

# 2293

## Automatic Transformer Winding Analyser

■ The **2293** is an automatic winding analyser, optimized for three phase power and distribution transformer measurements.

It uniquely combines winding resistance measurement, turns ratio, dynamic resistance measurement, core demagnetisation, transformer type detection, magnetic balance, short circuit impedance and heat run test (temperature rise and cooling curve) in the fastest single instrument solution on the market.

A simple “one-time-connection” system drastically reduces measuring time: once connected all tests can be performed in a row without any reconnection.

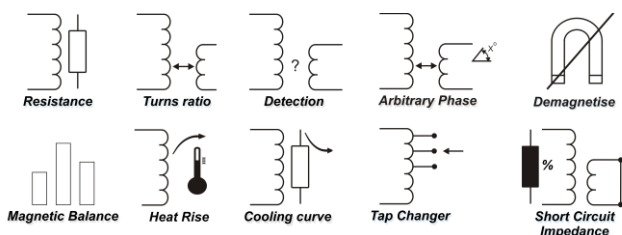
The built-in simultaneous winding magnetization method guarantees fast and reliable resistance measurements. Stable measurements are reached even on large power transformers with delta windings on the low voltage side.

A progressive method for measuring transformer turns ratio guarantees results closer to the nominal ratio even in large power transformers with tertiary windings.

Dynamic resistance measurement on tap changer perform an efficient and reliable check of the transformer tap changer.

The demagnetisation function eliminates the magnetic remanence, which can cause faulty measurements, high inrush currents and incorrect operation of protective relays.

Short circuit impedance test at reduced current helps locating mechanical damages.



In addition the magnetic balance test can detect faults in the transformer magnetic core.

Personnel safety is guaranteed by an emergency button as well as a state-of-the-art active discharge circuit and a “caution” indicator that continues to operate even without line power. An optional interlock connector can be ordered.

### FEATURES

- ☑ Multipurpose winding analyzer: **transformer winding resistance, turns ratio, dynamic resistance on tap changer, type detection, arbitrary phase ratio measurement, demagnetisation, short circuit impedance, magnetic balance** and **heat run test** (heat rise and cooling curve) in one instrument.
- ☑ **Setup made easy** – simple “one-time-connection” system: once connected can perform all tests in all phases on both windings\*.
- ☑ Easy operation on touch screen interface with full graphical test visualization.
- ☑ Unique **simultaneous winding magnetisation** method for winding resistance measurements, equivalent to traditional equipment with up to 100 A test current.
- ☑ Automated **tap changer test by dynamic resistance** (with optional tap changer controller).
- ☑ Advanced procedure for turns ratio and phase displacement measurement allows measurement also **on non regular phase displacements** (arbitrary phase shifted transformers).
- ☑ **Demagnetisation function** - transformer is returned to a demagnetized status after measurement.
- ☑ **Automatic magnetic balance test** for magnetic core fault detection.
- ☑ **Short circuit test** at reduced current for mechanical damages detection.
- ☑ Tap changer control signal.
- ☑ **Data transfer** over USB memory-stick or LAN.

### APPLICATIONS

The 2293 is a valuable tool for factory test, acceptance test and regular maintenance on:

- Power and distribution transformers
- All type of HV windings

\* Except short circuit impedance,

## MULTIPURPOSE MEASURING DEVICE

The 2293 measures:

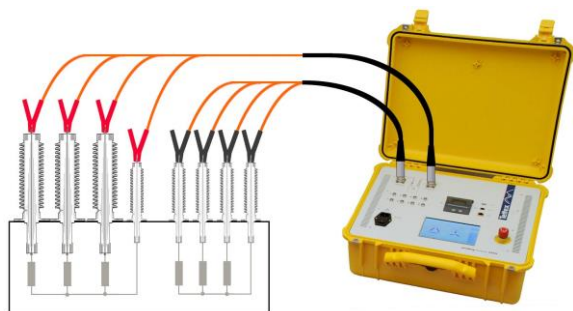
- 👉 Turns ratio
- 👉 Winding resistance
- 👉 Demagnetisation,
- 👉 Tap changer dynamic resistance,
- 👉 Short circuit impedance,
- 👉 Magnetic balance
- 👉 Heat rise test
- 👉 Colling curve measurement

All Test are done on all **windings without any reconnections (Except short circuit impedance)**



## COMPLETE AUTOMATIC TEST PROCEDURE

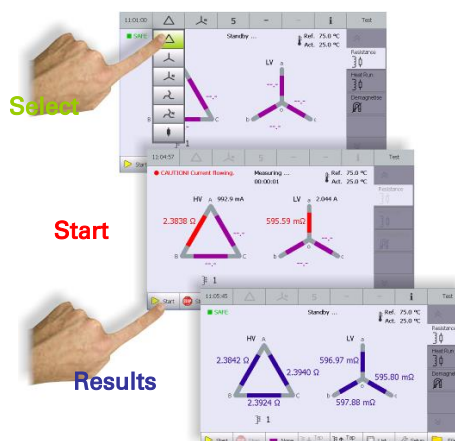
Once the cable set is connected to the test object, the instrument will automatically measure the turns ratio of all taps. Then - without reconnection - the winding resistance can be measured followed by the demagnetisation function which will put the transformer in a demagnetised state. In addition, dynamic resistance and magnetic balance test will provide information about



A complete transformer **can be tested by a single person** in a fraction of the time compared to traditional instruments

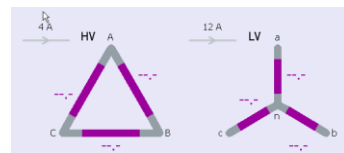
## RESISTANCE WINDING

The **Simultaneous Winding Magnetisation** method together with the integrated DC power-supply guarantees fast and reliable winding resistance measurements. The 7" touch screen full graphical interface guides the operator through the single test procedures.



Select the test object by touching the appropriate icon and press start – the unit then visualizes each test cycle and displays the results graphically or in list format.

Independent currents can be selected for each winding, which guarantees reliable results even in transformers with large differences between windings.

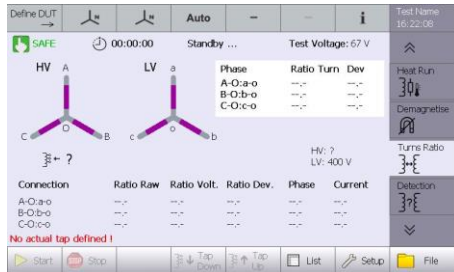


With one optional temperature probe (available for liquids and magnetic), results can be automatically referenced to any target temperature (for example 75 degrees).

Measurement	Data	Tap Control	Temperature	Miscellaneous																					
<div><input checked="" type="checkbox"/> Correct to Reference</div> <div><input checked="" type="radio"/> 75 °C</div> <div><input type="radio"/> 85 °C</div> <div><input type="radio"/> 95 °C</div>	<div>Sensors</div> <div>Mean = 30.2 °C</div> <div><input type="checkbox"/> Manual</div> <div>25.0 °C</div>		<table><thead><tr><th>#</th><th>Temp.</th><th>Description</th></tr></thead><tbody><tr><td><input checked="" type="checkbox"/> 1</td><td>30.2 °C</td><td></td></tr><tr><td><input type="checkbox"/> 2</td><td>31.4 °C</td><td></td></tr><tr><td><input type="checkbox"/> 3</td><td></td><td></td></tr><tr><td><input type="checkbox"/> 4</td><td></td><td></td></tr><tr><td><input type="checkbox"/> 5</td><td></td><td></td></tr><tr><td><input type="checkbox"/> 6</td><td></td><td></td></tr></tbody></table>	#	Temp.	Description	<input checked="" type="checkbox"/> 1	30.2 °C		<input type="checkbox"/> 2	31.4 °C		<input type="checkbox"/> 3			<input type="checkbox"/> 4			<input type="checkbox"/> 5			<input type="checkbox"/> 6			
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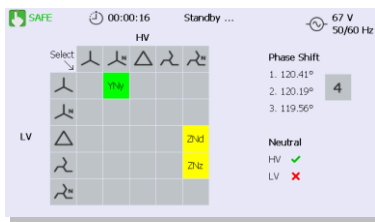
## URNS RATIO (OPTIONAL)

The AC power-supply integrated in the 2293 allows **full-automatic measurement** of turns and voltage ratio, ratio deviation, phase displacement and excitation current of transformers.



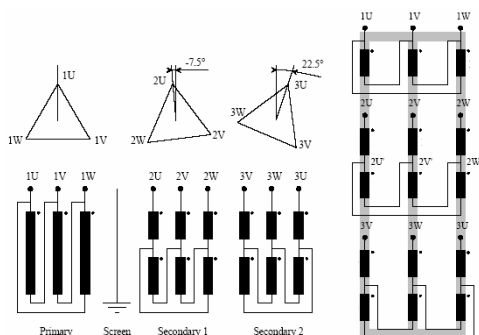
The specially developed algorithmic included in “compensated” mode reduces the influence of leakage flux while using low voltage, giving results much closer to the nominal ratio.

The included **type detection** feature works as a nameplate guesser. It helps the user to determine the correct transformer configuration by showing the possible types and eliminating the wrong vector-groups during the automatic detection process.



## MEASURING TRANSFORMERS WITH ARBITRARY PHASE-SHIFTS (OPTIONAL)

Arbitrary phase shifts or those that do not follow the 30° phase steps between the primary and secondary winding are common in special transformers like phase-shifting, rectifier / furnace and traction transformers.



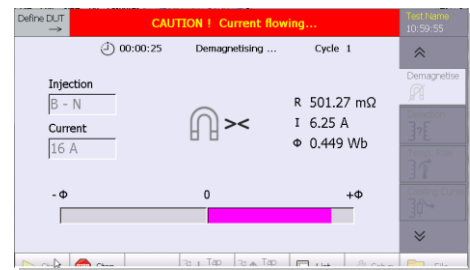
With the optional Arbitrary Phase-Shift software key (2293/SKAP), the 2293 can measure turns and voltage ratio, phase displacement and excitation current of these special-type transformers.

## DEMAGNETISATION FUNCTION

After a power or distribution transformer is disconnected from the power grid or when a DC current is applied to it, for example during a routine winding resistance measurement, the transformer core is likely to have some remnant magnetism. This remnant magnetism will generate high over currents when the transformer is reconnected to the grid, and this is commonly known as transformer Inrush Current.

In addition, Magnetic remnant has an adverse effect on other measurements like FRA or TTR.

The 2293 includes a **fully automatic demagnetisation** feature which eliminates the magnetic remnant. Select the winding where to perform the demagnetisation and press start the unit visualizes the whole demagnetisation cycle and performs the correct core demagnetisation in seconds.

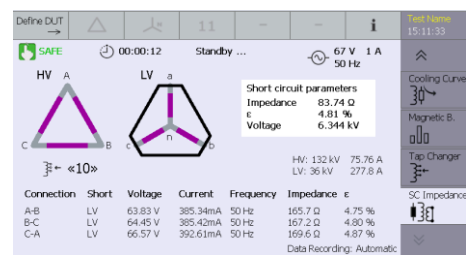


## SHORT CIRCUIT IMPEDANCE (OPTIONAL)

Short circuit impedance is a routine test done to all transformers after manufacture and specified in the transformer nameplate.

Changes in the short circuit impedance along transformer life is normally an indication of mechanical damages.

The 2293 automatically performs a short circuit impedance test at reduced voltage on power and distribution transformers and calculates the three phase equivalent short circuit impedance for comparison with previous test or with nameplate values.

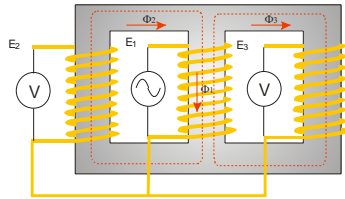




## MAGNETIC BALANCE TEST (OPTIONAL)

Magnetic balance test is performed to detect faults in the magnetic core. The test looks for changes in the reluctance of the magnetic circuit caused by defects in the magnetic core structure, shifting or shape changes in the windings or inter turn insulation fault.

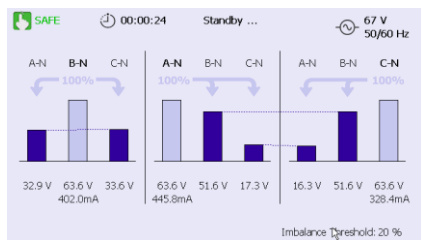
The test is performed on three phase transformers by applying a voltage on one of the phases and measures the voltage on the other two. The induced voltage will depend on the limb position into the core as the following table.



	Left phase	Central Phase	Right phase
Voltage to left phase	100%	66%	33%
Voltage to central phase	50%	100%	50%
Voltage to right phase	33%	66%	100%

The 2293 performs the magnetic balance test automatically and without any reconnection. Test results are shown graphically for a better understanding.

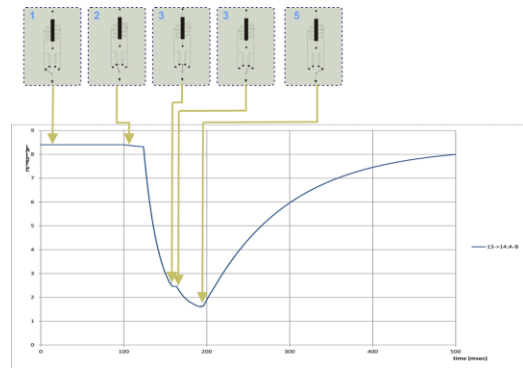
Imbalances will be graphically noted including the involved phases.



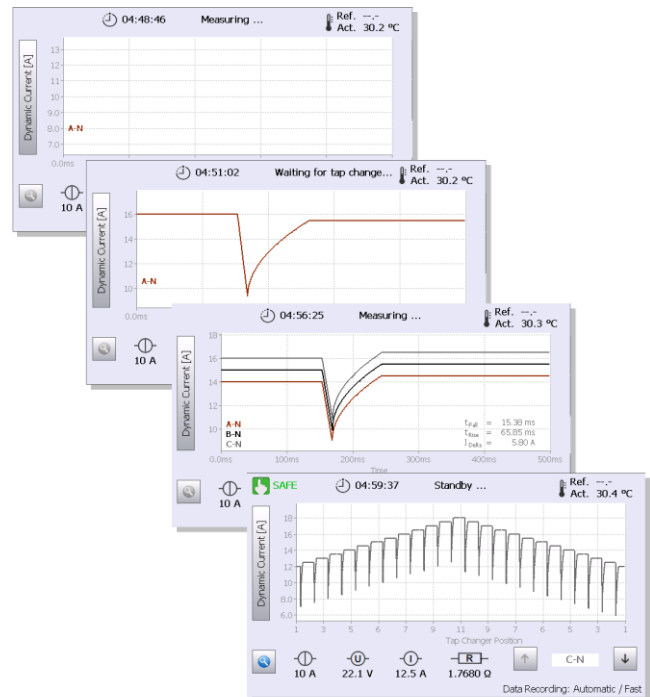
## TAP CHANGER DYNAMIC RESISTANCE (OPTIONAL)

On load tap changer main function is to switch between transformer taps without interrupting the current. The 2293 registers the current while tap changer is operated and records the values at a defined sample rate.

Discontinuities or Deviations between different taps are a sign of tap changer fault.



The tap changer test with the 2293 is done automatically and without reconnection. In addition, the tap changer control accessory (optional) allows a complete automatic sequence without human intervention.



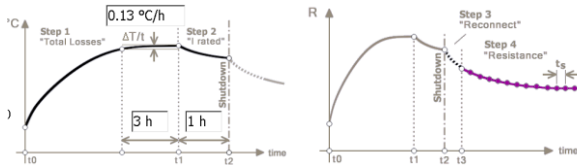
Calculation of the main curve parameters like time to rise, time to fall or Delta, for failure detection, is automatically done.



## HEAT RUN TEST

Heat run test on transformers consist of two steps;

1. **Heat rise**, where the transformer runs at nominal losses and transformer temperature rises.
2. **Cooling curve**, when transformer is disconnected and winding resistance is measured.



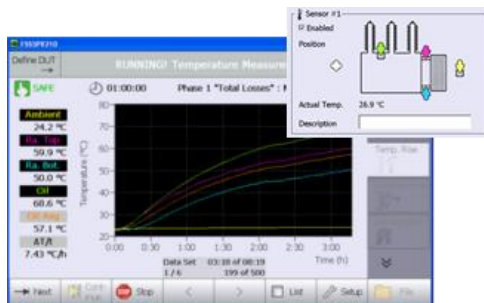
Heat Rise

Cooling Curve

The 2293 performs the measurements on both steps. It monitors the transformer temperature during the heat rise and measures HV and LV side resistances simultaneously during the cooling curve.

For the Heat Rise (optional), connection of the temperature sensors could not be easier. The included 6 temperature inputs can be easily extended up to 30 by using the optional temperature extension box (2293/TEMP). The available magnetic and liquids temperature probes (2293/TEMP2, 2293/TEMP1) are easily connected to the transformer. Probe configuration is done graphically (oil, radiator top, radiator bottom, ambient...).

In addition, pre-configured tests according ANSI and IEC standards are included, calculating the transformer temperature in real time and informing when stabilization is reached.



For the cooling curve, the 2293 can measure HV and LV side resistances simultaneously and accurately. It provides efficient and accurate acquisition of the required data points to allow the user to draw the necessary **cooling curve**. Results can be easily exported to CSV files to calculate the winding temperature at switching off time.

## TRANSFORMER MAINTENANCE MADE EASY

Combine the **Winding Analyzer 2293** with the **MIDAS micro 2883** for an entire test solution on transformers.

Compatible file formats allow data exchange between the two units and measurements results are combined for further analysis or processing.



Winding analyzer  
2293  
Midas micro  
2883

Winding resistance		<input checked="" type="radio"/>
Turns ratio		<input checked="" type="radio"/>
Demagnetisation		<input checked="" type="radio"/>
Dissipation Factor (tan δ)		<input checked="" type="radio"/>
Short circuit impedance		<input checked="" type="radio"/>
Arbitrary phase shift		<input checked="" type="radio"/>
Magnetic Balance		<input checked="" type="radio"/>
Excitation Current		<input checked="" type="radio"/>
Heat Run Test		<input checked="" type="radio"/>
Tap changer Dyn. Resistance		<input checked="" type="radio"/>

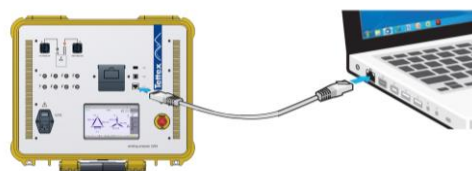
## DATA HANDLING AND TEST REPORTS

The 2293 allows easy data handling. Results can be saved on a **USB** memory stick or a simple test report can be printed with the built-in **thermal printer**.



## REMOTE CONTROL

Remote control is also supported through the **Ethernet interface**.



## STANDARD SCOPE OF SUPPLY

- 2293 measuring device
- Eight measuring cables 10m each equipped with kelvin probes
- Cable bag
- Test certificate
- Instruction manual (English)



## VERSIONS



2293 Portable Version



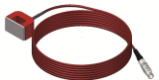

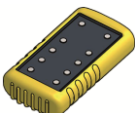
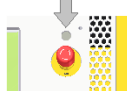


2293R Rack Mounted Version

## SOFTWARE KEYS

2293/SKTTR	3-phase transformer turns ratio measurement add on application for 2293
2293/SKAP	Arbitrary phase shift add on application for the 2293, (2293/SKTTR needed)
2293/SKTR	Heat rise add on application for the 2293
2293/SKMB	Magnetic balance add on application for the 2293
22937/SKTC	Tap changer test, dynamic resistance
22937/SKSC	Short circuit impedance measurement at reduced current

## OPTIONS

	2293/TAP	Tap changer control
	2293/TEMP1	Temperature probe for liquids
	2293/TEMP2	Magnetic temperature probe
	2293/10HV 2293/10LV	Extension cable 10m High voltage side Extension cable 10m low voltage side Extension cables can be plugged for longer distances
	2293/TEMPEXT	Temperature extension box to connect up to 8 additional temperature sensors.  Up to three extension boxes (24 temperature inputs) can be connected to a single 2293.
	2293/ITLOCK	Safety interlock plug to stop test from an external switch



## TECHNICAL SPECIFICATIONS

### Resistance Measurement

Max. Measuring Current DC	32 A (user selectable)
Max. Charging Voltage DC	100 V
Range	0.1 $\mu\Omega$ ... 300 k $\Omega$
<b>Resistance range</b>	<b>Accuracy<sup>(1)</sup></b>
0.1 $\mu\Omega$ ... 300 $\mu\Omega$	0.1% $\pm$ 0.5 $\mu\Omega$
300.1 $\mu\Omega$ ... 30 k $\Omega$	0.1%
30.01 k $\Omega$ ... 300 k $\Omega$	1%

### Ratio measurement

Max. Supply Current ACQ	1 A <sub>Peak</sub> / 700 mA <sub>RMS</sub>
Max. Meas. Voltage AC	95 V <sub>Peak</sub> / 67 V <sub>RMS</sub>
Range	1.0 ... 100'000
<b>Ratio range</b>	<b>Accuracy<sup>(1)</sup></b>
1.0 ... 100	0.05%
100 ... 2'000	0.1%
2'000 ... 20'000	1%
20'000 ... 100'000	5%
<b>Phase (Ratio measurement)</b>	<b>Typical Accuracy<sup>(2)</sup></b>
1.0 ... 500	$\pm$ 0.25°
500 ... 10'000	$\pm$ 1.00°
<b>Phase (Clock number detection)</b>	<b>Accuracy<sup>(2)</sup></b>
1.0 ... 500	$\pm$ 0.05°

### Temperature

<b>Temperature sensor</b>	
Type	PT 100 Class A
<b>Temperature sensor range</b>	<b>Accuracy</b>
-50 ... +200 °C	$\pm$ 0.15° $\pm$ 0.2% t
<b>Measuring device range</b>	<b>Accuracy</b>
-50 ... +200 °C	$\pm$ 0.25°C

### Mains Power Supply

Voltage	90 VAC ... 264 VAC
Maximum Power	1000 W
Frequency	47 Hz ... 63 Hz

### Environmental

Operating temperature	-10°C ... +60°C
Storage temperature	-20°C ... +70°C
Humidity	5% ... 95% r.h. , non-condensing
Vibration	MIL-STD-810G Table 514.6C-II. Category Common carrier

### Mechanical

Dimensions (W x D x H)	521 mm x 425 mm x 216 mm
Weight	17.9kg

### General

8 measuring channels, 6 built-in temperature channels, 7" graphical touch screen interface, tap changer control signal, built-in printer, USB and LAN connections for data exchange

<sup>(1)</sup> at temperature 0 ... +50°C at highest available current <sup>(2)</sup> at 0 ... +50°C at highest available voltage <sup>(3)</sup> Unit only without measuring cables

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**COMPLETE PORTFOLIO FOR TRANSFORMER TESTING**


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**☑ TTR 2795 / TTR 2796**

Transformer Turns Ratio Meter  
with 100/250 V test voltage

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Onsite testing of turns and voltage ratio, phase displacement and excitation current. Automatic winding connection identification and vector group detection. Remotely controllable via USB.

**☑ FRA 5311**

Frequency Response Analyser

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Detection of winding movements and mechanical failures of transformers. Active probing assures reliable and repetitive measurement results. Advanced analysis and touch screen operation.

**☑ RVM 5462**

Recovery Voltage Meter

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Mobile system for non-destructive diagnosis of the state of paper-oil insulation (effect of moisture content and aging) using the recovery voltage method.

**☑ MIDAS MICRO 2883**

Mobile Insulation, Diagnosis & Analysing system

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The MIDAS micro 2883 is the smallest and most compact insulation diagnosis set on the market. The weight of only 25 kg / 55 lbs and the one box design makes it the ideal tool for power / dissipation factor /  $\tan \delta$

**☑ OC60-DI**

Oil Cell Tester

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Fully automated digital liquid electrical test set designed to reliably and accurately test the dielectric strength of insulation liquids.