz): 50

Max. time (s): 3600

Start ramp (s): 1

Fix ramp (s): 60

Stop ramp (s): 1

OK Cancel

The following outputs are connected internally to the same output transformer and should be considered "live" when one of the outputs is activated.

- 0-2200 V AC
- 0-250 V/10 A AC
- 0-300 V DC
- 0-200/800 A AC

The 2.2 kV output is additionally disconnected with a relay and the output is "live" only when this generator is selected to be used.

The 1, 16 and 100 A DC current outputs are intended for resistance measurements.

3] Make settings for "Frequency".

4] Select "Manual" or "Ramp".

In manual mode the generator is started instantly. A maximum generating time can be set.

In ramp mode, the output signal amplitude is increased continuously, hold at the set value and decreased back to zero. Ramp and hold times are selectable.



Warning

The Manual Control is not designed for resistance measurements on inductive loads.

Note *If Manual Control is used for resistance measurements on inductive loads, manual setting with small and slow adjustment of test current should be used. For measuring highly inductive loads, e.g. transformer windings, the winding resistance app should be used.*

App settings

1] Press 

Integration/measurement time: 1

Averaging: 1

Display update frequency: 2

Data capture and hold at generator stop

Hold on stop

Store data on stop

OK Cancel


Integration / measurement time	Integration time for the individual measurement record
Averaging	Number of averaged measurement records in the measured value
Display update frequency	Interval for updating displayed values (Time per measurement record)

Example: 1,1,1 means that a measurement is performed over 1 s, no additional averaging and the display is updated every second. 2, 3, 1 means that a measurement is performed over 2 seconds and 3 measurements are averaged. The display shows a running average every second (2/2).

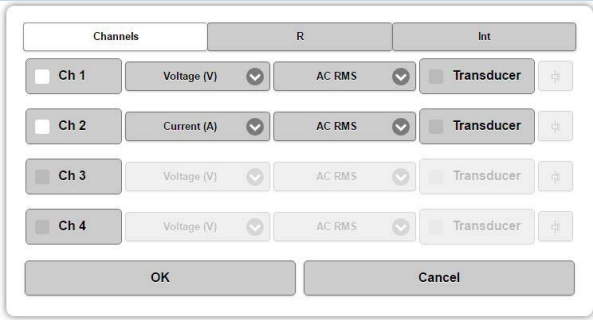
Data capture and hold at generator stop

Make desired action at generator stop, "Hold on stop" and/or "Store on stop".

App channel selection

1] Press  to select measurement channels.

Channels



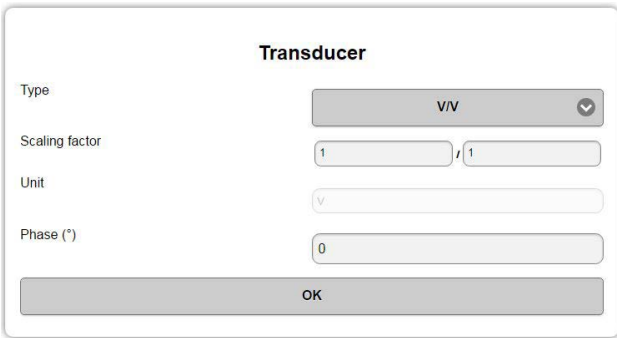
External multi-purpose AC/DC voltage or current measurement channels that are separately activated.

The measurement data can be selected to be displayed and used in calculations as:

AC RMS	RMS value of the AC component in the test signal
Freq	Narrow-band data for the selected frequency (factory default)
RMV	Rectified Mean Value of signal multiplied by 1.11 to equivalent RMS value
DC	DC value

Transducer

Transducers can be used to convert a measurement signal to an appropriate current or voltage signal to be measured by TRAX, e.g. active current clamps (current to voltage).



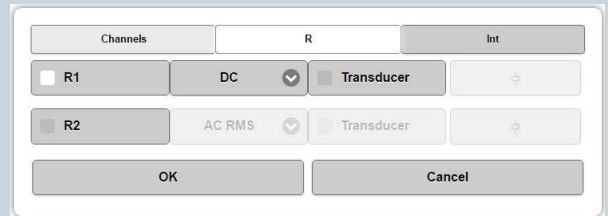
Voltage measurement channels	
Type	V/V V/A V/Custom
Current measurement channels	
Type	A/A A/V A/Custom
Scaling factor	Conversion data for the transducer is entered in two fields; Output entity and input entity (+ phase deviation if applicable, default = 0)

Example:

Active current clamp, labeled 10 mV/A

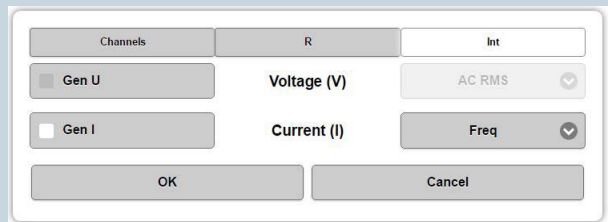
Selected type	V/A
Scaling factor	0.01/1
Unit	A (preset)
Phase	Phase deviation as stated in datasheet

R



Voltage measurement channels, R1 and R2 are intended for DC resistance measurements. But they can also be used for AC measurements and/or with transducers. If used for AC measurements (up to 60Hz, can be used for higher frequencies at somewhat reduced accuracy), the voltage must not exceed 40 V RMS.

Int



Internal measurement channels. Always active showing RMS values in the analog meters. Needs to be selected to be captured and hold and/or used for calculations.

The measurement data can be selected to be displayed and used in calculations as:

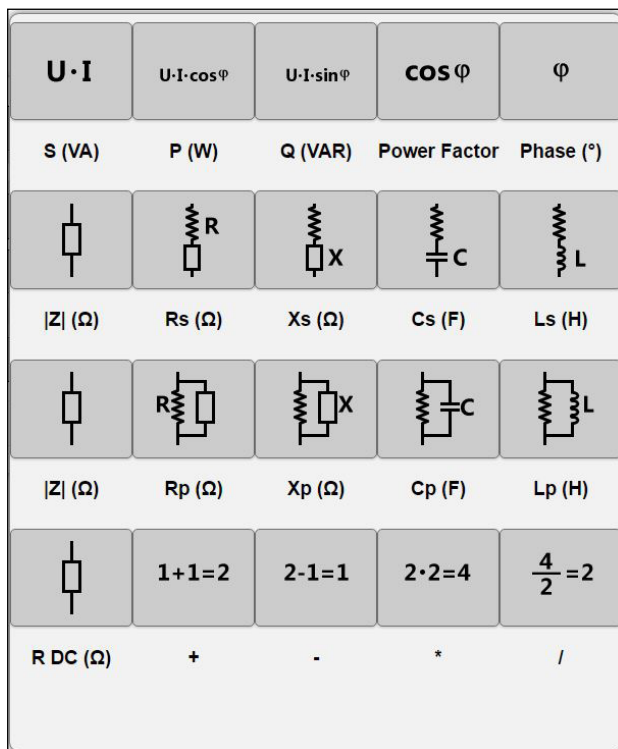
AC RMS	RMS value of the AC component in the test signal
Freq	Narrow-band data for the selected frequency (factory default)
RMV	Rectified Mean Value of signal multiplied by 1.11 to equivalent RMS value
DC	DC value

Calculated parameters

1] Press $f(x)$



The dialog activates mathematical operations on test data. Measured data can be used to calculate one or two selected parameters out of the following list:



For phase measurements, the lowest channel number is reference (e.g. phase difference between Ch 1 and Ch 2 is calculated as Ch 2 lag).

For phase related measurements e.g. Z, X etc. the value is calculated with voltage reference.

Oscilloscope

1] Press

The oscilloscope can be used to monitor measurement signals.

2] Press "Inputs" (red square) and select measurement channels for display.

3] Press "Freeze" to hold and show the oscilloscope picture.

4] To close the oscilloscope, press

Start/Stop measurements

1] Press to start the measurement.

Output signals and selected measurement signals are continuously displayed on the analog meters and in the results fields.



2] Press to stop the generator.

Measurement data and calculated parameters are captured and held. Pending app settings, the results are stored in the results table.

Note *Selected measurement channels in Manual Control are "always on" (multimeter mode) to be able to be used with or without TRAX generators. This means that values are displayed also before the TRAX generator is started.*

5.3 Manual control application examples

Important
 Read and comply with the safety instructions "2 Safety" on page 8. Always comply with local safety regulations.

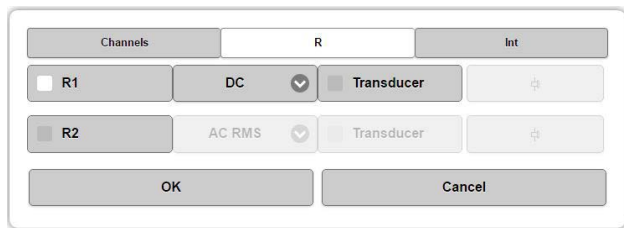
Note *The circuitry for safe discharge of inductive loads is activated in Manual Control as well as in the winding resistance app. Discharge is performed via the current output and the R1/R2 voltage measurement inputs.*

Resistance measurements

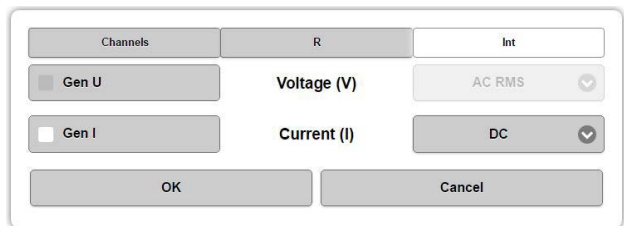
- 1] Press
- 2] Select a DC current generator 1, 16 or 100 A output (pending the resistance of the test object. Max resistance is about 10 kΩ when generating 5 mA from the 1 A generator).

Recommended test current ranges		
1 A generator	5 mA – 1 A	Resistance range 1 mΩ – 10 kΩ
16 A generator	1 A – 16 A	Resistance range 160 μΩ – 50 Ω
100 A generator	10 A – 100 A	Resistance range 10 μΩ – 5 Ω

- 3] Press
- 4] Select "R" > "R1" > "DC"

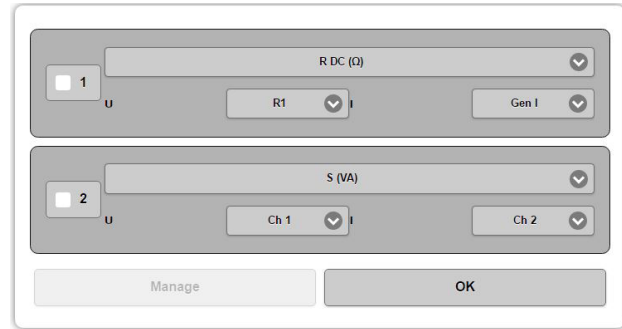


- 5] Select "Int" > "Gen I" > "DC".



- 6] Press "OK".
- 7] Press

- 8] Select resistance calculation "R DC (Ω)" using "R1" and "Gen I".



- 9] Connect current and voltage sense leads to the test object.

Note *This is a 4-wire method. Connect voltage sense leads "inside" the current leads connectors. The connectors must NOT touch each other.*

- 10] Select an appropriate test current suitable for the test object. Always use as high current as possible but avoid unintentional heating of the test object.




- 11] Press
- 12] Wait for results to stabilize.
- 13] Press and read the results.

Note *Manual Control is not designed for resistance measurements on inductive loads e.g. transformer windings. If Manual Control is used for this, manual setting with small and slow adjustment of test current should be used. For measuring highly inductive loads, e.g. transformer windings, the winding resistance app should be used.*

Note *For measuring high resistances it is possible to use a simplified 2-wire technique. Connect the 1A DC outputs directly to the R1 inputs and connect from R1 inputs to the resistor. Please observe that maximum compliance voltage is about 50 V so select a very low current when measuring in the kΩ range.*

Excitation current (impedance) measurements

- 1] Select 0-250 V or 0-2200 V generator pending the expected saturation voltage of the test object.
- 2] Select "Gen I" and "Gen U" measurement channel set to frequency to measure the excitation voltage and current and use the data for calculations.

- 3] Press $f_{(x)}$ and select e.g. "Inductance", "Impedance", "Power factor" or other parameters to get additional information of the test
- 4] Connect the generator leads to the test object.
- 5] Select an appropriate test voltage for the test object or manually control the voltage (after pressing ) and observe the excitation current for e.g. determine saturation/knee-point.
- 6] Press  to start the generator.
- 7] Wait for results to stabilize or manually control the voltage and observe the excitation current for e.g. determine saturation/knee-point.
- 8] Press  and read the results.

Note *The description above is using an internal current measurement channel and measures the total current generated into the test object. (GST-GND)*

If the test object has two parallel parts e.g. a winding in a delta configuration, the measured value is the current going through one winding in parallel with two series windings. For measuring excitation current on a single winding in a delta configuration, an external current measurement can be used and by grounding correctly a UST measurement can be performed.





Warning

When using 2.2 kV output and external ammeter, it is ABSOLUTELY MANDATORY to ground black terminal and connect the external current measurement channel to the grounded side of the generator/winding.

Short-circuit/leakage reactance measurements

- 1] Select 0-10 A AC generator.
- 2] Select Gen I measurement channel, set to freq, to measure the excitation current and use the data for calculations.
- 3] Select Ch 1, set to freq, for voltage measurement. (Gen U can be used for the measurement but for higher accuracy a separate voltage measurement using Ch 1 is recommended).
- 4] Press $f_{(x)}$ and select e.g. Inductance, Impedance, Reactance or other parameters to get appropriate data for the test.
- 5] Connect current leads and voltage sense leads to 0-10 A output and channel 1 voltage input respectively. At sample, place voltage sense leads "inside" current connectors.
- 6] Short appropriate low voltage winding (e.g. first measurement of a YNyn0, measure 1U-1N, short 2U-2N).
- 7] Select an appropriate test current for the test object. For power transformer windings, typical test current are 1 to 5 A for short-circuit impedance/leakage reactance measurements.

Note *Max compliance voltage is 250 V. When measuring small transformers with high winding resistance you need to select a lower current, (typically 100 mA or lower) to not trip the generator.*




- 8] Press 
- 9] Wait for results to stabilize.
- 10] Press  and read results.
- 11] Move to next phase and continue the test.

Note *This measurement can also be performed by using the 250V generator and adjust the voltage until the preferred test current is achieved.*


Zero-sequence impedance measurements


- 1] Select 0-250V AC generator and 55 Hz.
- 2] Select Gen I measurement channel, set to freq, to capture and hold the excitation current and use the data for calculations.
- 3] Select Ch 1, set to freq, for voltage measurement. (Gen U can be also used for the measurement


but for higher accuracy on low inductances a separate voltage measurement using Ch 1 is recommended).

- 4] Press  and select e.g. Inductance, Impedance, Power factor or other parameters to get appropriate data from the test.
- 5] Connect generator leads and voltage sense leads to 0-250V A output and Ch1 voltage input to one winding of the transformer.
- 6] Connect the other two windings of the transformer in parallel with the first winding (e.g. for a YNyn transformer A-B-C should be connected in parallel).
- 7] Press  to start the generator and adjust the voltage to get an appropriate current, typically a few amps.
- 8] Wait for results to stabilize.
- 9] Press  and read results.

Power transformer turns-ratio measurements


- 1] Select 0-250 V AC generator.
- 2] Select Ch 1 and Ch 2 for AC voltage measurements set to freq. If excitation current needs to be recorded select Gen I measurement channel set to Freq.
- 3] Press  and select ratio calculation “/” (division) between Ch 1 and Ch 2. If phase deviation is to be recorded select “Phase” between Ch 1 and Ch 2.
- 4] Connect the generator cable to the HV winding.
- 5] Connect the Ch 1 voltage measurement to the HV winding and the Ch 2 voltage measurement to the LV.



Note  This is a 4-wire method and the Ch 1 voltage measurement lead must NOT be connected “outside” or in contact with the voltage generator lead.

- 6] Select an appropriate test voltage for the test object. For power transformer windings, use 250 V for highest accuracy.
- 7] Wait for results to stabilize.
- 8] Press  and read the results.

CT excitation current

- 1] Select 0-250 V or 0-2200 V generator pending the expected saturation voltage of the CT.
 - 2] Select frequency, typically 50 or 60 Hz.
 - 3] Activate Int “Gen U”, configure it to RMV*.
 - 4] Activate Int “Gen I” configure it to AC RMS*.
- * As stated in IEC 61869-2: 2012 and IEEE C57.13
- 5] Connect CT terminal S2/X2 to ground. Connect black generator terminal to S2/X2 and green (250V)/red (2200V) generator terminal to CT terminal S1/X1.
 - 6] Make sure that one side of primary winding P1/H1 or P2/H2 is floating (other side may be connected to ground).
 - 7] Set a start voltage level at about 1% of max generator voltage, 2.5V and 22V for respective generator.


Note  For very small CTs, start at minimum voltage 1 V.

- 8] Press  to start the generating.
- 9] Slowly increase voltage until knee point is reached, or until a certain current level is achieved e.g. 500 mA. Press data capture button to save a data point. Slowly decrease voltage in steps and after let current stabilize, capture data points.
- 10] Press .







CT ratio with voltage



Caution

 Make sure that one side of primary side winding is connected to ground at all times. Otherwise, the measurement results will be affected and the instrument may be damaged.

- 1] Select 0-250 V or 0-2200 V generator pending the expected saturation voltage of the CT. Select frequency, for highest accuracy 55Hz test frequency is recommended.
- 2] Activate Int Gen U, configure it to Freq. If excitation current is of interest, also activate Int Gen I and configure it to AC RMS.
- 3] Activate Channel Ch 1, configure it to Voltage (V) and Freq.

- 4] Press .
For calculation 1, select ratio "/" (division) between Gen U and Ch 1.
If phase deviation is to be recorded, for calculation 2, select "Phase" between Gen U and Ch 1.
 - 5] Connect CT terminal S2/X2 to ground.
 - 6] Connect black generator terminal to S2/X2 and green (250V)/red (2200V) generator terminal to CT terminal S1/X1.
 - 7] **IMPORTANT**
Connect P1/H1 (or P2/H2) to ground.
Connect Ch1 terminals to primary winding, black terminal to P2/H2 and red terminal to P1/H1.
 - 8] Select an appropriate test voltage, best accuracy is achieved at about 75% of saturation voltage.
 - 9] Press  to start the generating.
 - 10] Wait for results to stabilize
 - 11] Press  and read results.
- 4] Press .
For calculation 1, select ratio "/" (division) between Gen I and Ch 1.
If phase deviation is to be recorded, for calculation 2, select "Phase" between Gen I and Ch 1.
 - 5] Connect CT terminal S2/X2 to ground.
Connect black Ch 1 terminal to terminal S2/X2 and blue Ch 1 to terminal S1/X1.
 - 6] **IMPORTANT**
Connect P1/H1 (or P2/H2) to ground.
Connect 200A/800A current output terminals to primary winding, black terminal to P2/H2 and red terminal to P1/H1.
 - 7] Select an appropriate test current, usually rated primary current or a fraction of rated primary current.
Make sure expected resulted secondary current is lower than 1 A (IEC) or 5 A (IEEE).
 - 8] Press  to start the generator.
 - 9] Wait for results to stabilize
 - 10] Press  and read results.



TIP

If saturation voltage is unknown: start energizing with a low voltage, approximately 1% of generator max voltage. Increase the voltage slowly until excitation current starts increasing considerably (e.g. to 100 mA) and the lower voltage to about 75% of its value result in high current. Now a high accuracy measurement of "ratio with voltage" is achieved.

CT ratio with current






Caution

Make sure that one side of primary side winding is connected to ground at all times. Otherwise, the measurement results will be affected and the instrument may be damaged.

- 1] Select 0-200 A (or 0-800 A if TRAX 280) generator.
Select frequency, typically 50 or 60 Hz.
- 2] Activate Int Gen I, configure it to Freq.
- 3] Activate channel Ch 1, configure it to Current (A) and Freq.

Voltage withstand measurements

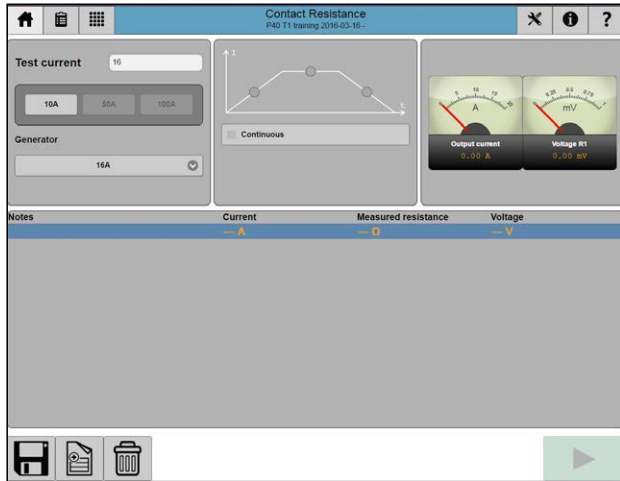
- 1] Select 2.2 kV generator and 55 Hz.
- 2] Select Gen I and GenU measurement channels set to Freq.
- 3] If insulation properties are to be measured, press  and select e.g. Cp and PF.
- 4] Connect red terminal to the actual test object and black terminal to ground
- 5] Make sure the test object is connected to ground at one end (generator black)!
- 6] Set the test voltage as high as possible with respect to the test object. In most cases 2.2 kV is used.
- 7] Press  to start the generator
- 8] Wait for results to stabilize.
- 9] Press  and read results.

Note *The test mode is GST-GND which means that the total current to ground will be measured. The test result will be affected by all stray capacitors including e.g. cables and surface current. To estimate the effect of cables (typically 50-100 pF), measure the cables without connecting to the specimen.*

5.4 Contact resistance

Important
 Read and comply with the safety instructions "2 Safety" on page 8.
 Always comply with local safety regulations.

1] Press 



Settings

1] Press 

Make desired settings for the following subjects, Ramp, Temperature correction DualGround and Integration.

Ramp

Ramp	Temperature correction	Dual ground	Integration
Ramp up time (s)		1	
Constant current time (s)		3	
Ramp down time (s)		1	
OK			

Ramp up time (s)	1, 2, 3, 5, 10 or 20
Constant current time (s)	3, 5, 10, 20, 60 or 3600
Ramp down time (s)	0.3, 1, 2, 3, 5, 10 or 20

Temperature correction

Ramp	Temperature correction	Dual ground	Integration
Temperature correction		Off	
Object temp (°C)	30		
Reference temp (°C)	70		
Material coefficient	Cu		
Custom coefficient	381.9		
OK			

Temperature correction	On/Off Measured values will be automatically corrected to the reference temperature.
Object temp (°C)	Enter test object temperature.
Reference temp (°C)	Reference temperature to where the resistance will be adjusted to.
Material coefficient	For copper, aluminum or as customer defined.
Custom coefficient	Only applicable when Material coefficient is set to customer defined.

DualGround

Ramp	Temperature correction	Dual ground	Integration
Dual ground		Off	
Clamp-on ammeter (mV/A)	NaN		
Show current	Off		
OK			

DualGround	On/Off
Clamp-on ammeter (mV/A) (optional accessory, connected to R2 input)	Set the ratio for the clamp-on ammeter (mV)
Show current	On/Off

Integration (Only for continuous mode operation)




Ramp	Temperature correction	Dual ground	Integration
Integration/measurement time		1	▼
Averaging		3	▼
Display update frequency		2	▼
OK			

Integration/measurement time	0.1, 0.2, 0.5, 1, 2, or 4
Averaging	1, 2, 3, 4 or 5
Display update frequency	1, 2, 3 or 4

The parallel current is measured with an external clamp-on CT connected to channel R2 and a value for the clamp-on ammeter in Volt/A is needed (settings page). This is used to calculate the current flowing in the parallel path.

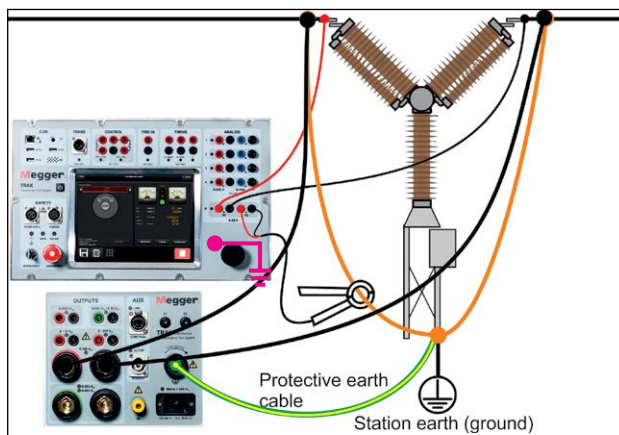
Measurements are performed as above and the measured value is automatically adjusted for the parallel current.

Connection for measurement

- 1] Connect to the test object and ground one side.
- 2] Select desired "Test current" and "Generator".
After selection the test current can be adjusted within the actual current range.
- 3] Select "Continuous" if desired.
Single test is default.
- 4] Press  to start injecting current.
A) In single test, the measurement will be performed automatically and the result is displayed.
B) In continuous mode, press  to record each test and press  to stop the generator.

Dual ground measurements

The DualGround feature is used in situations where the current through the test object is not the same as the generated current. A typical example is measuring circuit breaker contacts while the circuit breaker is grounded on both sides.



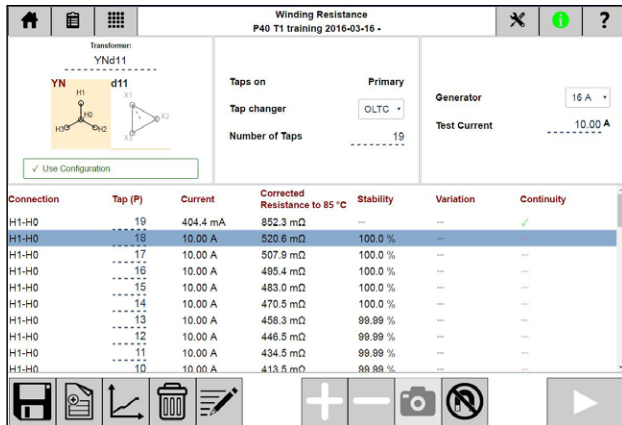
5.5 Winding resistance



Important

Read and comply with the safety instructions "2 Safety" on page 8. Always comply with local safety regulations.

1] Press



The winding resistance app is used for measuring DC resistance in transformer windings and other objects with high inductance. The app supports single channel and dual channel (Simultaneous Winding Magnetization, SWM).

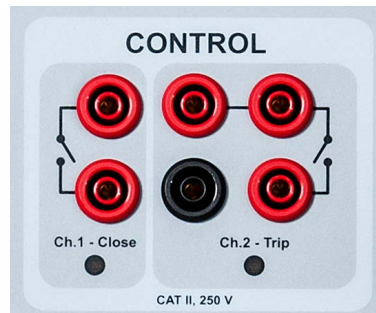
Recommended test current ranges

1 A	5 mA–1 A	Resistance range 1 mΩ–10 kΩ
16 A	1 A–16 A	Resistance range 160 μΩ–50 Ω
100 A	10 A–100 A	Resistance range 10 μΩ–5 Ω

Note When testing transformer windings, the test current should be sufficient to saturate the core and thus minimizing inductance. This happens typically at about 1% of the rated winding current. Avoid testing at >15% of rated current since this may cause heating which will affect the accuracy. Typical test currents are 1-15% and using 5-15% will give fast and stable readings.

Controls for tap changer operation

The CONTROL contacts are used to remotely operate the tap-changer.



+ / raise controls the left ch 1 contact.

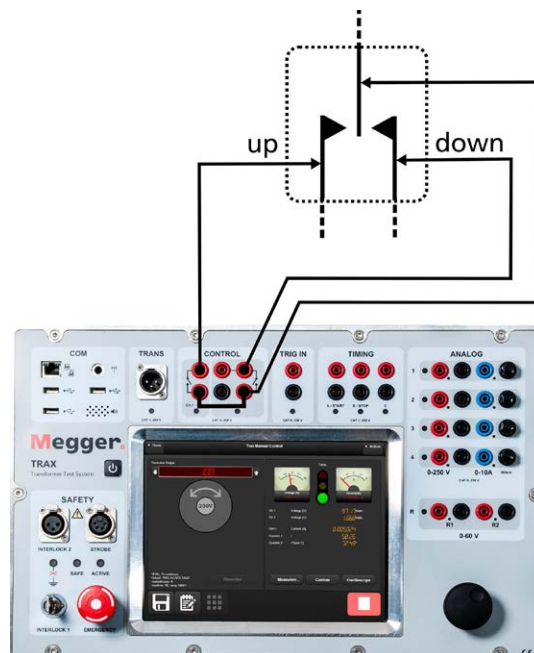
- / lower controls the right ch 2 contact.

Buttons to use during operation

	+ / raise
	- / lower
	capture/measure data without stopping the generator (for OLTC measurements).

Activating + or - buttons closes the contact for about 500 ms. After one operation the contacts are blocked for about 2 seconds before the next operation is possible.

Run two wires from each output contact and connect them in parallel with the manual operating contacts for raise/lower tap (at the tap-changer control cabinet). Max carrying current (short-term) is 35 A.



Note *The tap-changer must be powered separately, typically with 3-phase AC for the motor and a DC control voltage.*

Measurements can be performed on defined/configured transformers or in "no configuration/manual test." Discharge is automatic when the generator is stopped and performed via the current cables (primary) and also (secondary) via the voltage measurement cables. Discharge is also performed if the input power to TRAX is accidentally lost.



CAUTION

The no power emergency discharge may take significantly longer time due to lower discharge voltage. Make sure to wait for a sufficient time (>2 minutes for a large transformer) before removing any cables.

Transformer configuration (Vector diagram)

Transformer configuration and vector group is selected by entering configuration via keyboard or selecting in the matrix.

Transformer:		Taps on					
YNa	0						
YNd	1	3	5	7	9	11	
YNy	0	2	4	6	8	10	
YNyn	0	2	4	6	8	10	
YNz	1	3	5	7	9	11	
YNzn	1	3	5	7	9	11	
Yd	1	3	5	7	9	11	
Yy	0	2	4	6	8	10	
Yyn	0	2	4	6	8	10	
Yz	1	3	5	7	9	11	

If no configuration is entered the test will automatically be defined as a manual test



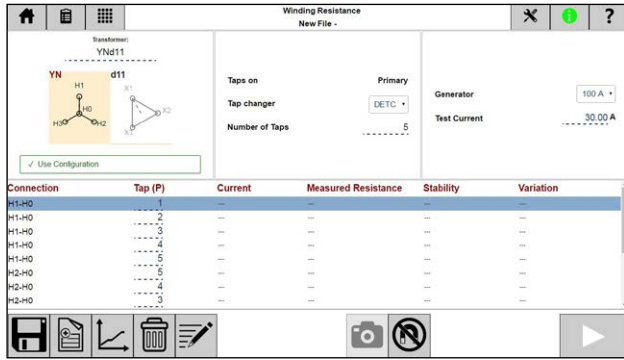
Note *It is possible to mix configured and manual tests in the same session but NOT two tests with different configurations.*

When configuration is defined, select which measurement to define and/or perform by activating the actual winding(-s). Windings can be turned on or off and if two windings are active, TRAX assumes that it should do a dual-channel (simultaneous winding magnetization) test (recommended for LV delta configurations). If the activated winding(-s) have tap-changers, define type, location, number of taps and which taps that should be measured in the actual test.

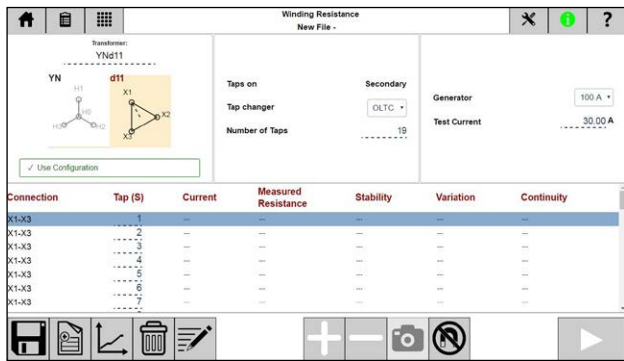
Example:

2-w transformer with DETC (5 taps) on HV and OLTC (19 taps) on LV.

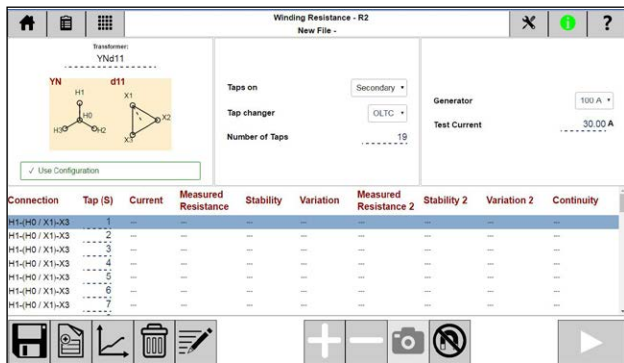
HV measurements



LV measurements

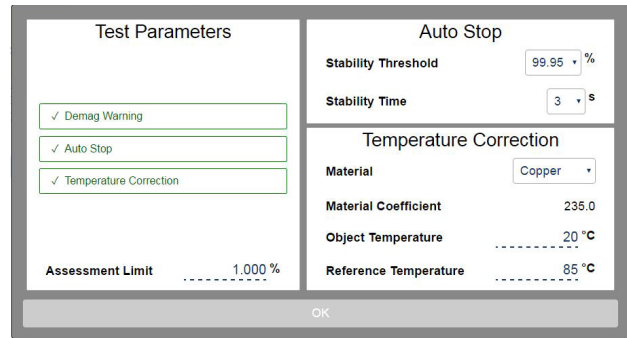


Dual – taps on LV



Settings

1] Press



Test Parameters

2] Select test parameters and make settings.

Demag Warning	When activated, TRAX suggest to do demagnetization when leaving the WRM app.
Auto Stop	<p>Stability Threshold Select minimum values for stability</p> <p>Stability Time Minimum time for stability before initiating measure/stop. E.g when stability is > 99.95% for > 3 s the measurement is automatically stopped.</p>
Temperature Correction	<p>Material Copper, Aluminum or Custom</p> <p>Material Coefficient For copper, aluminum or as customer defined</p> <p>Object Temperature (°C) Enter the winding temperature</p> <p>Reference Temperature (°C) Reference temperature for the correction</p>
Assessment Limit	Limit for winding resistance variation between windings Default 2%

Connection for measurement

No configuration measurements

1] Connect current and voltage leads to the test object.

Note *This is a 4-wire method. Connect voltage sense leads "inside" the current leads connectors. The connectors must NOT touch each other.*

2] Select test current and start measurement.

- 3] When reading is stable (manual mode), stop measurement and the result is displayed. In autostop, measurement will be automatically stopped.
- 4] Perform next measurement.
- 5] Discharge is automatic.

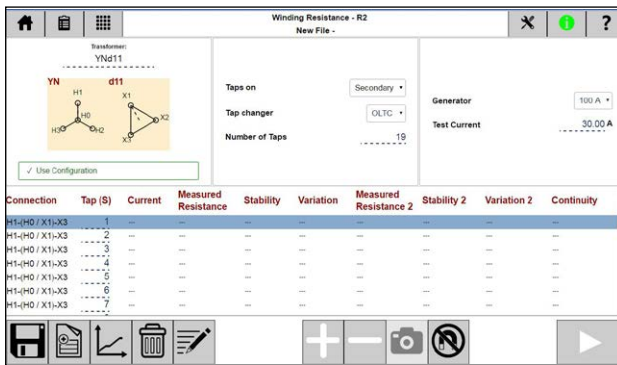


WARNING

Do not remove any cables until discharge is finalized.

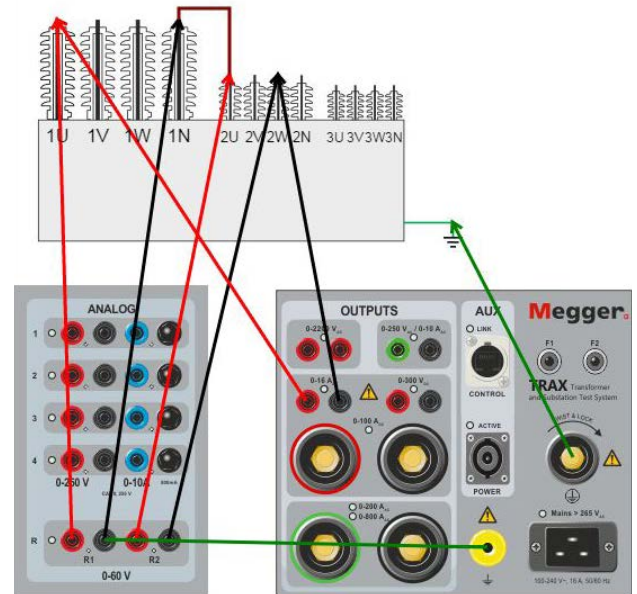
Winding resistance with transformer configuration

- 1] Enter the transformer configuration and select winding(-s) for test.
- 2] Connect the cables as described, e.g. current H1- X3 with H3X0 short, R1 H1-H3, R2 X0-X3.



- 3] Connect current and voltage leads to the test object. Pressing "?" will show the connection.

Note This is a 4-wire method. Connect voltage sense leads "inside" the current leads connectors. The connectors must NOT touch each other.



- 4] Select test current and start measurement.

If no OLTC and no taps

- 1] When reading is stable, stop measurement and the result is displayed.
- 2] Reconnect cables and perform test on next phase.

Resistance variation between windings will be displayed when all phases are measured.

If taps with DETC (de-energized tap changer)

Note In field tests, the transformer is often tested with the DETC position "as found" and it may not be recommended to change the DETC selector switch. Make sure to confirm with the transformer owner before making any changes. DETC and OLTC measurements should be performed by winding (see global settings).

- 1] When reading is stable, stop measurement and the result is displayed
- 2] Stop generator.
- 3] Operate tap changer.
- 4] Start generating, when reading is stable, stop measurement and the result is displayed
- 5] Repeat from step 2 until last tap.
- 6] Reconnect cables and perform test on next phase.


Winding variation will be displayed when all phases are measured.

If OLTC




Important

Do not use autostop when testing OLTC. OLTC measurements must be performed by winding (see global settings).

- 1] When reading is stable, press  The measurement and the result is captured and displayed for the actual row/tap. Measurement will continue on the next table row (next tap position).

Note *Do not stop generating until last tap is tested.*

- 2] Operate tap changer.
 - A] If a discontinuity occurs (brake before make), TRAX will automatically stop the test, discharge the winding and report fail in the continuity column. The discontinuity is reported on the row/ tap that the switch transition is going TO, i.e a transition discontinuity when going from tap 5 to 6 will be reported on the row for tap 6.
 - B] If continuity is OK, TRAX will start measure resistance for the actual tap on the active row. Wait for stable reading and press  TRAX will continue to measure next position.
- 3] Repeat from step 2. Continue until last tap.
- 4] Stop measurement (generator) and capture data when the reading is stable.
- 5] Reconnect cables and perform test on next phase.


Winding variation will be displayed when all phases are measured.

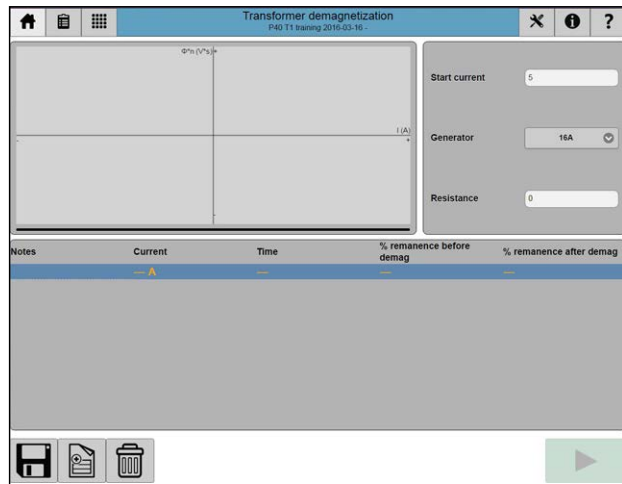
5.6 Demagnetization



Important

Read and comply with the safety instructions "2 Safety" on page 8. Always comply with local safety regulations.

- 1] Press 



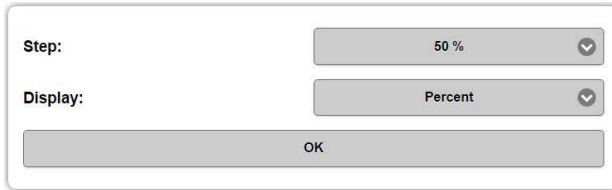
Demagnetization is recommended before performing any tests on the transformer and in particular before excitation current and/or SFRA.

Demagnetization with TRAX is performed by injecting an alternating and decreasing DC voltage/current to magnetize the core in two directions. Starting current is normally selected as about the same as the last performed winding resistance test and should be above the DC saturation level of the actual winding (typically 1 % of rated winding current). Demagnetization is normally done on the HV side of the transformer and on the connection with the lowest excitation current (the mid-leg for a YN configuration). For configurations with no neutral, demagnetization connection is terminal-terminal.

The adaptive algorithm for the demagnetization process is based on measuring and reducing V_s (voltage * time). This implies that the voltage measurement R1 MUST be connected during demagnetization.


Settings

1] Press 



Step	Vs reduction per demag cycle (default 50%)
Display	% remanence or absolute values in Vs (default %)

Step-by-step instructions

- 1] Connect generator cable and R1 measurement cable to the transformer HV terminals. If YN, connect to H2/V to neutral, if Y or D connect H1/U to H2/V.
- 2] Select generator.
- 3] Select demagnetization current, normally the same as the test current, about 1% of rated winding current.
- 4] Press  to start test
- 5] Demagnetization starts and stops automatically when finished.

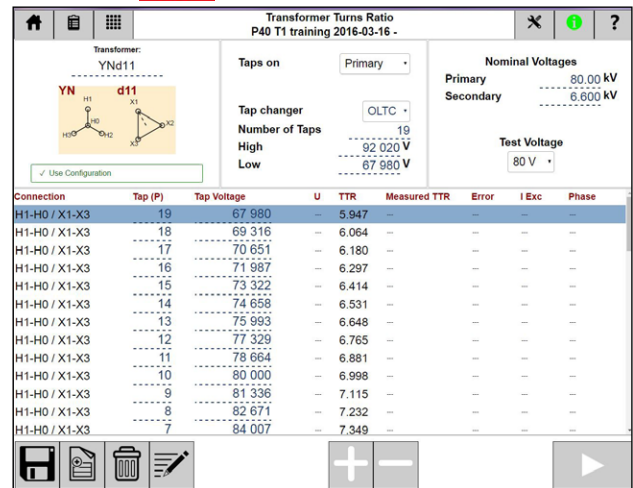
5.7 Turns ratio



Important

Read and comply with the safety instructions "2 Safety" on page 8. Always comply with local safety regulations.

1] Press 



Connection	Tap (P)	Tap Voltage	U	TTR	Measured TTR	Error	I Exc	Phase
H1-H0 / X1-X3	19	67 980	--	5.947	--	--	--	--
H1-H0 / X1-X3	18	69 316	--	6.064	--	--	--	--
H1-H0 / X1-X3	17	70 651	--	6.180	--	--	--	--
H1-H0 / X1-X3	16	71 987	--	6.297	--	--	--	--
H1-H0 / X1-X3	15	73 322	--	6.414	--	--	--	--
H1-H0 / X1-X3	14	74 658	--	6.531	--	--	--	--
H1-H0 / X1-X3	13	75 993	--	6.648	--	--	--	--
H1-H0 / X1-X3	12	77 329	--	6.765	--	--	--	--
H1-H0 / X1-X3	11	78 664	--	6.881	--	--	--	--
H1-H0 / X1-X3	10	80 000	--	6.998	--	--	--	--
H1-H0 / X1-X3	9	81 336	--	7.115	--	--	--	--
H1-H0 / X1-X3	8	82 671	--	7.232	--	--	--	--
H1-H0 / X1-X3	7	84 007	--	7.349	--	--	--	--

TRAX turns ratio app determines the transformer turns-ratio as defined by international standards. The app provides an excitation test voltage to the primary windings of the transformer and measures simultaneously the voltage at the corresponding secondary winding. The voltage ratio is displayed and compared with the expected nameplate ratio.

TRAX measures ratio, phase deviation and excitation current at the same time. Testing can be done at power frequency, or preferably at a frequency different from the power frequency to avoid interference. Default test frequency is 55 Hz.

Transformer configuration

Transformer configuration and vector group is selected by entering configuration via keyboard or selecting in the matrix.

If no configuration is entered the test will automatically be defined as a manual TTR test on a 2-winding transformer.

Note *It is possible to mix configured and manual tests in the same session but NOT two tests with different configurations.*

Define the winding pair to test (nameplate voltages). If the configuration is a three-winding transformer, select which winding pair to define and/or test.

If the activated winding pair has tap-changers, define type, location, number of taps, tap voltages and which taps that should be measured in the actual test.

Example:

3-w transformer with DETC (5 taps) on HV, OLTC (19 taps) on LV, no taps on tertiary

HV-LV, taps on primary

Connection	Tap	Tap Voltage	U	TTR	Measured TTR	Error	I Exc	Phase
H1-H0 / X1-X3	1	84 000	--	7.348	--	--	--	--
H1-H0 / X1-X3	2	82 000	--	7.173	--	--	--	--
H1-H0 / X1-X3	3	80 000	--	6.998	--	--	--	--
H1-H0 / X1-X3	4	78 000	--	6.823	--	--	--	--
H1-H0 / X1-X3	5	76 000	--	6.648	--	--	--	--
H2-H0 / X2-X1	5	76 000	--	6.648	--	--	--	--
H2-H0 / X2-X1	4	78 000	--	6.823	--	--	--	--
H2-H0 / X2-X1	3	80 000	--	6.998	--	--	--	--
H2-H0 / X2-X1	2	82 000	--	7.173	--	--	--	--
H2-H0 / X2-X1	1	84 000	--	7.348	--	--	--	--
H3-H0 / X3-X2	1	84 000	--	7.348	--	--	--	--
H3-H0 / X3-X2	2	82 000	--	7.173	--	--	--	--
H3-H0 / X3-X2	3	80 000	--	6.998	--	--	--	--

Note *If the transformer has dual tap changers, the not tested tap is default assumed to be nominal. If not, the actual (as found) tap can be changed manually*

HV-LV, taps on secondary

Connection	Tap	Tap Voltage	U	TTR	Measured TTR	Error	I Exc	Phase
H1-H0 / X1-X3	1	7 600	--	0.665	--	--	--	--
H1-H0 / X1-X3	2	7 489	--	0.655	--	--	--	--
H1-H0 / X1-X3	3	7 378	--	0.645	--	--	--	--
H1-H0 / X1-X3	4	7 267	--	0.636	--	--	--	--
H1-H0 / X1-X3	5	7 156	--	0.626	--	--	--	--
H1-H0 / X1-X3	6	7 044	--	0.616	--	--	--	--
H1-H0 / X1-X3	7	6 933	--	0.607	--	--	--	--
H1-H0 / X1-X3	8	6 822	--	0.597	--	--	--	--
H1-H0 / X1-X3	9	6 711	--	0.587	--	--	--	--
H1-H0 / X1-X3	10	6 600	--	0.577	--	--	--	--
H1-H0 / X1-X3	11	6 489	--	0.568	--	--	--	--
H1-H0 / X1-X3	12	6 378	--	0.558	--	--	--	--
H1-H0 / X1-X3	13	6 267	--	0.548	--	--	--	--

HV-Tertiary

Connection	Tap	Tap Voltage	U	TTR	Measured TTR	Error	I Exc	Phase
H1-H0 / Y1-Y3	1	92 020	--	132.3	--	--	--	--
H1-H0 / Y1-Y3	2	86 010	--	124.1	--	--	--	--
H1-H0 / Y1-Y3	3	80 000	--	115.5	--	--	--	--
H1-H0 / Y1-Y3	4	73 990	--	106.8	--	--	--	--
H1-H0 / Y1-Y3	5	67 980	--	98.12	--	--	--	--
H2-H0 / Y2-Y1	5	67 980	--	98.12	--	--	--	--
H2-H0 / Y2-Y1	4	73 990	--	106.8	--	--	--	--
H2-H0 / Y2-Y1	3	80 000	--	115.5	--	--	--	--
H2-H0 / Y2-Y1	2	86 010	--	124.1	--	--	--	--
H2-H0 / Y2-Y1	1	92 020	--	132.3	--	--	--	--
H3-H0 / Y3-Y2	1	92 020	--	132.3	--	--	--	--
H3-H0 / Y3-Y2	2	86 010	--	124.1	--	--	--	--
H3-H0 / Y3-Y2	3	80 000	--	115.5	--	--	--	--

Settings

1] Press

Ratio

Ratio can be displayed as TTR/voltage ratio or nameplate ratio. TTR/voltage ratio is calculated with respect to the actual configuration using common recalculation factors for various configurations. When selecting nameplate ratio, results are calculated to reflect the ratio between the transformers line-to-line (nameplate) voltages. Example: For a Dyn11 100 to 10 kV transformer, the TTR/voltage ratio is $10 \times \sqrt{3}$, 100 kV to 10 kV $\times \sqrt{3}$ while the nameplate voltage is 10, 100 kV to 10 kV.

Phase Deviation

Can be selected as degrees or minutes

Max Error (%)

Setting defines the limit where measured values should be highlighted.

Voltage unit

V or kV

Test Frequency

Test frequency selection; 16 2/3, 25, 50, 55 (default) or 60 Hz

Step-by-step instructions

No configuration


- 1] Connect cables.
- 2] Select test voltage.
- 3] Press to start test.
- 4] Perform next measurement.
- 5] Save results.

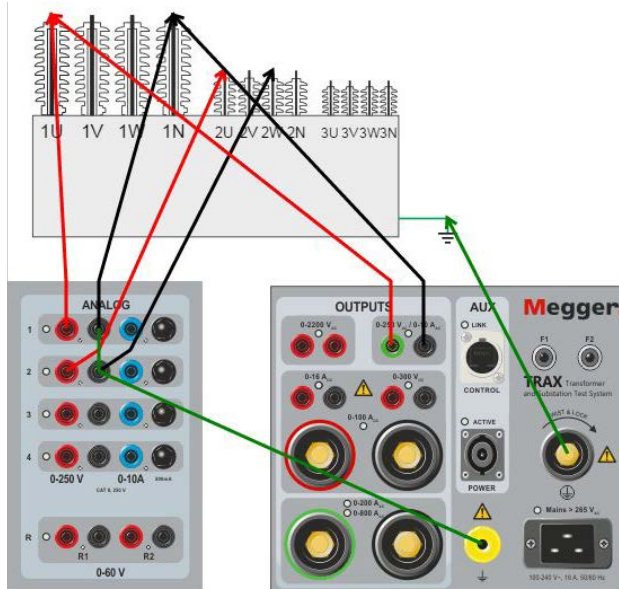
With configuration



- 1] Select transformer "Configuration" and enter the first and last tap voltage values.

Note *First tap voltage must be higher than nominal voltage for the winding with taps and last tap voltage lower.*
In case the calculated tap voltage differs from the nameplate it is possible to manually enter the values in the table.

- 2] Connect cables.

Press  to display a connecting diagram.



- 3] Select test voltage.
- 4] Press  to start test
- 5] Select next tap, operate tap changer and continue until all taps are measured.
- 6] Reconnect cables to next phase. Press  to see connecting diagram.
- 7] Measure all taps.
- 8] Continue with next phase.
- 9] Save results.

5.8 Excitation current



Important

Read and comply with the safety instructions "2 Safety" on page 8.
 Always comply with local safety regulations.

- 1] Press 

Connection	Tap	U	Frequency	I	Xp	Lp
H1-H0	19	1.998 kV	50.00 Hz	22.89 mA	109.9 kΩ	349.9 H
H1-H0	18	1.998 kV	50.00 Hz	22.03 mA	114.4 kΩ	364.2 H
H1-H0	17	1.999 kV	50.00 Hz	21.22 mA	119.2 kΩ	379.4 H
H1-H0	16	1.998 kV	50.00 Hz	20.44 mA	124.1 kΩ	395.1 H
H1-H0	15	1.998 kV	50.00 Hz	19.61 mA	129.9 kΩ	413.6 H
H1-H0	14	1.998 kV	50.00 Hz	18.88 mA	135.5 kΩ	431.2 H
H1-H0	13	1.998 kV	50.00 Hz	18.19 mA	141.0 kΩ	448.7 H
H1-H0	12	1.999 kV	50.00 Hz	17.52 mA	147.1 kΩ	468.4 H
H1-H0	11	1.998 kV	50.00 Hz	16.81 mA	154.2 kΩ	490.9 H
H1-H0	10	1.998 kV	50.00 Hz	15.89 mA	166.8 kΩ	530.9 H
H1-H0	9	1.998 kV	50.00 Hz	15.29 mA	174.4 kΩ	555.2 H
H1-H0	8	1.998 kV	50.00 Hz	14.76 mA	181.8 kΩ	578.5 H
H1-H0	7	1.998 kV	50.00 Hz	14.28 mA	188.8 kΩ	600.9 H

TRAX Excitation current app is intended for measuring current and impedance on one side of a transformer with the opposite windings open.

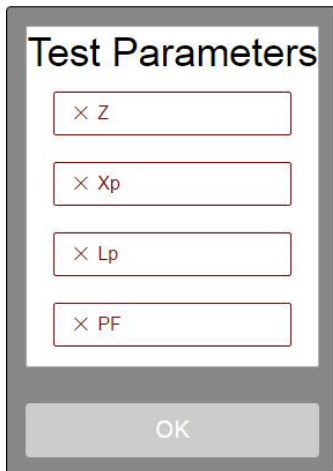


WARNING

The common practice is to measure excitation current on HV windings. If excitation current is to be measured on LV side on a transformer please note that the HV side will be energized at a higher voltage that can be very dangerous.

Settings


- 1] Press 




Select the calculated parameters to be displayed in results table. For description of the parameters see “Calculated parameters” on page 24.

Step-by-step instructions

No configuration

- 1] Select what generator to use, 250 V AC or 2200 V AC.
- 2] Connect the generator leads to the HV winding.
- 3] Press  to start the first test.
- 4] Readings will be displayed automatically when stable and generator will stop.
- 5] Continue with next test. New tests will be added to the table. It is possible to re-measure a line in the table by activating the actual row and start a new measurement.
- 6] When the test is finished the results can be saved to a file/report.

With transformer configuration

- 1] Select transformer configuration and number of taps.
- 2] Select what generator to use, 250 V AC or 2200 V AC.
- 3] Connect cables to the test object as described in the table and connection picture.
- 4] Press  to start the first test.
- 5] Readings will be displayed automatically when stable and generator will stop.
- 6] Continue with next test. New tests will be added to the table. It is possible to re-meas-

ure a line in the table by activating the actual row and start a new measurement.

- 7] When the test is finished the results can be saved to a file/report.

Note *The app is using an internal current measurement channel and measures the total current generated into the test object. If the test object has two parallel parts e.g. a winding in a delta configuration, the measured value is the current going through one winding in parallel with two series windings.*

For measuring excitation current on a single winding in a delta configuration, Manual Control with external current measurement can be used and by doing correct grounding, measurements can be performed on single windings.

5.9 Short-circuit impedance / Leakage reactance

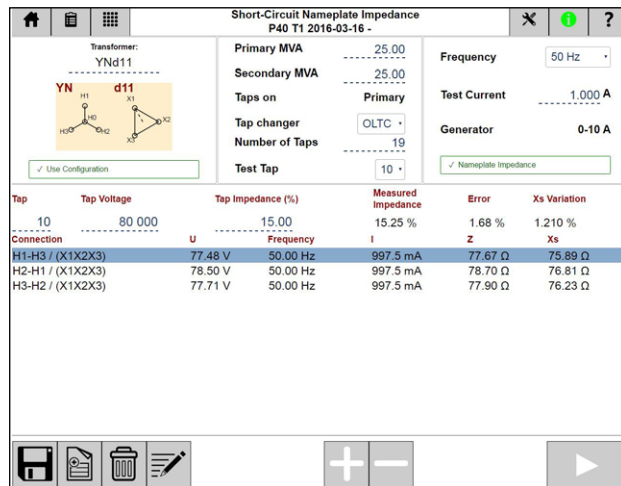


Important

Read and comply with the safety instructions "2 Safety" on page 8.

Always comply with local safety regulations.

1] Press 



Short-Circuit Nameplate Impedance
P40 T1 2016-03-16

Transformer: YNd11

Primary MVA: 25.00
Secondary MVA: 25.00
Frequency: 50 Hz

Taps on: Primary
Test Tap: 10

Test Current: 1.000 A
Generator: 0-10 A

Tap	Tap Voltage	Tap Impedance (%)	Measured Impedance	Error	Xs Variation
10	80.000	15.00	15.25 %	1.68 %	1.210 %
Connection	U	Frequency	I	Z	Xs
H1-H3 / (X1X2X3)	77.48 V	50.00 Hz	997.5 mA	77.67 Ω	75.89 Ω
H2-H1 / (X1X2X3)	78.50 V	50.00 Hz	997.5 mA	78.70 Ω	76.81 Ω
H3-H2 / (X1X2X3)	77.71 V	50.00 Hz	997.5 mA	77.90 Ω	76.23 Ω

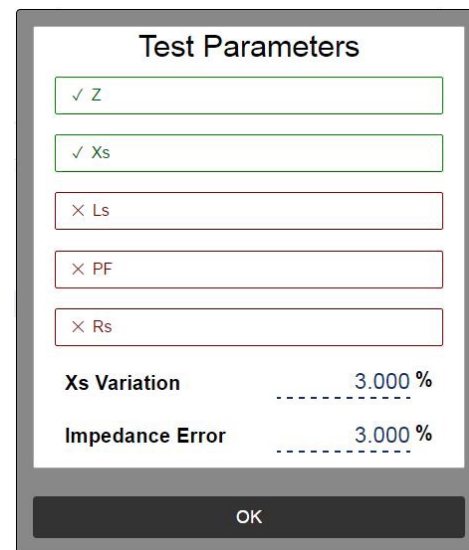
TRAX Short-circuit Impedance/Leakage Reactance app is intended for impedance measurements on the HV side of the transformer with the LV side shorted.

Without configuration you need to decide how to connect and what to measure. With configuration, the app supports short-circuit impedance/leakage reactance measurement phase-by-phase or by using three-phase equivalent model.

Note *Not all transformer configurations are supported in this app. Three phase equivalent impedance analysis is not supported for zig-zag configurations. Per phase measurements are not supported for configurations without HV neutral (Dx, Yx and Zx). For measuring these configurations on an individual basis with custom connections and shorts, please use Manual Control.*

Settings

1] Press 



Test Parameters

Z

Xs

Ls

PF

Rs

Xs Variation: 3.000 %

Impedance Error: 3.000 %

OK

Select the calculated parameters to be displayed in results table. For description of the parameters see "Calculated parameters" on page 24.

Xs Variation	Variation between windings Default 3%
Impedance Error	Deviation from nameplate impedance Default 3%

Transformer configuration

1] Configuration is selected by entering the corresponding transformer vector diagram via keyboard or selecting in the matrix (see winding resistance app).
If no configuration is entered the test will automatically be defined as a manual test on a 2-winding transformer.

Note *It is possible to mix configured and manual tests in the same session but NOT two tests with different configurations.*

2] Define the winding pair to test.
If impedance is to be calculated (3-phase equivalent), enter MVA, voltage and impedance for actual tap to test). If the configuration is a three-winding transformer, select which winding pair to define and/or test.

A] If "Impedance" is not selected, the test will be "per phase". Please note that the connections and shorts are different between "per phase" and "3-phase equivalent".

B] If the activated winding pair has

tap-changers, define type, location, number of taps, tap voltages and which taps that should be measured in the actual test.

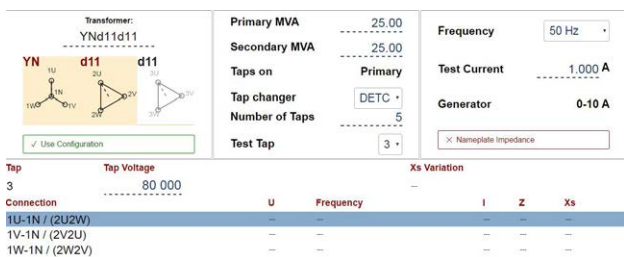
- C] If the configuration is not supported at all for leakage reactance tests it is still possible to run manual and connect and short based on previous experiences with the actual transformer and/or configuration.

Example:

3-w transformer with DETC (5 taps) on HV, OLTC (19 taps) on LV, no taps on tertiary

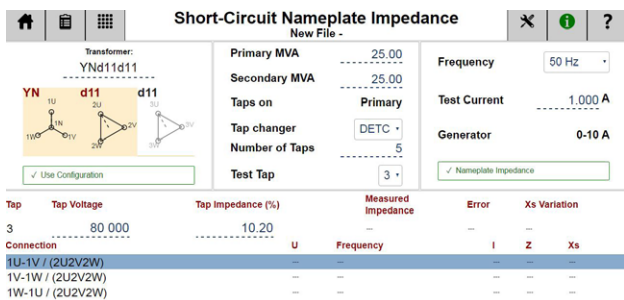
HV-LV Impedance

Per-phase measurements



When configuration is selected, TRAX suggest measurements per-phase and the variation in leakage reactance, Xs, is calculated and displayed.

Three-phase equivalent




By providing a value for as per nameplate “Impedance” the app automatically selects three-phase equivalent model and the results can be compared with the transformer nameplate.

Three-phase equivalent works for Y and delta configurations with the three LV terminals (but NOT the neutral) shorted. Make sure the shorts are good with low resistance since LV current will be test current multiplied with transformer ratio.

Three-phase equivalent model does not work for Zigzag configurations and the resulting impedance cannot be compared with nameplate.

Step-by-step instructions

- 1] Select transformer configuration (and number of taps, however this test is normally done on nominal tap only).
- 2] Enter transformer nameplate information including: “Impedance”, Nominal HV voltage (kV), Power (MVA) and Impedance (%).
- 3] Confirm cable connections/hook-up.
- 4] Select test frequency:
Default and recommended frequency for short-circuit measurements is line frequency and winding variation is calculated for Xs (leakage reactance). For higher frequency comparisons of Rs and Ls, select 500 Hz. Please note that winding variation is still calculated for Xs.
- 5] Select test current (default 1 A). Short-circuit impedance is not pending test current. Typical test current are 1-5 A. Note that maximum output voltage is 250 V which may be limiting the maximum test current for small transformers with high HV winding resistance.
- 6] Press  to start the generator and measure.
- 7] Reconnect cables to next phase.
- 8] Save results.
- 9] After all three phase have been tested, compare calculated impedance value with nameplate. Deviation should typically be < 3%. Also compare Xs values for the three phases, winding variation should typically be < 3%.

6 Data handling and reporting

6.1 General

- The data architecture in TRAX is based on tests performed with a specific app where each test can contain one or several measurements.
- Tests can be collected together in a test session containing several tests on e.g. a power transformer.
- Tests can be stored in files as separate tests or as a file containing a complete session with several tests.
- A test session can only contain measurements for one configuration and additional manual tests. If a session is started with configuration of e.g. a two-winding Delta-Wye transformer with 17 taps, the consecutive tests will automatically have the same configuration.
- A test session is started when TRAX is started and finished when TRAX is closed or when the user select "new" in the home view.
- Any test session can be saved in the report file during the session, after the session or when closing the session. This is defined as "active save" i.e. data is saved with an action e.g. with the "save" button from one app to another.
- If autosave mode is selected, TRAX will create a file when the first (new) app is opened and contain one first measurement, and ask for name and location. After this, every measurement and/or change in the apps will be automatically saved.
- If save reminder mode is selected TRAX will give a reminder to save data when an app is closed without saving
- In manual ("never"/"multimeter")mode, TRAX will not send save reminders but the user can still manually save results if needed.
- Besides saving results from measurements and tests, TRAX is automatically saving each individual measurement in logfiles for each app. This is to be considered as a back-up and not intended for general reporting

6.2 Test object configuration

No configuration – Manual test


Several TRAX apps are as factory default opened without any test object configuration. This is a manual test mode that allows direct measurement without entering any specific information. You specify (and can enter in the notes field) the connections and the app displays the test results in the table. Any number of measurements can be performed and if/when the test is saved, the file will not contain any test object information other than those entered directly in the report file.

Test configuration
















In many situations it is advisable and sometimes mandatory to enter the test object configuration, e.g. when measuring transformer turns ratio and comparing with nameplate.

When "Use configuration" is selected, TRAX will ask for information: vector group, HV and LV voltage etc. This information will be used in the consecutive tests and stored in the report file.


6.3 Save and report





A measurement or a test session can be saved to the file/report during the session or after the session is finalized. The report files can be viewed anytime by .by pressing the report icon 

Menu buttons in report and save views

	Home
	Return to app
	Apps
	Load test
	Save
	Save a copy to a selectable destination e.g. USB stick
	Return to previous report/file
	Print
	Export as xml
	Export as text
	 Activates/deactivates the edit function in the Test report table
	Deleting file. Can only be used if the file folder is unlocked
	Create new folder
	Safe eject USB for USB sticks connected to TRAX
	 Toggle to show PC or TRAX folders and files
	Refresh folder content
	Lock/unlock folder for deleting files

Action buttons

The report may contain several tests on multiple pages. The action buttons, described below, are activated with the button  upper right in the "Test report" window.


	Moves the test back to the actual app for e.g. remaking or adding measurements.
	Creates a new test within the same test session.
	Deleting a test from the session/report.
	Copy the result table in CSV/text format to a selected destination e.g. a USB stick.

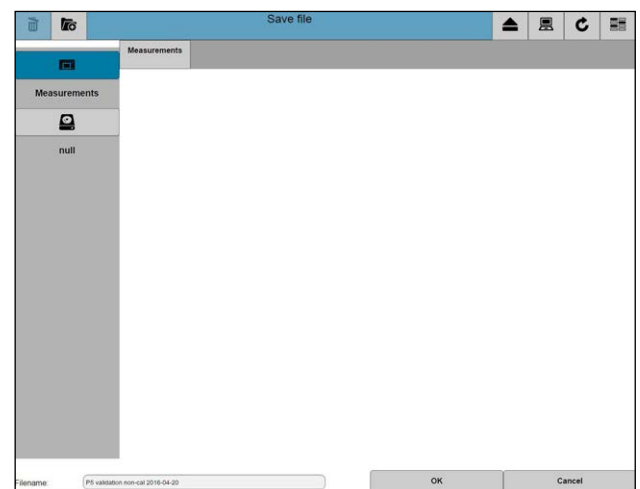
Save a test in a report file

1] Press  to save.

If autosave is selected, TRAX automatically ask for saving when the first app in the test session is opened.

You can save on PC, TRAX or USB stick.


To toggle location for saving (TRAX / PC), press 




2] Change/edit file name and press "OK"

3] Press the report button 


4] Press  to save.

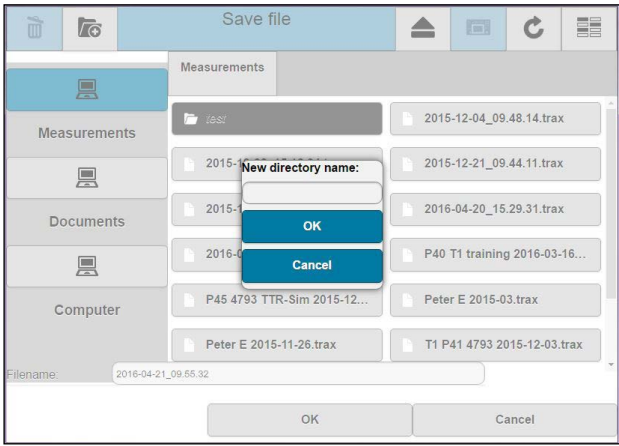
5] To save a copy in a new folder press 

6] Select location for the copy.

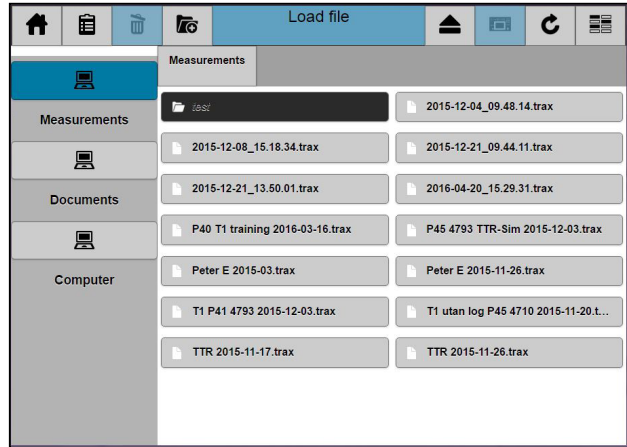
7] Press  to make a new folder.

6.4 Load file

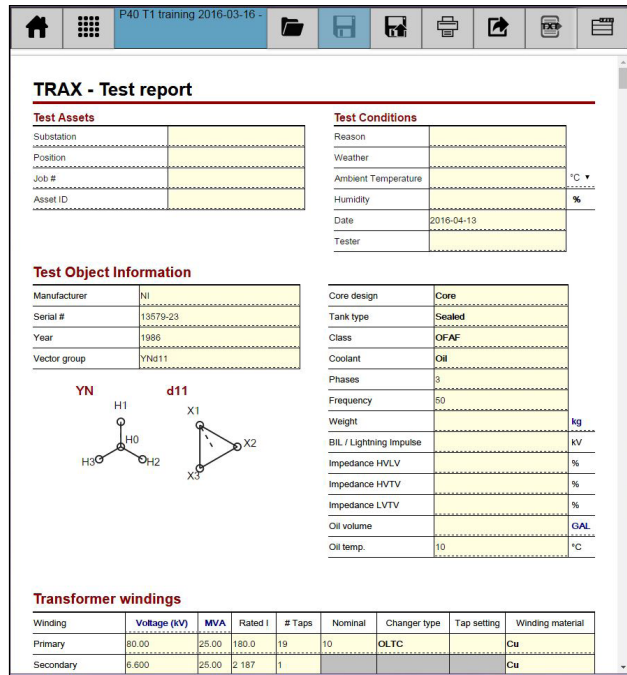
1] Press  The "Load file" window will be shown.





- 8] Enter new directory name and press OK.
- 9] Press "Filename" to enter the name.
- 10] Press "OK" button to save the file.



2] Select test report to open.



3] To select another report, press  to select report/file.

4] Press  to enable the action buttons, see "Action buttons" on page 45.


The screenshot shows the TRAX software interface. At the top, there's a title bar with 'P40 T1 training 2016-03-16'. Below it, there are navigation icons and a toolbar. The main area is divided into several sections:

- Transformer windings:** A table with columns: Winding, Voltage (kV), MVA, Rated I, # Taps, Nominal, Changer type, Tap setting, and Winding material.

Winding	Voltage (kV)	MVA	Rated I	# Taps	Nominal	Changer type	Tap setting	Winding material
Primary	80.00	25.00	180.0	19	10	OLTC		Cu
Secondary	6.600	25.00	2 187	1				Cu
- Test results:** A section titled 'Winding resistance measurements' with a table and action buttons.

Connection	Tap (P)	Current	Corrected Resistance to 85 °C	Stability		
H1-H0	19	404.4 mA	852.3 mΩ	---	---	✓
H1-H0	18	10.00 A	520.6 mΩ	100.0 %	---	---
H1-H0	17	10.00 A	507.9 mΩ	100.0 %	---	---
H1-H0	16	10.00 A	495.4 mΩ	100.0 %	---	---
H1-H0	15	10.00 A	483.0 mΩ	100.0 %	---	---
H1-H0	14	10.00 A	470.5 mΩ	100.0 %	---	---

6.5 Load Template

- 1] Press  to load an existing report as template for a new test session, e.g. when a similar transformer shall be measured. The TRAX file/report will be opened as-is with transformer data and test tables but without any measurements.

5] Scroll down to find desired measurements.

By using the action buttons you can:

- Move the test back to the actual app for e.g. remaking or adding tests.
- Start a new test within the same test session.
- Delete a test from the session/report.
- Copy the table in CSV/text file (tab separator and decimal point) format to a selected destination e.g. a USB stick.

Note *Deleting data in the file is not done until question "Save changes?" is answered. If deleting by mistake; Close/leave report view, answer "No" on question to save changes. The original report without any changes is stored. Reload the report.*



Save Changes?

You have unsaved changes. Would you like to save before moving on?

Yes No Cancel

Delete files

In the "Load file" window you can also select files to delete.

- 1] Press  to enable deleting.
- 2] Select on ore more files to delete.
- 3] Press 

6.6 TRAX logfile

The logfile is accessed via “Logging” in the home menu. The files are organized by apps.

The screenshot shows a software interface for a TRAX logfile. At the top, there are navigation icons (home, list, delete, share) and a title bar with the filename 'TTR 2016-04-07_16.01.04.log'. Below the title bar is a vertical sidebar with icons for different measurement modes: Resistance, Turn ratio (10:1), Demag, CR, Manual Control, and Excitation. The main area is a table with the following columns: Time, Winding, Tap, Tap Voltage, U (Fq), TTR, Measured TTR, % error, I exc (Fq), Phase (Deg), and Phase (Minutes). The table contains 16 rows of data, each representing a different tap position and winding configuration.

Time	Winding	Tap	Tap Voltage	U (Fq)	TTR	Measured TTR	% error	I exc (Fq)	Phase (Deg)	Phase (Minutes)
16:01:04	H1-H3 / X0-X3	1	288.8	79.82	8.745	8.731	155.3 m	10.90 m	221.3 m	13.28
16:02:49	H1-H3 / X0-X3	1	288.8	79.73	8.745	8.731	155.4 m	10.86 m	218.8 m	13.13
16:03:06	H1-H3 / X0-X3	2	281.9	79.80	8.536	8.521	186.8 m	11.17 m	218.5 m	13.11
16:03:26	H1-H3 / X0-X3	3	275.0	79.79	8.328	8.315	161.1 m	11.63 m	217.9 m	13.08
16:03:43	H1-H3 / X0-X3	4	268.1	79.80	8.119	8.109	130.8 m	12.17 m	222.0 m	13.32
16:03:59	H1-H3 / X0-X3	5	261.3	79.78	7.911	7.898	165.2 m	12.73 m	225.6 m	13.54
16:04:23	H2-H1 / X0-X1	5	261.3	79.79	7.911	7.898	160.8 m	12.40 m	218.2 m	13.09
16:04:35	H2-H1 / X0-X1	4	268.1	79.79	8.119	7.898	2.725	10.95 m	218.2 m	13.09
16:04:41	H2-H1 / X0-X1	4	268.1	79.79	8.119	7.898	2.725	10.95 m	218.2 m	13.09
16:04:48	H2-H1 / X0-X1	4	268.1	79.79	8.119	7.898	2.725	10.95 m	218.2 m	13.09
16:04:58	H2-H1 / X0-X1	4	268.1	79.81	8.119	8.108	134.9 m	12.50 m	234.2 m	14.05
16:05:13	H2-H1 / X0-X1	4	268.1	79.82	8.119	8.109	128.7 m	11.72 m	208.2 m	12.49
16:05:30	H2-H1 / X0-X1	3	275.0	79.80	8.328	8.315	156.9 m	11.21 m	204.1 m	12.25
16:05:46	H2-H1 / X0-X1	2	281.9	79.80	8.536	8.521	185.9 m	10.73 m	203.9 m	12.23

Logfiles can be downloaded to USB or PC with the upper right button. Filename is *.log. Format is tab delimited text and the files can be directly imported as data from text in Excel. See example below.

Time	Winding	Tap	Tap Voltage	U (Fq)	TTR	Measured TTR	% error	I exc (Fq)	Phase (Deg)	Phase (Minutes)
16:01:04	H1-H3 / X0-X3	1	288,8	79,82298404	8,745039742	8,731460191	0,155282892	0,010902529	0,221320916	13,27925495
16:02:49	H1-H3 / X0-X3	1	288,8	79,73316426	8,745039742	8,731449598	0,155404028	0,010857631	0,218763181	13,12579086
16:03:06	H1-H3 / X0-X3	2	281,9125	79,79627549	8,536482051	8,520539455	0,186758382	0,011168756	0,218539378	13,11236269
16:03:26	H1-H3 / X0-X3	3	275,025	79,79326395	8,327924359	8,314507258	0,161109794	0,011634864	0,217935571	13,07613426
16:03:43	H1-H3 / X0-X3	4	268,1375	79,79542276	8,119366668	8,108744178	0,130829053	0,012166128	0,221951353	13,31708117
16:03:59	H1-H3 / X0-X3	5	261,25	79,77780771	7,910808977	7,897740809	0,165193822	0,012727199	0,225619454	13,53716726
16:04:23	H2-H1 / X0-X1	5	261,25	79,78636983	7,910808977	7,89808453	0,160848871	0,012395819	0,218229426	13,09376555
16:04:35	H2-H1 / X0-X1	4	268,1375	79,78636983	8,119366668	7,89808453	2,725362054	0,010952381	0,218229426	13,09376555
16:04:41	H2-H1 / X0-X1	4	268,1375	79,78636983	8,119366668	7,89808453	2,725362054	0,010952381	0,218229426	13,09376555
16:04:48	H2-H1 / X0-X1	4	268,1375	79,78636983	8,119366668	7,89808453	2,725362054	0,010952381	0,218229426	13,09376555
16:04:58	H2-H1 / X0-X1	4	268,1375	79,81087537	8,119366668	8,108414203	0,134893092	0,012499431	0,234196821	14,05180929
16:05:13	H2-H1 / X0-X1	4	268,1375	79,82208271	8,119366668	8,108918592	0,128680924	0,011717519	0,208185549	12,49113297
16:05:30	H2-H1 / X0-X1	3	275,025	79,79962282	8,327924359	8,314860947	0,156862758	0,011205049	0,204101436	12,24608618
16:05:46	H2-H1 / X0-X1	2	281,9125	79,80317883	8,536482051	8,520615935	0,185862464	0,010733944	0,203901405	12,2340843
16:06:03	H2-H1 / X0-X1	1	288,8	79,77118962	8,745039742	8,731616601	0,153494341	0,010298725	0,19919886	11,95193158
16:06:30	H3-H2 / X0-X2	1	288,8	79,81990417	8,745039742	8,723758047	0,243357324	0,007902342	0,154869073	9,292144371
16:06:38	H3-H2 / X0-X2	2	281,9125	79,81990417	8,536482051	8,723758047	2,193831082	0,007902342	0,154869073	9,292144371
16:07:01	H3-H2 / X0-X2	2	281,9125	79,83213248	8,536482051	8,513217914	0,272526038	0,008275373	0,161657851	9,699471065
16:07:18	H3-H2 / X0-X2	3	275,025	79,8004086	8,327924359	8,513275052	2,225652933	0,008245765	0,159178623	9,550717375
16:07:41	H3-H2 / X0-X2	3	275,025	79,7937044	8,327924359	8,307139828	0,249576371	0,008573294	0,157461986	9,447719172
16:08:06	H3-H2 / X0-X2	4	268,1375	79,81373307	8,119366668	8,101472628	0,220387141	0,008930984	0,159015948	9,540956886
16:08:31	H3-H2 / X0-X2	5	261,25	79,80348985	7,910808977	7,890445678	0,257411077	0,009323349	0,160623372	9,637402331

Note The logfile is intended for emergency/backup use and are normally not used for reporting.

7 Remote control and communication ports

7.1 Communication ports

TRAX has the following data communication ports:

- Ethernet port for running the instrument from an external PC or connect it to an external network.
- WiFi (optional) for running the instrument from an external PC or other device.
- Three USB ports for multi-purpose use: Transfer data and reports to PC, use an external mouse or keyboard, upgrading the unit from a USB memory stick etc.

7.2 Remote control

TRAX220 and 280 can be used stand-alone or remote control via an external device with identical functionality.

TRAX219 is only used with remote control.

Note *For remote control, TRAX Control must be installed on the remote device.*

The external device must have a Windows operating system version 7 or higher and must have latest version Chrome web browser installed.

Connecting a device to TRAX

When connecting the device the first time, "TRAX Control" SW must be installed on the device. Find the SW on the USB stick delivered with the unit and run/install on your device.

Connecting to TRAX:

- 1] Connect the Ethernet cable to TRAX or to a network where TRAX is connected.
- 2] Wait until your device has discovered an unknown unit (normally by displaying a "?" in your network symbol)
- 3] Start TRAX Control.
- 4] After a while, the screen will display all TRAX units found on the network.
- 5] Select the unit you want to connect to.
- 6] A dialog is started where you are asked to confirm remote control by pressing and holding the control knob on TRAX to allow remote control.

Note *If TRAX has a different SW version than the remote device, TRAX will automatically change the external SW version to its own version*

- 7] Stop remote control by closing the program and unlocking TRAX for stand-alone use.

Note *The pairing procedure has to be repeated every time you make an attempt to connect. This is a safety feature especially in situations where one or more TRAX units are connected to a network and possible to operate from several computers.*

Off-line (simulation) mode

- 1] Start TRAX Control.
- 2] Select "Work offline" to access the TRAX SW for demonstration/training purposes and for working with TRAX reports.
- 3] For some of the apps it is possible to "measure" and get simulated data.

Note *TRAX has no autostop functions in simulation mode.*

8 Update TRAX

8.1 Upgrading

TRAX SW can be upgraded via Internet or with a USB stick.

Upgrading via Internet

- 1] Connect TRAX to an open Internet port with unlimited access.
- 2] From the home page select "Settings" and "Update".
- 3] TRAX will start searching for available updates and if/when an update is found, display "Update available".
- 4] Download the update.
- 5] Start the updating process.



Important

Do NOT interrupt the updating process.

Upgrading via USB

- 1] Insert the USB stick to one of the USB ports.
- 2] Select "Updates" and "USB".
- 3] Download the update.
- 4] Start the updating process.



Important

Do NOT interrupt the updating process.

Getting a TRAX (USB) upgrade via PC

- 1] Connect the PC to an open Internet port with unlimited access.



Important

The PC used to download the TRAX update must have been connected to the physical TRAX unit that is to be updated. This connection must be the last connected TRAX. The procedure is mandatory for identifying the correct update.

- 2] From the home page select "Settings" and "Update".
- 3] The PC will start searching for available updates and if/when an update is found, display "Update available".
- 4] Download the update and save on a USB
- 5] Bring the USB to the TRAX and continue as described in section "Upgrading via USB" on page 52.

9 Specifications

Specifications TRAX

Specifications are valid at nominal input voltage and an ambient temperature of +25°C ±5°, (77°F). Specifications are subject to change without notice.

Environment

<i>Application field</i>	For use in high-voltage substations and industrial environments
--------------------------	---

Temperature

<i>Operating</i>	-20°C to +55°C (-4°F to +131°F)
------------------	---------------------------------

<i>Storage</i>	-20°C to +70°C (-4°F to +158°F)
----------------	---------------------------------

<i>Humidity</i>	< 90%RH, non-condensing
-----------------	-------------------------

CE- marking

<i>EMC</i>	2004/108/EC
------------	-------------

<i>LVD</i>	2006/95/EC
------------	------------

General

<i>Mains input</i>	100-240 V, 50/60 Hz (± 10%)
--------------------	-----------------------------

<i>Input current</i>	≤ 16 A continuous Short-term up to 30 A < 60 s
----------------------	---

<i>Main fuses</i>	F1 and F2, 25 A
-------------------	-----------------



TEST GROUND
To be connected to the test object ground before connecting any other cables to the unit.



GROUND
For connecting an additional ground between the main unit and accessories or to ground external objects e.g. optional trolley

<i>Dimensions</i>	475 x 315 x 330 mm (excl. handles) (18.7" x 12.4" x 13")
-------------------	---

Weight

<i>TRAX 219</i>	25 kg (55 lbs)
-----------------	----------------

<i>TRAX 220</i>	26 kg (57 lbs)
-----------------	----------------

<i>TRAX 280</i>	30 kg (66 lbs)
-----------------	----------------

Display

<i>Size</i>	10.4"
-------------	-------

<i>Resolution</i>	1024x768 XGA
-------------------	--------------

<i>Type</i>	TFT touch
-------------	-----------

<i>Contrast ratio</i>	1000:1
-----------------------	--------

<i>Brightness</i>	1000 cd/m ²
-------------------	------------------------

Outputs

Item	Specification	Comment
0-2200 V_{AC}	1 A, 1 min 0.2 A, >2 h Frequency range: 5-70Hz	The output is disconnected with a relay and the output is "live" only when this generator is selected
0-250 V_{AC} / 0-10 A_{AC}	10 A, 1 min 20 A, max 10s 2.5 A, >2 h Frequency range: 5-505Hz	
0-200 A_{AC}	200 A/6 V, 1 min 80 A, >2 h Frequency range: 45-70 Hz	TRAX220
0-800 A_{AC}	0-800 A/6 V, 1 min 0-200 A/10 V, >2 h Frequency range: 45-70 Hz	TRAX280
0-16 A_{DC}	16 A, continuous 1 A continuous	
0-300 V_{DC}	10 A, 1 minute 2.5 A, >2 h	Rectified DC. Intended to be used as e.g. auxiliary DC supply
0-100 A_{DC}	100 A, 2 minutes 70 A, continuous	
<i>DC output power</i>	Max 1000 VA, continuous Max 50 V compliance voltage	
<i>Binary output</i>	250 V/35 A (max) 2 x 0-10000 s	Output contacts for OLTC and circuit breaker operation with internal voltage and current measurements

AUX

CONTROL	54 V DC	Ethernet communication and power to accessories.
POWER	0-235 V AC	Directly from power amplifier for powering accessories (TDX/TCX)
<i>With TRAX TDX</i>	12 kV AC 0-12 kV, 1 min 0-12 kV/300 mA, 4 min 0-12 kV/100 mA, continuous	
<i>With TRAX TCX</i>	2000 A AC 0-2000 A/2.4 V, 1 min 0-1000 A/4.8 V, 1 min	

Inputs		
ANALOG		
1 2 3 4		
<i>Current</i>	4 x 0-10 A AC/DC	
<i>Voltage</i>	4 x 250/350V AC/DC	
R1 R2	2 x 0-50 V DC	Intended for resistance measurements but can be used for AC voltage measurement up to 40V _{RMS}
TRANS		Input for analog transducers and low level analog signals
TRIG IN		Contact or voltage sense
TIMING	3 x 0-10000 s	Binary inputs for timing measurements in timer and relay testing applications. A and B inputs dedicated for Start and Stop.

Calculated / displayed parameters	
<i>Arithmetic</i>	+, -, *, /
<i>Power</i>	P, VA, Q, S
<i>Impedance</i>	R (DC), Z, Xp, Xs, Rs, Rp, Ls, Lp, Cs, Cp, phase

Derating at lower mains voltage

TRAX specification is valid at 230-240 V mains voltage. Output power is decreased at lower mains voltages.

Derating at high ambient temperature

TRAX specification is valid at 23 ±5°C. Max output current times will be reduced when using TRAX in high ambient temperature.

Derating at lower frequencies

TRAX voltage output specification is at 50 Hz. Maximum voltage output at lower frequencies is limited by the transformer. Derating is linear with frequency and max voltage output at 5 Hz is 10% of rated output.

Measurement accuracy	
<i>External AC/DC voltage and current</i>	0.05% of reading + 0.05% FS
<i>Internal DC current</i>	0.1% of reading + 0.1% FS
<i>Internal AC current</i>	0.2% of reading + 0.2% FS
<i>Internal AC voltage</i>	0.2% of reading + 0.2% FS

COM	
Ethernet port	For running the instrument from an external PC or connect it to an external network.
Connector for Wifi antenna	For running the instrument wireless from a PC or tablet. (Option)
<i>USB</i>	3 USB ports for multipurpose use

Index

A	
Action buttons.....	45
Analog inputs.....	15
Apps.....	20
B	
Binary outputs.....	15
C	
Calculated parameters.....	24
Communication.....	14
Communication ports.....	50
Configured test.....	16
Connecting a device to TRAX.....	50
Connectors.....	12
Contact Resistance.....	30
CONTROL.....	15
Control knob.....	13, 22
Controls.....	12
Create a test session in advance.....	16
CT excitation current.....	28
CT ratio with current.....	29
CT ratio with voltage.....	28
D	
Data handling.....	44
Delete files.....	47
Demagnetization.....	36
DualGround.....	30
Dual ground measurements.....	31
E	
EMERGENCY.....	14
Excitation current.....	26
Excitation Current.....	39
G	
Generator settings.....	22
Global settings.....	18
GUI Settings.....	19
I	
Impedance.....	26
Indicators.....	12
Instrument safety.....	8
Instrument settings.....	23
INTERLOCK 1.....	14
INTERLOCK 2.....	14
L	
Leakage Reactance.....	41
Leakage reactance measurements.....	27
Load file.....	46
Load Template.....	47
Logfile.....	48
M	
Main menu.....	18
Maintenance.....	10
Manual control.....	26
Manual Control.....	16, 21
Manual test.....	16
O	
Off-line (simulation) mode.....	51
Open ground detection.....	8
Operating instructions.....	16
Oscilloscope.....	25
P	
Power transformer turns-ratio measurements.....	28
Product description.....	6
R	
Remote control.....	50
Reporting.....	44
Resistance measurements.....	26
S	
Safety.....	8
Safety instructions.....	9
Save and report.....	45
Save a test.....	45
Short-circuit Impedance.....	41
Short-circuit measurements.....	27
Side panel.....	12
Specifications.....	54
STROBE.....	14
Symbols.....	8
T	
Tap changer operation.....	32
Temperature correction.....	30
Test object configuration.....	44
Test object information (nameplate).....	16
TIMING.....	15
Top panel.....	13
TRANS.....	15
Transformer configuration.....	33

TRIG IN	15
Turn off TRAX.....	18
Turns ratio	37
U	
Upgrading.....	52
Use measurement as template.....	17
V	
Voltage withstand measurements.....	29
W	
Warning and Caution Notices.....	8
Warranty	7
Warranty repair.....	7
Winding resistance	32
Z	
Zero-sequence impedance measurements ...	27

Your "One Stop" Source for all your electrical test equipment needs

- Battery Test Equipment
- Cable Fault Locating Equipment
- Circuit Breaker Test Equipment
- Data Communications Test Equipment
- Fiber Optic Test Equipment
- Ground Resistance Test Equipment
- Insulation Power Factor (C&DF) Test Equipment
- Insulation Resistance Test Equipment
- Line Testing Equipment
- Low Resistance Ohmmeters
- Motor & Phase Rotation Test Equipment
- Multimeters
- Oil Test Equipment
- Portable Appliance & Tool Testers
- Power Quality Instruments
- Recloser Test Equipment
- Relay Test Equipment
- T1 Network Test Equipment
- Tachometers & Speed Measuring Instruments
- TDR Test Equipment
- Transformer Test Equipment
- Transmission Impairment Test Equipment
- Watthour Meter Test Equipment
- STATES® Terminal Blocks & Test Switches
- Professional Hands-On Technical and Safety Training Programs

Megger is a leading global manufacturer and supplier of test and measurement instruments used within the electric power, building wiring and telecommunication industries.

With research, engineering and manufacturing facilities in the USA, UK, Germany and Sweden, combined with sales and technical support in most countries, Megger is uniquely placed to meet the needs of its customers worldwide.

Megger is certified according to ISO 9001 and 14001. Megger is a registered trademark.

Megger Group Limited
UNITED KINGDOM
Dover, Kent CT17 9EN
ENGLAND

- | | |
|----------------------|------------------------|
| ■ AUSTRALIA | ■ POLAND |
| ■ BULGARIA | ■ ROMANIA |
| ■ CANADA | ■ RUSSIA |
| ■ CZECH REPUBLIC | ■ SINGAPORE |
| ■ CHINA | ■ SLOVAK REPUBLIC |
| ■ FRANCE | ■ SOUTH AFRICA |
| ■ GERMANY | ■ SPAIN |
| ■ HUNGARY | ■ SWEDEN |
| ■ INDIA | ■ SWITZERLAND |
| ■ INDONESIA | ■ TAIWAN |
| ■ KINGDOM OF BAHRAIN | ■ THAILAND |
| ■ KOREA | ■ UNITED ARAB EMIRATES |
| ■ MALAYSIA | ■ USA |
| ■ PAKISTAN | ■ VIETNAM |
| ■ PHILIPPINES | |



Megger

WWW.MEGGER.COM

Postal address:

Megger Sweden AB
Box 724
SE-182 17 DANDERYD
SWEDEN

Visiting address:

Megger Sweden AB
Rinkebyvägen 19
SE-182 36 DANDERYD
SWEDEN

T +46 8 510 195 00 seinfo@megger.com
F +46 8 510 195 95 www.megger.com