

TWA THREE-PHASE WINDING OHMMETERS & TAP CHANGER & WINDING ANALYZERS

Manual



Manual Version: M-W0XXDA-212-EN

This User guide refers to the following TWA models and their corresponding firmware versions

Model	Firmware Version
TWA25A	TW2A-5.05
TWA40D	TW4D-5.05

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1 Introduction

The purpose of this Manual is to provide helpful instructions on how to use the TWA instruments safely, properly and efficiently.

The following instructions will help the user avoid unsafe situations, reduce maintenance costs and will ensure the reliability and durability of the TWA instrument.

The TWA must be used in accordance with all existing safety requirements and regulations based on national/local standards for accident prevention and environmental protection. In addition, the relevant international standards are listed in paragraph 8.6 of the “Technical data” section of this document.

1.1 Safety Instructions

Safety is the responsibility of the user. Before operating the TWA, please read the following safety instructions carefully.

It is not recommended that the TWA is used (or even turned on) without careful observation of the instructions listed in this Manual. The TWA should only be operated by trained and authorized personnel.

1.1.1 Safety Terms and Symbols

Terms in this Manual. The following terms may appear in this manual:

WARNING: Warning statements identify conditions or practices that could result in injury or loss of life.

CAUTION: Caution statements identify conditions or practices that could result in damage to this product or to other property.

Terms on the Device. The following warning terms used in this document may appear on the device:

WARNING: indicates that potential hazard may occur.

CAUTION: indicates that potential damage may occur to the instrument or to the test object connected to the instrument.

Symbols on the Product. The following symbols may appear on the device:



Refer to
Manual



Protective
Earth
Terminal

1.1.2 Terms of Use

- The TWA shall be used only if it is in good technical condition. Its use shall be in accordance with local safety and industrial regulations. Adequate precautions must be taken to avoid any risks related to high voltages associated with this equipment and nearby objects.
- The TWA is intended exclusively for the application purposes specified in the “Intended Use” section of this Manual. The manufacturer and distributors are not liable for any damage resulting from wrong usage. The user bears responsibility in case of not following the instructions defined in this document.
- Do not remove the protective casing of the TWA.
- All service and maintenance work must be performed by qualified personnel only.

1.1.3 Orderly Practices and Procedures

- The Manual shall always be available on the site where the TWA is used.
- Before using the TWA, all personnel (even personnel who only occasionally, or less frequently, work with the TWA) assigned to operate the TWA should read this Manual.
- Do not make any modifications, extensions, or adaptations to the TWA.
- Use the TWA only with the original accessories provided by its manufacturer.
- Use the TWA and its original accessories for the device's intended use only.

1.1.4 Device Maintenance

The device should be kept clean in order to prevent excessive cases of dust or other contaminants affecting its operation. It should be cleaned with water/isopropyl alcohol after any dirt/contaminants are noticed on its surfaces.

1.1.5 Operator Qualifications

- Testing with the TWA should only be carried out by authorized and qualified personnel.
- Personnel receiving training, instruction or education on the TWA should remain under the constant supervision of an experienced operator while working with the test set and the test object.

1.1.6 Safe Operating Procedures

- Hazardous voltages of up to 400 V can occur inside the TWA. Therefore, it is not permitted to remove the protective casing of the TWA.
- Hazardous voltages exist on the terminals of the TWA when the red LED is lit. Never assume that the connections are safe even if this LED is off. Switch off and unplug the TWA before touching the connections, particularly if a fault is suspected.
- Before putting the TWA into operation, check the test set for any visible damage.
- Cables between the TWA and other equipment shall be connected and disconnected from the TWA only while the instrument is switched off.
- Do not operate the TWA under wet or moist conditions (condensation).
- Do not operate the TWA if explosive gas or vapors are present.
- Only the external devices which meet the requirements for SELV equipment according to EN 60950 or IEC 60950 should be connected to the TWA through the serial interface.
- When setting up the TWA, make sure that the air slots of the test set remain unobstructed.
- Removing the TWA protective casing will void the warranty. Any work inside the instrument without prior authorization from DV Power will also void the warranty.
- If the TWA seems to be malfunctioning, please contact the DV Power Support Team (refer to the "Manufacturer Contact Information" section) after previously checking the "Error Messages" section.
- Prior to connecting the TWA, ensure that the transformer (object) to be tested is completely de-energized and isolated from both the line and the load. Every terminal should be checked and verified before connecting the TWA. Ground connections may be left in place.
- Do not use the TWA without the extra protective ground cables supplied with the TWA. It must never be operated in a non-grounded configuration as this may result in an electric shock to the user or damage to the TWA. Always establish this connection first before establishing any other connections and remove this connection last.
- Wherever possible, the outer casing of the transformer under test should also be connected to a safety earth to prevent the risk of shock. Where this cannot be achieved, adequate precautions should be taken to prevent access to the transformer (e.g. barriers).



CAUTION: Never open the measuring circuit while the test is in progress as dangerous high voltage may occur. Tap Changer positions may be changed during the test only when the appropriate testing mode is selected, and when prompted to do so. Ignoring these instructions can cause excessive voltage arcs within the transformer and on external terminals.

1.2 Power Supply

- Supply the TWA only from a power outlet which is equipped with protective ground.
- Besides supplying the TWA from phase-neutral (L1-N, A-N), it may also be supplied from phase to phase (e.g., L1-L2; A-B). However, the voltage must not exceed 264 V AC. Please refer to the “Technical Data” section.
- The TWA should be positioned in such a way that it is possible to safely disconnect it from the power supply at any moment.

WARNING / AVERTISSEMENT

This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Il s'agit d'un produit de classe A. Dans un environnement domestique, ce produit peut provoquer des interférences radio, auquel cas l'utilisateur peut être amené à prendre des mesures adéquates.

1.3 Intended Use

The devices from the TWA series are stand-alone or PC-controlled digital instruments designed for analysis of on-load tap changers and for measuring resistances of inductive and resistive test objects used in the electric power industry or similar industries. It is employed for resistance measurement during the manufacturing, commissioning and testing of:

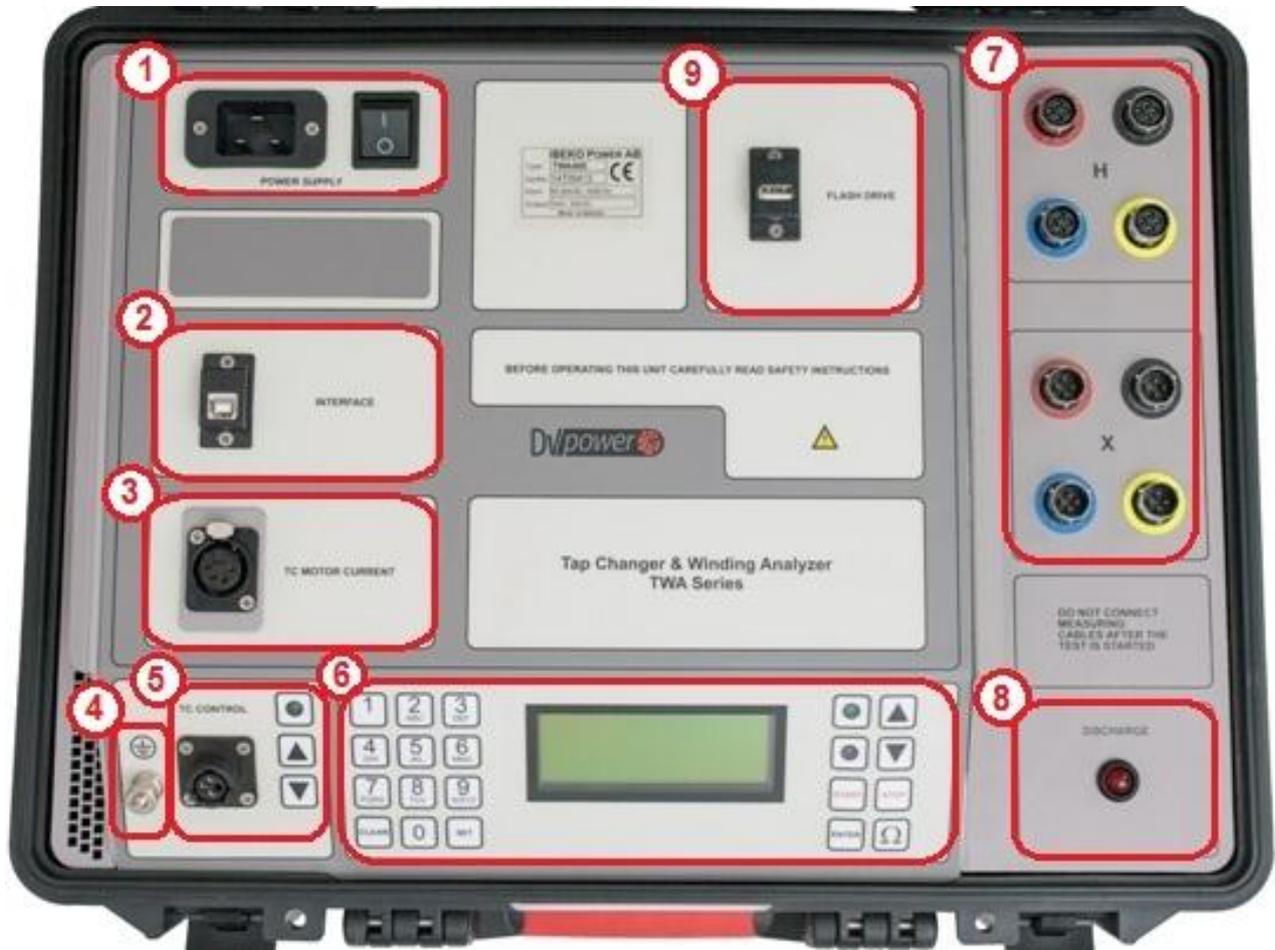
- transformers,
- on-load tap changers,
- generators and electrical motors,
- high current busbar joints,
- cable splices.

The TWA40D model supports simultaneous three-phase tap changer analysis and simultaneous three-phase winding resistance measurement for windings connected in YN configuration. Both, the TWA40D and TWA25A models are designed for six-winding resistance measurement of all six transformer windings with a single-step test lead connection. The TWA generates a true DC ripple free current. Injection of current as well as an automatic discharge of energy from the magnetic circuit are automatically regulated. Tap changer analysis performed by the TWA includes both, the static and the dynamic resistance measurements.

The TWA is also capable of automatic transformer demagnetization. It is recommended to perform transformer demagnetization after all DC current tests have been completed in order to avoid problems such as erroneous electrical measurements and diagnostics or an inrush current at the start-up of a power transformer or incorrect operation of protective relays due to magnetized CT cores.

2 Description

2.1 Front Panel Components



1. Mains Power Connector and Power Switch

Mains power connector

Connects the TWA to the mains power supply with a power cord.

Power switch – Double pole switch

- **I** - In this position, the TWA is connected to the mains power supply.
- **0** - In this position, the TWA is separated from the mains power supply.

2. USB PC Interface

The USB PC interface enables controlling the instrument from the PC, or to download previously recorded results from the instrument's internal memory. A USB cable is provided as an accessory.

3. OLTC Motor Current Measurement Connector

The AC current monitoring channel is intended for monitoring and recording the OLTC mechanical drive motor current during the tap changer operation. The motor current waveform is also printed on the DV-Win generated graph and can help in detecting OLTC mechanical problems. An AC current clamp is available for purchase.

This feature is available on the TWA40D model.

4. Protective Earth Connector

For protection against parasitic currents or voltages, the TWA earth/ground connector should always be connected to protective ground (PE). Only the originally provided cable should be used for this purpose.

For safety reasons, this connection should be established as the first one before any other connections and separated last.

5. TC Control

The external Tap Changer Control Unit is used for an easier tap changer testing. It allows the operator to change the tap position remotely from the TWA and to proceed to the next tap measurement. The TC control is a set of the two dry-contact switches. The brown wire is a Common wire. The yellow one is for UP while the green is for DOWN operation. Pressing the **UP** button closes the relay between the yellow wire and the brown wire. Pressing the **DOWN** button closes the relay between the green wire and the brown wire.

6. Operator Control

Display

Displays the settings during the device test mode selection as well as the measured values during and after a test operation.

Keyboard

Used to control the device.

- **UP/DOWN** buttons are used to navigate and set the test parameters.
- **ENTER** confirms the defined test parameters, language, time and date, and also navigates through menus. During the test it is used to switch to the measurement of the next phase.
- **STOP** stops the test, interrupts the alarm buzzer and to return to the previous menu.
- **Ω** records the resistance value currently displayed on the screen in the TWA instrument internal memory
- **START** starts the test.
- **SET** scrolls between the **Test**, **Demagnetization**, **Memory**, **USB Flash Drive** and **Settings** menus.

Green LED

- Lights continuously when the TWA is turned on.
- Flashes when the test can be started.
- Flashes alternately with the red LED during a test.

Red LED

- Lights continuously in case of operational error.
- Lights continuously during a discharging process.
- Flashes alternately with the green LED during the test.
- Flashes shortly during a resistance measurement
- Flashes alternately with the green LED during the demagnetization process.

7. H and X terminals

H cable terminal

The terminal for connecting the HV test cables.

X cable terminal

The terminal for connecting the XV test cables.

8. Discharge LED

The red LED remains lit until the accumulated energy of the measured object is reduced to a harmless level.



CAUTION: While the discharge LED is lit, the measurement cables must not be disconnected.

9. USB Flash Drive Feature

Data from the TWA internal memory can be exported to a USB flash drive. To do this, plug in the USB flash drive into the TWA device and press **ENTER** while in the **USB Flash Drive** menu. The data can be saved in TXT and CSV formats.

3 Getting Started

3.1 Connecting the TWA to a Test Object

Before the TWA has been connected to a test object (e.g. a power transformer), the following steps must be taken:

- The test object needs to be disconnected from its circuit in accordance with the national safety regulations and properly grounded to protective earth.
- The transformer is completely de-energized.
- One end of the measured windings is properly grounded. The only exception is the case when the YN connection is tested and neutral and earth bonds are mutually connected. In this case, one side of the measurement circuit should not be grounded because it is not necessary and because it will incorrectly affect the TWA reading.
- The TWA itself should be properly grounded. The grounding screw on the top of the TWA needs to be connected to protective earth using the original grounding cable.

Note: Always connect measuring cables to the instrument TWA first and then to the test object. When disconnecting, always disconnect the cables from the test object first and then from the TWA. If the cables are switched between the TWA and DV Power Three-Phase Transformer Turns Ratio Tester TRT63, always disconnect the cables from the test object first and then from the instrument. The grounding wire PE should be disconnected last. Not following these instructions may cause life-threatening situations.

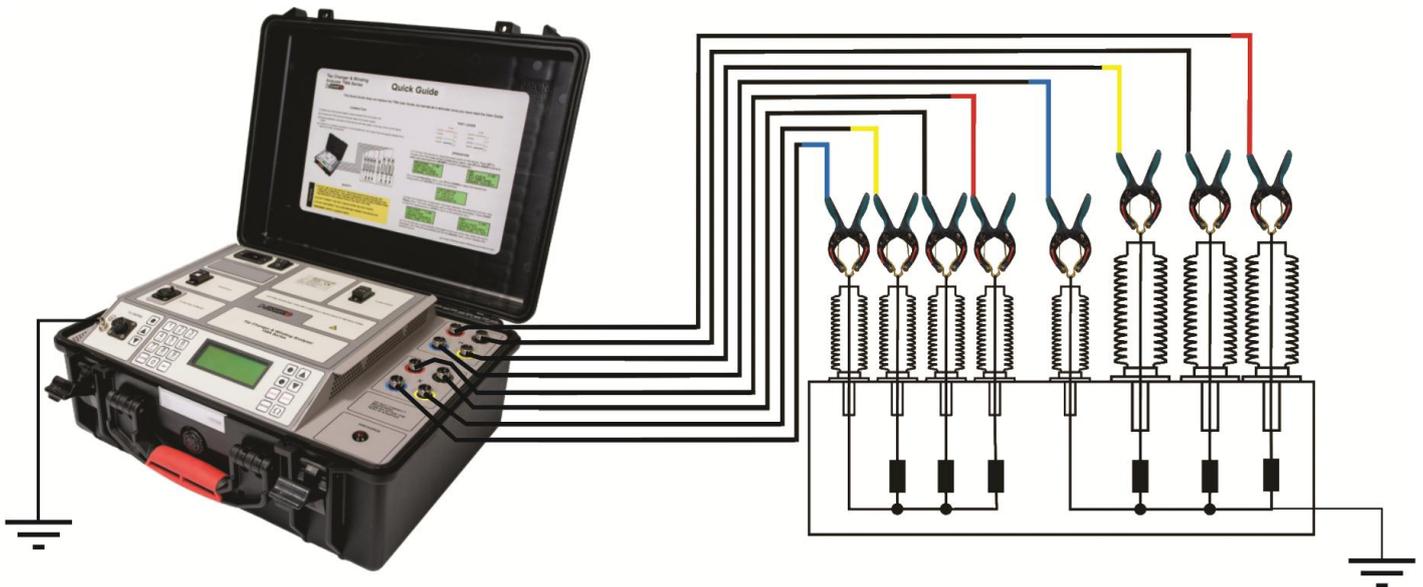


Figure 3-1: An example of connecting the TWA to a three-phase transformer

Cable test leads are terminated with the specially adjusted clips. The colors and markings of the test cables are shown in Table 3.1.

Table 3.1: Test lead colors and markings

IEC Test Lead Marking	ANSI Test Lead Marking	Australian Test Lead Marking	Transformer Terminal Voltage	Test Lead Color IEC	Australian Test Lead Colors	Malaysian Test Lead Colors
1N	H0	N	Neutral	Blue	Black	Black
1U	H1	A	High	Red	Red	Red
1V	H2	B	High	Black	White	Yellow
1W	H3	C	High	Yellow	Blue	Blue
2N	X0	n	Neutral	Blue	Black	Black
2U	X1	a	Low	Red	Red	Red
2V	X2	b	Low	Black	White	Yellow
2W	X3	c	Low	Yellow	Blue	Blue

The “H” connections are to be connected to the High Voltage side of the transformer. The “X” connections are to be connected to the Low Voltage side of the transformer.

The HV and LV cables should be physically separated to minimize the effects of any capacitive coupling between them. Any source of interference should be eliminated from the test area if possible.

- If the primary neutral connection does not exist, the 1N (H0; N) lead should not be used, and it should not be connected to either the transformer or the instrument.
- Connect the test leads to the test object while the device is turned OFF.
- To maximize the accuracy and measurement repeatability, make sure that all clamps have a good connection to the test object and avoid any crossing between the measuring cables.
- If the three-phase transformer has a tertiary winding, it should be tested in the same manner as the secondary. Test leads 2U, 2V, 2W and 2N (X1, X2, X3 and X0; a, b, c and n) are in this case connected to the tertiary winding of the transformer.
- If only one side of the transformer is tested, it is sufficient to connect one set of test cables. If, for example, only the HV side is tested, it is sufficient to use the H test cables and to connect clips 1U, 1V, 1W and 1N. If only the LV side is tested, it is sufficient to use the X test cables and to connect clips 2U, 2V, 2W and 2N.

Note: HV test lead clamps have red markings, while XV test lead clamps have white markings. When testing the LV side of autotransformer, the HV side cables should always be disconnected.



CAUTION: For safety reasons, a connection of the device should be always established with the test object in the way described in this User guide. The measuring cables should not be connected after the start of the test. The leads should not be disconnected before the discharge LED and the alarm buzzer are off.

3.2 Setting the Measurement Parameters

Immediately after the first (initial) message on the display, the TWA automatically changes the display to the **Test** menu and the green LED lights up.

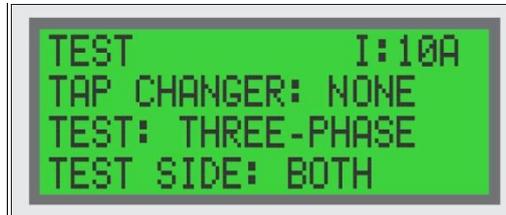
By pressing the **SET** button, the user can switch between the **Test** menu, the **Demagnetization** menu, the **Memory** menu, the **Settings** menu and the **USB Flash Drive** menu.

The TWA instrument can perform the following tests:

- Measurement of a transformer winding resistance (Test mode),
- Measurement of a dynamic resistance during OLTC operation (DVtest, performed when the instrument is operated from the DV-Win software),
- Automatic transformer demagnetization (DEMAGNETIZATION mode).

3.2.1 The Test Menu

Figure 3-2:
The **Test** menu



In the **TEST** menu, the following parameters need to be selected:

- **Test current.** The following values can be selected: 5 mA, 10 mA, 50 mA, 100 mA, 500 mA, 1 A, 2 A, 3 A, 5 A, 10 A, 15 A, 20 A and 25 A. When the instrument is controlled by the DV-Win software suite the TWA40D model can produce the output currents up to 40 A when testing in the three-phase synchronization mode available. The maximum selectable current is 33 A, and it can increase up to 40 A during the test.
- **Tap changer.** The following options are available: *None*, *OLTC* and *DETC*. If no tap changer is present, or if the operator wants to measure just the resistance of a single tap position, *None* should be selected. If the operator wants to measure the resistance of multiple OLTC (on-load tap changer) positions, the *OLTC* option should be selected, and in case of DETC (de-energized tap changer), the *DETC* option should be selected.
- **Test type.** There are three available test types: single-phase test, three-phase test and single-phase autotransformer test (a special test mode for single-phase measurements on autotransformers).
- **Test side.** The user can choose to measure the winding resistances of the transformer's HV side, LV side or both sides.

The test current is the first parameter to be set. The desired value is set by pressing the **UP / DOWN** buttons. Pressing the **ENTER** button moves the selection to the next parameter. Pressing **STOP**, while in this menu, returns the user to the previous parameter selection.

The Configuration screen is the second step in the Test menu. After all the selections have been confirmed by pressing **ENTER**, the instrument switches to the **Configuration** menu where transformer configuration and a phase displacement are set. If the OLTC or DETC options were selected in the previous screen, the transformer side on which the tap changer is located will also be selected in this menu. Press **UP/DOWN** to choose the HV configuration. To confirm a selection press **ENTER**. After pressing **ENTER**, the cursor will automatically go to the LV configuration position. Enter the LV configuration and then the phase displacement number.

Figure 3-3:
The **Configuration** screen
which sets the vector group of
three-phase transformers



The measurement process has been separately optimized for each vector group. To achieve the shortest transformer saturation and the fastest measurement time, the vector group should be selected correctly. The available vector group configurations are listed in the Table 3.2.

Table 3.2: Available vector group configurations

Configuration	Displacements
D-d, D-z, D-zn, ZN-d, Z-d	0-2-4-6-8-10
D-y, D-yn	1-3-5-7-9-11
Y-y, Y-Yn, YN-y, YN-yn	0-6
Y-d, YN-d, Y-z, Y-zn, YN-zn, YN-z, ZN-y, ZN-yn, Z-y, Z-yn	1-5-7-11
Ya, Yna	0-4-8

The **Configuration** screen will look differently in case a single-phase test was selected on the starting screen. It is possible to exactly select which winding of the transformer will be tested on either side of the transformer. In case of single-phase transformers, this menu will select which leads will be used for the measurement.

Figure 3-4:
The **Configuration** screen for the single-phase test of both transformer sides



Once the information has been confirmed by pressing **ENTER**, the **Ready** screen will be displayed.

Figure 3-5:
The **Ready** screen for the three-phase test



The **Ready** screen presents an overview of the selected test current, the transformer configuration and the measured transformer side(s). If the user is satisfied with the selection, the test can be started by pressing **START**. If any of the test parameters need to be changed, it is possible to return to the **Configuration** screen by pressing **STOP**.

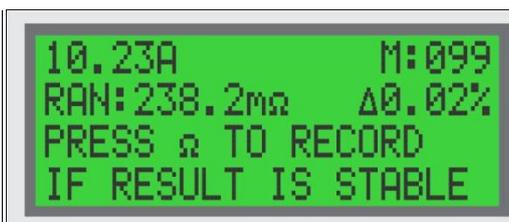
The **Charging** screen is displayed when the measurement starts. When the test current has been established, the stabilization process begins.

Figure 3-6:
The **Charging** screen



The exact windings to be measured in the first step will differ for different vector groups.

Figure 3-7:
The measured resistance for the HV side of the YNyn configuration, first step



The figure above shows an example of the HV side winding resistance measurement of a transformer with YN configuration.

The following values are displayed during the test: the test current, the value of the currently measured resistance, and the active memory position. Another useful information provided is the deviation of the resistance Δ which can be used to track the current stabilization process. The closer the Δ is to 0%, the results are more stable. These values are automatically refreshed every second.

The displayed resistances will be recorded in the same memory location when the Ω key is pressed. The test will be stopped at any time by pressing **STOP** and the results last shown will be saved in the memory. The instrument will automatically make the necessary adjustments and proceed with charging the transformer and with the next phase of measurements after the Ω key is pressed.

Figure 3-8:
The measured resistances for the LV side of the YNyn configuration, first step



The exact stages of the test will depend on the selection which was made during the test setup. In case a single-phase test was selected, the test will automatically end after the active phase has been measured. If a three-phase test was selected, the instrument will automatically switch to the measurement of the next phase after the active phase has been measured.

If the DETC testing mode has been selected, the instrument will prompt the operator to change the tap position after all three phases have been measured in the active tap position, as shown in the figure below. After the tap position has been changed, the **ENTER** button should be pressed to continue the measurement. The DETC position can only be changed while the message below is displayed. If the final tap position has already been tested, the operator can end the test by pressing **STOP**.

Figure 3-9:
The „Change tap position“ message for the DETC mode



If the OLTC testing mode was selected, the measurement will have different stages. The resistances of the first phase will be tested in the all tap positions. When the resistance of the first tap position has been measured, the instrument will wait for the test current drop which appears during the change of OLTC position. The “Change tap position” message shown in the figure below will be displayed. If the change of a tap position is not automatically recognized by the instrument, it is possible to manually switch to the resistance measurement of the next position by pressing Ω while the “Change tap position” message is being displayed. If the last tap position has been measured, the **ENTER** button should be pressed to switch to the measurement of the next phase.

Figure 3-10:
The „Change tap position“ message for the OLTC mode



At the end of the OLTC test, after all the phases have been measured, the instrument will stop the test if just the measurement of the tap changer side of the transformer has been selected. If the measurement of

both sides has been selected, the instrument will automatically start the measurement of the resistances on the non-tapped transformer side.

After the test has been completed, the TWA 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.

Figure 3-11:
The „Discharging,,
message



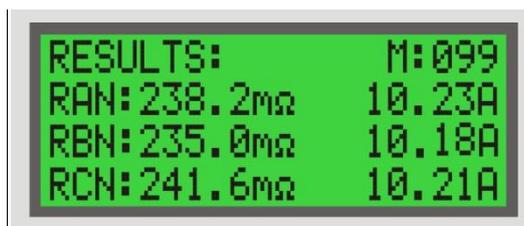
When the test is stopped, the TWA immediately stops producing output voltage. However, because of the test object inductivity, the current still flows. Because of the enormous amount of energy that can be stored in a magnetic field, precautions should be taken before disconnecting the test leads from the tested transformer. Never remove the leads during the testing process and always allow enough time for the tested transformer to completely discharge. Large transformers can require several minutes to discharge.



CAUTION: The leads should not be disconnected before the “Discharging” message disappears on the display and the discharging LED is off.

The obtained results are displayed after the test is completed. The first results screen displays all three HV side resistances and the test currents which were used to measure each of these resistances. The second screen shows the LV resistances and the corresponding test currents. These two screens are illustrated in the figures below. To view the next screen, press **ENTER**. Press **STOP** to return to the **Test** menu.

Figure 3-12:
The **Results** screen for
the three-phase test



Measured resistances of the test object



Memory position where the results are saved

Test currents

Note: The DV-Win software enables storing the test results on a PC. The results from the selected memory locations can be exported to various file formats including XLS, PDF and DOC.

3.2.2 The Demagnetization Menu

While in the instrument's **Test** menu, press **SET** to switch to the **Demagnetization** menu.

Figure 3-13
The **Demagnetization**
menu



Before demagnetization can be started, the following parameters need to be defined in the **DEMAG** menu:

- The starting demagnetization current,
- Winding configuration,
- The Demagnetization process on all three phases (three transformer core legs) or on a single phase (medium transformer core leg).

It is recommended that the starting current has the starting value of at least 20% above the value of the transformer saturation current. After the starting demagnetization current has been selected, the winding configuration of the tested transformer has to be selected by using the **UP/DOWN** keys. The available winding configurations are: Y, YN, D, Z, ZN, SINGLE.

Once the test parameters are selected, press **ENTER** to confirm the selection.

Figure 3-14:
„Ready for demagnetization“
screen



Press **START** to begin the demagnetization process.

Demagnetization will be carried out automatically. During the demagnetization process, its progress will be shown on the display. The order in which the phases are demagnetized depends on the winding configuration which was set in the **Demagnetization** menu. The demagnetization process was determined separately for different configurations in order to reduce the duration of the process.

Figure 3-15:
Demagnetization progress



When the demagnetization current value starts dropping from its peak value (in this case 25 A), the on-screen status will be changed from „CHARGING“ to „DISCHARGING“. The next value of the current will be -60% of the previous value. This will continue until the 5 mA value is reached. Demagnetization of the next phase will then start automatically.

The process can be completed in two ways:

- By pressing **STOP**,
- Automatically, after the demagnetization current has reached the 5 mA value.

When demagnetization of all three phases has been completed, the TWA displays the following message to inform the user:

Figure 3-16:
The „Demagnetization done!“
message



3.3 Measurement Parameters

The highest resolution of the reading is always displayed. The resistance range selection is performed automatically and therefore manual setting by the operator is not necessary.

Table 3.3: Maximum resistances for each test current

Test Current	Max Test Voltage	Max Resistance
5 mA	50 V	10 kΩ
10 mA	50 V	5 kΩ
50 mA	50 V	1 kΩ
100 mA	50 V	500 Ω
500 mA	50 V	100 Ω
1 A	50 V	50 Ω
2 A	50 V	25 Ω
5 A	50 V	10 Ω
10 A	50 V	5 Ω
15 A	50 V	3,33 Ω
20 A	50 V	1,875 Ω
25 A	50 V	1,2 Ω

Table 3.4: Resolution and full scale for each measuring range

Full scale	Resolution
0,1 μΩ – 999,9 μΩ	0,1 μΩ
1,000 mΩ – 9,999 mΩ	1 μΩ
10,00 mΩ – 99,99 mΩ	10 μΩ
100,0 mΩ – 999,9 mΩ	0,1 mΩ
1,000 Ω – 99,99 Ω	10 μΩ
100,0 Ω – 999,9 Ω	0,1 Ω
1000 Ω – 9999 Ω	1 Ω

Typical accuracy of the TWA is $\pm (0,1 \% \text{ rdg} + 0,1 \% \text{ F.S.})$, for 0,1 μΩ – 1,999 kΩ range, and $\pm (0,2\% \text{ rdg} + 0,1\% \text{ F.S.})$ for 2,000 kΩ – 9,999 kΩ range with the full scale values shown in Table 3.4. This accuracy is valid if the maximum possible current is used. Always try to use as high current as possible, but to avoid the risk of heating the winding, it is recommended not to exceed from 10 % to 15 % of the nominal current of transformer. It is important to get a good connection between clamps and the connecting point on the test object to achieve stable and accurate test results. 95% of all units have an accuracy better than specified as Typical.

The guaranteed accuracy of the TWA is $\pm (0,2 \% \text{ rdg} + 0,2 \% \text{ F.S.})$.

4 Error Messages

Any operational error is indicated by the red LED and accompanied by an alarm buzzer. Furthermore, the display indicates an error status message. To stop the alarm buzzer, the status message should be removed from the display. Return to the **Test** menu by pressing **STOP**.

If abnormal operating conditions occur during the transformer testing, the following error messages will appear on the display.

4.1 Error Message "Open Connection"

This message is displayed if the current path is interrupted.

Figure 4-1:
Error message
"Open Connection"



4.2 Error Message "Change Current"

This message is displayed if the voltage at the test object is too high during the test. In this case, the test current should be reduced and the test repeated.

Figure 4-2:
Error message
"Change Current"



4.3 Error Message "Overcurrent"

This message is displayed if the test voltage is less than 10 V per channel but the test current is still too high for that resistance. The red LED will light continuously in this case.

Figure 4-3:
Error message
"Overcurrent"



4.4 Error Message "Overheat"

This message is displayed when the TWA operating temperature rises too high. In this case, it is necessary to wait for the test set to cool down and repeat the test.

Figure 4-4:
Error message
"Overheat"



4.5 Error Message "Mains Voltage < 90V"

This message is displayed when the TWA mains voltage is below 90 V. The TWA must be restarted to reset the status message.

Figure 4-5:
Error message
"Mains Voltage < 90V"



5 Troubleshooting

If it is suspected that the device is presenting inaccurate results, the following tests should be performed:

5.1 Accuracy Check

1. Connect the TWA device and test shunt R_1 (1Ω) as shown in the Figure 5.1. Connect phase **A**, **B** and **C** cables to one side of the test shunt and neutral **N** cable to the other side.
2. Set the test on the TWA device as described in 3.2.1: test mode, no tap changer, three-phase test, test **HV** side, HV configuration **YN**, set the first test current from the Table 5.1 and start the test. Read the resistance values measured with the TWA device and compare it to expected values. Repeat this step for all test currents listed in the Table 5.1. The test current values can be viewed on the device display.
3. Connect the TWA device and test shunt R_2 ($10 \text{ m}\Omega$) as shown in the Figure 5.2. Connect phase **A**, **B** and **C** cables to one side of the test shunt and neutral **N** cable to the other side
4. Set the test according point 2, set the first test current from the Table 5.2 and start the test. Read the resistance values measured with the TWA device and compare it to expected values. Repeat this step for all test currents listed in the Table 5.2. The test current values can be viewed on the device display.
5. If the measured results differ from the expected values, please proceed to the next step – determining the root cause of the inaccurate measurements.



Figure 5.1 – Accuracy check – 1Ω

Set current I [mA]	Reached current I [mA]	$R_1[\Omega]$		
		AN	BN	CN
10				
100				
1000				

Table 5.1 – Accuracy check – 1Ω



Figure 5.2 – Accuracy check – $10 \text{ m}\Omega$

I [A]	Reached current I [mA]	$R_2[\text{m}\Omega]$		
		AN	BN	CN
2				
5				
10				

Table 5.2 – Accuracy check – $10 \text{ m}\Omega$

5.2 Open Circuit Voltage Check

1. Connect the phase **A** and neutral **N** cables on the H side of the device. Connect the digital voltmeter between phase **A** and neutral **N**, as shown in the Figure 5.3.
2. Set the test on the TWA device as described 3.2.1: test mode, no tap changer, three-phase test, test **HV** side, HV configuration **YN**, set test current of 10 A and start the test. Check if the voltage measured with the voltmeter is approximately $52 V_{DC}$.
3. Check if any resistance measurement value is shown on the device display and if the discharge LED is ON.
4. After 120 seconds the device should display **Open connection** error.

5. Connect phase **a** and neutral **n** cables on the X side of the device. Connect digital voltmeter between phase **a** and neutral **N**, as shown in the Figure 5.4.
6. Set the test on the TWA device as described in 3.2.1: test mode, duration unlimited, three-phase test, test **LV** side, LV configuration **yn**, set the test current of 10 A and start the test. Check if the voltage measured with the voltmeter is approximately 52 V_{DC}.
7. Check if any resistance measurement value is shown on the device display and if the discharge LED is ON.
8. After 120 seconds the device should display **Open connection** error.
9. If measured voltages in both steps are not approximately 52 V_{DC} please contact the DV Power Support Team. Otherwise, please proceed to the next step.



Figure 5.3 – Open circuit voltage check - HV



Figure 5.4 – Open circuit voltage check - LV

5.3 Test Currents and Voltage Measurement Check

1. Connect the TWA device and test shunt R_1 (1 Ω) as shown in the Figure 5.5. Connect phase **A**, **B** and **C** cables to one side of the test shunt and neutral **N** cable to the other side. Connect DC voltmeter in parallel to the test shunt.
2. Set the test on the TWA device as described in 3.2.1: test mode, duration unlimited, three-phase test, test **HV** side, HV configuration **YN**, set the first test current from the Table 5.3 and start the test. Read resistance values measured with the TWA device, the voltages measured with voltmeter and compare them to the expected values. Repeat this step for all test currents from the Table 5.3.
3. Connect the TWA device and test shunt R_2 (10 m Ω) as shown in the Figure 5.6. Connect phase **A**, **B** and **C** cables to one side of the test shunt and neutral **N** cable to the other side. Connect DC voltmeter in parallel to the test shunt.
4. Set the test according point 2, set the first test current from the Table 5.4 and start the test. Read resistance values measured with the TWA device, voltages measured with voltmeter and compare them with the expected values. Repeat this step for all test currents listed in the Table 5.4.
5. If measured voltages and resistances do not differ significantly from the expected ones, the device is measuring correctly.



Figure 5.5 – Voltage measurement check – 1 Ω

I [mA]	R ₁ [Ω]			V ₁ [mV]		
	AN	BN	CN	AN	BN	CN
10						
100						
1000						

Table 5.3 – Voltage measurement check – 1 Ω
Figure 5.6 – Voltage measurement check – 10 mΩ

I [A]	R ₂ [mΩ]			V ₂ [mV]		
	AN	BN	CN	AN	BN	CN
2						
5						
10						

Table 5.4 – Voltage measurement check – 10 mΩ

5.4 The Current Recording Check Using DV-Win Software

1. Connect the TWA and test shunt R₁ (1 Ω) as shown in the Figure 5.1. Connect phase **A**, **B** and **C** cables to one side of the test shunt and neutral **N** cable to the other side. Connect the current clamp to the device.
2. Connect the TWA device to PC using the USB cable. Switch the instrument ON. If the instrument is connected to the PC for the first time, it may be necessary to wait until the USB drivers are installed. When the driver installation is finished, the message “Your device is ready for use” should appear in the lower right corner of the screen.
3. Set the current clamp to 30 A and press the Zero button on the clamp.
4. Start the DV-Win program on the PC. The DV Win will detect the instrument. If the instrument is not detected click on the "New" icon. It will detect the instrument and start the program if everything is working properly.
5. DV-Win will display: “Please wait” for 10 seconds. The current clamp is being zeroed. Do not change the current clamp position or settings until the measurement described in #10.
6. Select the Tap changer mode tab and select following parameters:
 - Test object: Transformer;
 - Number of phases: Three-phase;
 - Measured side: HV side;
 - HV winding configuration: YN;
 - Test current: 10 A;
 - Tap Changer checkbox is checked;
 - Type: OLTC (On-load);
 - Tap changer settings: Standard;
 - Total taps: 3;
 - Direction: UP;
 - Multiple nominal positions: NO;
 - Tap changer detection trigger: Ripple trigger;
 - Dynamic resistance measurement (DVtest) checkbox is checked;
 - Test type : Three-phase (synchronization);
 - Recording: Continuous;
 - Current clamp range: 20/30.
7. Press START to start the test.
8. After the charging process is completed press OMEGA to start recording the current.
9. Real time graph plot contains graphs of three phases (red, black, yellow) and motor current graph (green).
10. The current graphs should have linear shape without disturbances.
11. The sum of current of all three phases should be equal to test current 10 A.
12. The currents of all three phases should be approximately equal.
13. The motor current (green graph) should be close to 0 (lower than 0,5 A).

14. Connect the CT clamp to the neutral (blue) cable connected to the HV side. Check the current on the motor current graph (green). This value should be equal to the total test current 10 A.

5.5 TestCom Diagnostic Software

In case the TestCom diagnostic software is not provided, please contact the DV Power Support Team to request the latest version.

1. Connect the device to the computer and turn it ON.
2. Run the TestCom.exe file.
3. Click Connect to establish communication between the device and the computer.
4. Click Start and a log file will be generated in the same folder where TestCom.exe is located.
5. Send the log file to DV Power Support Team for analysis.

Note: If experiencing problems with running TestCom.exe, please install the Patch.exe, which is included in the TestCom archive. After the installation, it should be possible to run TestCom.exe.

6 Customer Service

Before calling or sending an e-mail to Customer Service for assistance, please perform the following steps:

1. Check all cable connections.
2. If possible, try testing on another instrument of the same type
3. Provide following information: instrument serial number, instrument's installed software revision number, details about a PC configuration used and operating system installed.
4. As comprehensive as possible description of the problem, including DUT (Device under Test), error messages and the sequence of events before the problem appeared.

The DV Power Customer Service can be reached at:

Local support (Sweden): +46 8 731 78 24

International support: +46 70 0925 000

E-mail: support@dv-power.com

Note: The preferred contact is via e-mail. In this way the case is documented and traceable. Also time zone problems and busy telephone lines do not delay the response.

7 Packing the Instrument for Shipment

Prior to sending the instrument to DV Power for servicing, please contact the DV Power Customer Service at:

Local support (Sweden): +46 8 731 78 24

International support: +46 70 0925 000

E-mail: support@dv-power.com

Note: DV Power is not responsible for any damage during shipping. Please carefully protect each instrument from shipping and handling hazards. Ensure the protective covers are securely in place. Instrument has to be sent to DV Power as freight pre-paid, unless other arrangements have been authorized in advance by the DV Power Customer Service.

To prepare an instrument for shipment:

1. Disconnect and remove all external cables. Do not include manuals, cables, and transducer connecting rods unless recommended by DV Power Customer Service.
2. Reuse the original packing material if it is available.

If it is not available:

Pack the instrument following a practice used for fragile electronic equipment. It has to include a 2-wall minimum corrugated cardboard box with minimum 5 cm thick poly foam padding, or a wooden crate with minimum of 5 cm thick poly foam pads wrapping the instrument completely.

8 Technical Data

Mains Power Supply

- Connection: according to IEC/EN60320-1; C320
- Voltage: 90 V – 264 V AC, 50 / 60 Hz, single-phase
- Input power 1200 VA
- Frequency: 50 / 60 Hz
- Fuse: 12 A / 250 V, type F

Output Data

- Test current for TWA25A model 5 mA DC – 25 A DC
- Test current for TWA40D model 5 mA DC – 40 A DC

Measurement

Measuring range	/	Resolution
0,1 $\mu\Omega$ - 999,9 $\mu\Omega$		0,1 $\mu\Omega$
1,000 m Ω - 9,999 m Ω		1 $\mu\Omega$
10,00 m Ω - 99,99 m Ω		10 $\mu\Omega$
100,0 m Ω - 999,9 m Ω		0,1 m Ω
1,000 Ω - 99,99 Ω		10 m Ω
100,0 Ω - 999,9 Ω		0,1 Ω
1000 Ω - 9999 Ω		1 Ω
• Typical accuracy		\pm (0,1 % rdg + 0,1 % FS) for 0,1 $\mu\Omega$ – 1,999 k Ω range \pm (0,2 % rdg + 0,1 % FS) for 2,000k Ω – 9,999 k Ω range
• Guaranteed accuracy		\pm (0,2 % rdg + 0,2 % FS)

Environmental Conditions

- Operating temperature -10 °C – +55 °C
- Storage temperature -40 °C – +70 °C
- Maximum relative humidity 95 % non-condensing

Dimensions and Weight

- Dimensions (W x H x D) 480 x 197 x 395 mm
- Weight 12,8 kg

Applicable Standards

- Installation/overvoltage: category II
- Pollution degree 2
- Low voltage directive: Directive 2014/35/EU (CE conform)
Applicable standards, for a class I instrument, pollution degree 2, installation category II: IEC EN 61010-1
- Electromagnetic compatibility Directive 2014/30/EU (CE Conform)
Applicable standard EN 61326-1
- CAN/CSA-C22.2 No. 61010-1, 2nd edition, including Amendment 1

9 Accessories

Included accessories	Article No
DV-Win PC software including USB cable	
Built-in Tap Changer Control Unit	
Tap Changer Control cable 5 m	
Mains Power cable	
Ground (PE) cable	

Recommended Accessories	Article No
H winding test lead set, 4 x 10 m with TTA clamps	HC-10-4LMCWC
X winding test lead set, 4 x 10 m with TTA clamps	XC-10-4LFCWC
Current clamp 30/300 A power supplied from the instrument with 5 m extension *	CACL-0300-06
Transport case	HARD-CASE-LC
Cable plastic case	CABLE-CAS-03

* Recommended for the TWA40D model

Optional Accessories	Article No
H winding test lead set, 4 x 15 m with TTA clamps	HC-15-4LMCWC
X winding test lead set, 4 x 15 m with TTA clamps	XC-15-4LFCWC
H winding test lead set, 4 x 20 m with TTA clamps	HC-20-4LMCWC
X winding test lead set, 4 x 20 m with TTA clamps	XC-20-4LFCWC
Test shunt 1 m Ω (150 A / 150 mV)	SHUNT-150-MK
Bluetooth communication module	BLUETOOTH-00

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