

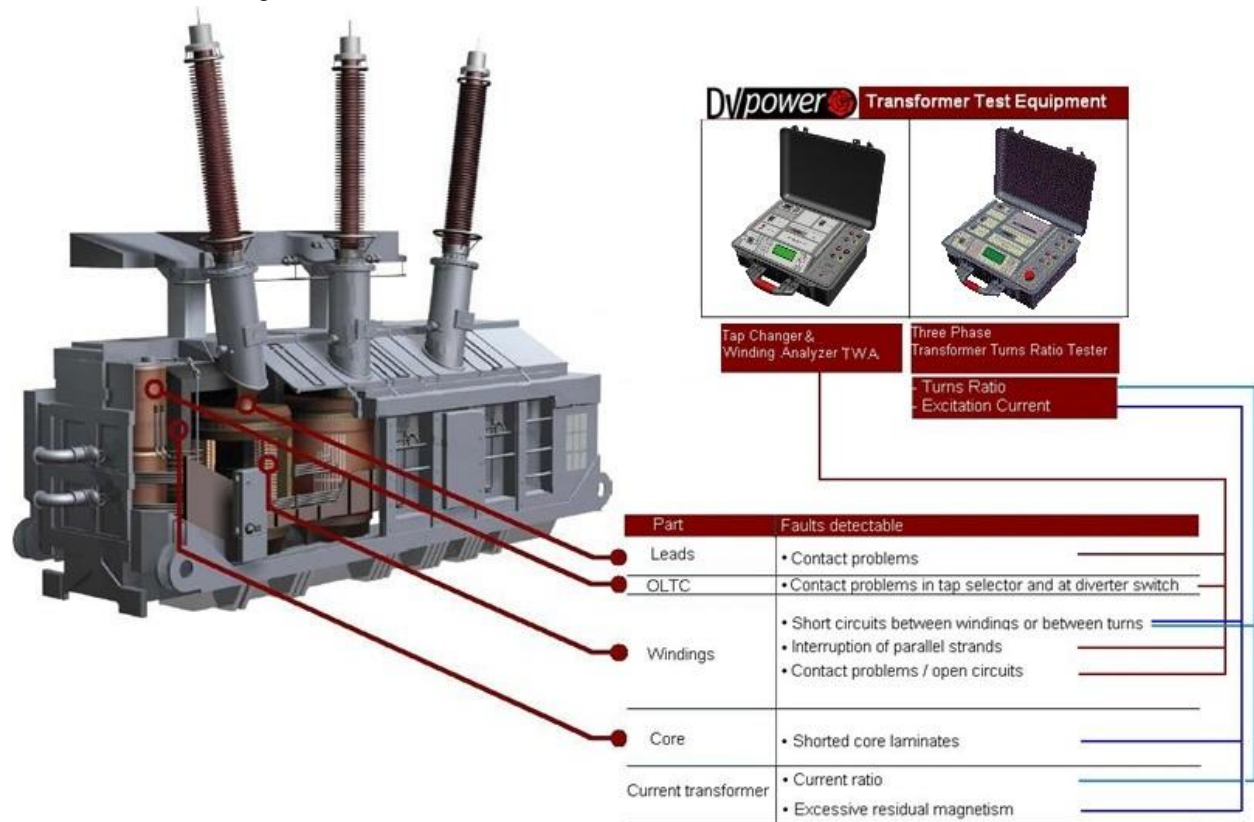
- Application Note -

Transformer Testing with TWA30D and TRT63 Instruments

DV Power products have greatly simplified the process of transformer testing. The new Tap Changer & Winding Analyzer TWA30D and Three-Phase Transformer Turns Ratio Tester TRT63, using the same test leads enable measurements of:

- transformer turns ratio,
- excitation current,
- phase angle,
- winding resistance in all tap positions,
- dynamic resistance in all on-load tap changer transitions,
- on-load tap changer motor current
- on-load tap changer transition time in all transitions,
- on-load tap changer transition ripples in all transitions,
- transformer vector group

In addition, the automatic three-phase transformer demagnetization can be performed. Demagnetization should be performed before turning the transformer on again. All these measurements can be accomplished making a single connection of the test leads. This drastically reduces the test setup time and the overall testing time.



Tap Changer & Winding Analyzer TWA30D

The Tap Changer & Winding Analyzer TWA30D is designed for a simultaneous three-phase tap changer analysis and six-winding resistance measurement of both the primary and the secondary transformer windings. All transformer windings, both primary and secondary, can be measured with a single cable setup. The total test current reaches up to 36 A DC, which is equivalent to a single-phase test with a much higher current.



Dynamic resistance graphs are recorded for all three phases simultaneously, so the synchronization is verified using the cursors provided in the DV-Win software. All three phase traces are plotted on the same graph. In addition, the tap changer motor current is recorded, and displayed on the same graph. The built-in tap changer control unit enables remote control of the tap changer operation from the instrument's keyboard. The measurement is completed quickly on even the largest power transformers. Each vector group has a special measurement algorithm which is optimized for the fast stabilization of the test results.

The unique combination of a three-phase tap changer analysis, highly accurate six-winding resistance measurement and automatic transformer demagnetization makes the TWA30D the best instrument of its type in the market.

Three-Phase Transformer Turns Ratio Tester TRT63

The TRT63A is a true three-phase, fully automatic, test set specially designed for turns ratio, phase shift and excitation current measurement of power, distribution and instrument transformers. It can be used to test single-phase and three-phase transformers, both with and without taps in accordance with the requirements of the IEC 60076-1 standard.



The instrument's true three-phase turns ratio measurement enables determining the transformer phase angle. These instruments are uniquely suited for the testing of phase-shifting transformers. If the transformer vector group is not known, the TRT63 can detect it automatically at the start of the test.

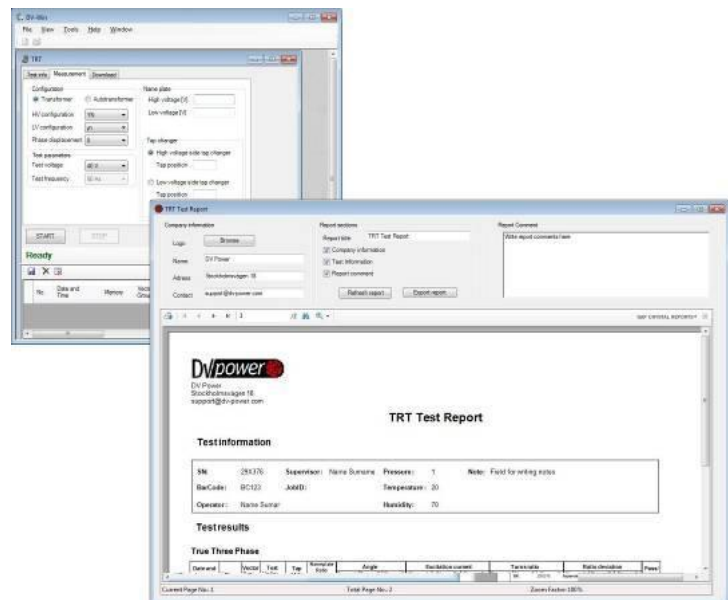
The test voltages range from 1 V to 250 V. The 250 V test voltage provides excellent turns ratio measurement accuracy of up to 0,03%. Also, results obtained with this test voltage are easily comparable with the results obtained at the mains power voltage.

The TRT instruments are highly accurate and reliable, and their true three-phase measurement capability enables testing of all types of transformers. In this way, a transformer operates in the same manner as when it is online.

DV-Win Software

The DV-Win software includes the following features:

- Full control of TRT63A and TWA30D functions from a PC.
- Creating the dynamic resistance measurement graph for the TWA30D
- Tap changer motor current measurement with the TWA30D
- Download of test results from the instrument.
- Acquisition and analysis of test results.
- Creating reports including numerical data.
- Test results can be viewed, edited, saved, printed and exported.



The Transformer Testing Process

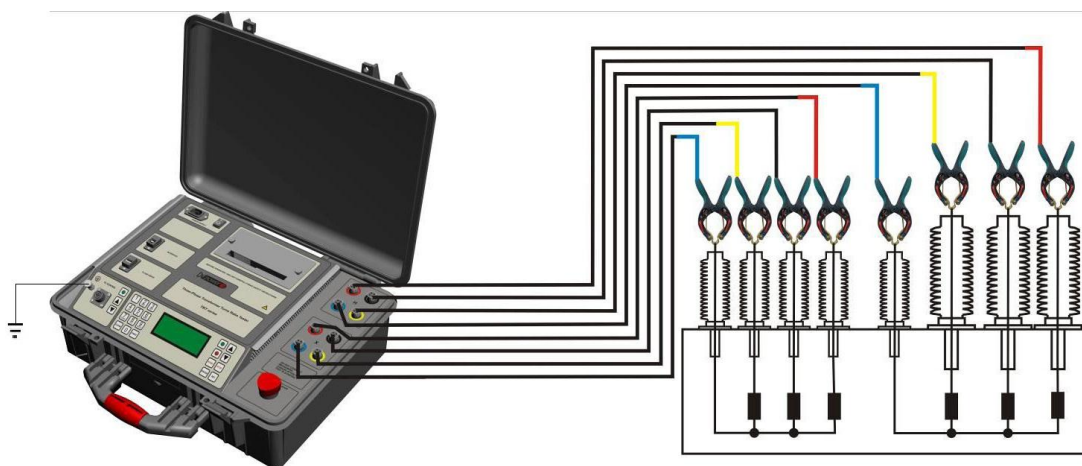
Before the testing is initiated, make sure that:

- The test object is disconnected or separated from its circuit in accordance with the national safety regulations and is properly grounded to protective earth.
- The transformer is completely de-energized.
- The TRT63 and TWA30 are properly grounded. The grounding is performed by connecting the grounding screw on top of the instrument to protective earth using the provided grounding cable.

The setup of test leads for the TRT63 and the TWA30D is quick and simple. Each test lead is connected to the corresponding transformer terminal according to the markings on the cables. If one side of the transformer is in Delta connection, or if the neutral is not accessible, the corresponding neutral test leads are not used. The tap changer remote cable can be connected to control the tap changer remotely from the instruments. The current clamps which are used to measure the tap changer motor current are connected to the tap changer motor supply.

Testing with the TRT63

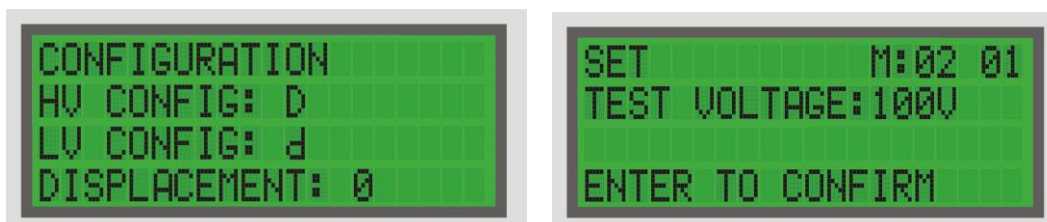
The first test to be performed is the transformer turns ratio test, which is done with the TRT63. The test leads and the tap changer remote control are connected to the instrument. The TRT63 can be operated either from the front panel, or from a PC using the DV-Win software that provides additional analysis options. The transformer configuration can be selected directly. If the configuration is unknown, the instrument has an Automatic Vector Group Detection feature, which automatically detects the vector group at the start of the test.



Note: It is important not to erroneously swap the HV and LV cables. If this happens, “Turns Ratio Too Low” warning message will be displayed, and the test will be interrupted in order to avoid dangerously high voltages.

In a single test, the instrument will measure a single-phase and a three-phase transformer turns ratio, excitation current and phase angle in all tap positions. The test voltage can be selected in the range from 1 V to 250 V. These values are measured simultaneously for each tap position. The measured turns ratio values can be compared to the nominal values, and an automatic Pass/Fail threshold can be set up in the DV-Win software.

The test procedure is simple and straightforward. All the parameters can be selected in the two screens as shown in the figures below.

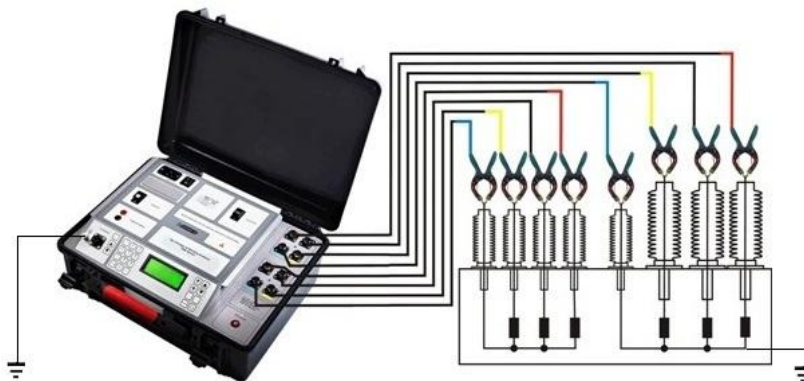


The DV-Win software supports a selection of additional result analysis options, such as Pass/Fail turns ratio condition for each tap position as compared to the nominal values and observing these values on a graph. The nominal values can be determined automatically by entering the number of the tap positions and the nominal values for the first and the last position.

Testing with the TWA30D

After the transformer turns ratio measurement, the test leads and the tap changer remote cable are switched from the TRT63 to the TWA30D instrument without replacing them on the transformer terminals. The current clamps that measure the tap changer motor current can also be connected to the TWA30D, either directly or using the provided extension cables.

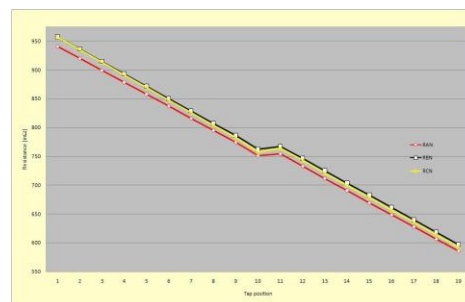
Note: All safety rules and regulations should be followed when switching the test leads from the TRT to the TWA.



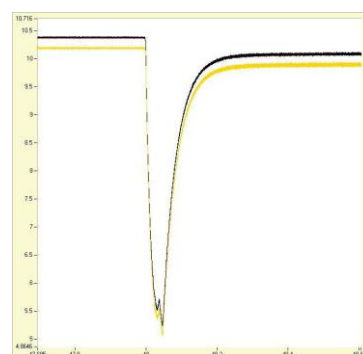
The TWA30D can perform a winding resistance measurement of all six windings in all tap positions in a single test. The instrument's Tap Changer mode also enables the dynamic resistance measurement of all tap transitions in all three phases simultaneously. The measurement can be performed either from the instrument front panel, or by controlling the TWA30D from the DV-Win PC software. Selecting the DV-Win software tool provides additional analysis options and creates the dynamic resistance measurement graph and tap changer motor current graph.

Three-Phase Tap Changer Analysis

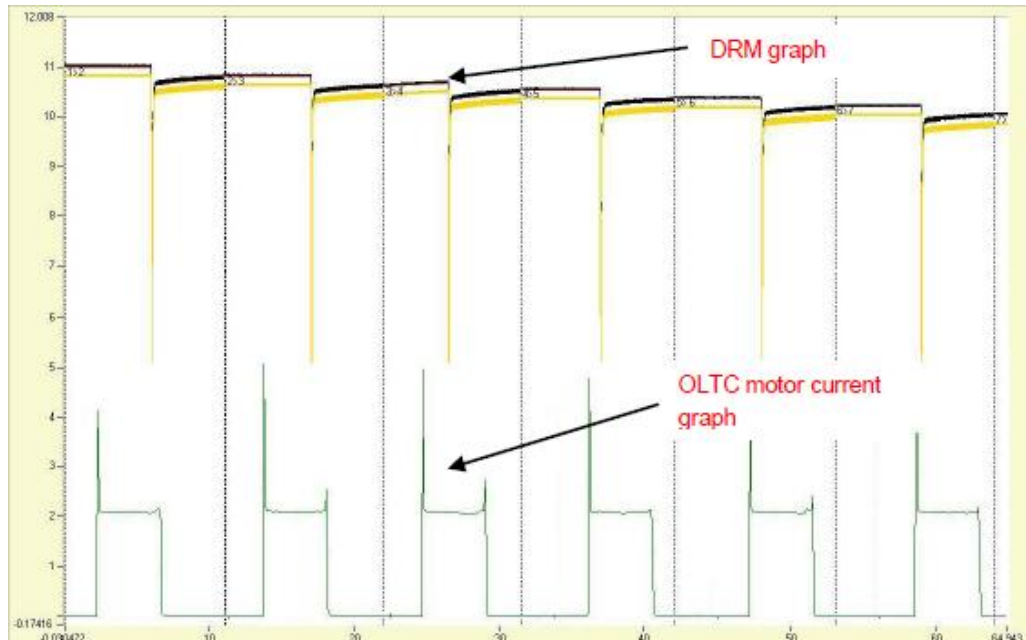
The instrument displays a warning if it detects an open circuit during a transition, and the graphs produced by the DV-Win software can be analyzed to detect problems with the diverter and selector switch, contact bouncing, resistor problems, mechanical and motor problems, etc. The transition times, transition current ripples and phase synchronization can also be checked.



The tap changer three-phase analysis with the TWA30D and the DV-Win can be performed in a single pass through the tap positions (if the tap changer is placed on the YN configuration). The instrument measures the three static winding resistances in the first tap position. Then next step is switching to dynamic resistance measurement mode. In this mode, the instrument waits for the test current drop during the transition, which triggers the dynamic resistance and tap changer motor current recording. This process is repeated until the last tap position is reached.




At the end of the measurement, the full dynamic resistance graph with all three phase traces is created and can be saved by the DV-Win software. The static resistance values in each position, the transition times and current ripples are shown in a results table in the DV-Win software. The software can create a test report containing these results, which can be saved in PDF, Word or Excel formats.



After the DC test with the TWA30D has been completed, the transformer should be demagnetized using the TWA30D demagnetization menu. The demagnetization is fully automatic, and it helps to avoid problems with incorrect FRA and excitation current readings, as well as problems with large inrush currents when the transformer is connected online again. The excitation current measurement performed by the TRT63 can be used to verify the transformer is completely demagnetized. This verification is performed by comparing the excitation current values for all three phases before and after the demagnetization.

When the test is stopped, the TWA30D immediately stops producing output voltage. However, because of the test object inductivity, the current still flows. After the test has been completed, the TWA30D starts the discharging process. During discharging, the discharging red LED is turned on and the alarm buzzer is active. The discharging stage is completed when the discharge red LED and the alarm buzzer are off. Until then, the “Discharging” message is displayed. It is not possible to start another measurement until the discharging process has been completed.

CAUTION!
 **The test leads should not be disconnected before the “Discharging” message disappears from the display and the discharging LED is off.**

After all the tests have been completed, the test leads are disconnected. They are removed in the following order: the test leads are removed first from the transformer, then from the instrument. The mains voltage supply cable is removed first from the supply source, and then from the instrument. Finally, the ground (PE) cable is removed from the instrument.

Technical Specifications

	TRT63
TEST VOLTAGES	TRT63A: (1,8,40,100,250) V AC $3 \times (1,8,40,100,250) \sqrt{3}$ V AC TRT63B: (1,10,40,100,250) V AC $3 \times (1,10,40,100,250) \sqrt{3}$ V AC TRT63C: (1,8,40,80,250) V AC $3 \times (1,8,40,80,250) \sqrt{3}$ V AC
RATIO RANGE	0,8 to 50 000
BEST RATIO ACCURACY	0,03 %
EXC. CURRENT RANGE	0 – 2 A
EXC. CURRENT ACCURACY	±1 mA
EXC. CURRENT RESOLUTION	0,1 mA
PHASE ANGLE RANGE	360 Degrees
PHASE ANGLE ACCURACY	±0,05 Degrees
PHASE ANGLE RESOLUTION	0,01 Degree

Specification	TWA30D
CURRENT RANGE	10 mA DC - 36 A DC
RESISTANCE RANGE	0,1 $\mu\Omega$ – 2 k Ω
RESOLUTION	0,1 $\mu\Omega$
ACCURACY	0,1 %
DYNAMIC RESISTANCE MESAUREMENT SAMPLING RATE	10 kHz

Accessories

Included

- DV-Win PC software
- Ground cable
- USB cable
- Built-in Tap Changer Control Unit
- Tap Changer Control cable set 5 m
- USB flash drive feature

Recommended

- H winding test cable set, 4 x 10 m with TTA clamps
- X winding test cable set, 4 x 10 m with TTA clamps
- Current clamp 30/300 A
- Cable plastic case

Optional

- Test shunt 150 A / 150 mV
- H winding test cable set, 4 x 15 m with TTA clamps
- X winding test cable set, 4 x 15 m with TTA clamps

