TRT3x

THREE-PHASE TRANSFORMER

TURNS-RATIO TEST INSTRUMENT

Manual

DVpower

Contents

Manual Version: M-T03XNN-205-EN

This Manual refers to the following TRT3x models and their corresponding firmware versions

Model	Firmware versions
TRT30A	TR3A-5.15
TRT30B	TR3B-5.15
TRT30C	TR3C-5.15
TRT33A	TR1A-5.15
TRT33B	TR1B-5.15
TRT33C	TR1C-5.15

1 Introduction

The purpose of this Manual is to provide helpful instructions on how to use TRT3x instrument 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 TRT3x instrument.

TRT3x 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 TRT3x, please read the following safety instructions carefully.

It is not recommended that TRT3x is used (or even turned on) without careful observation of the instructions listed in this Manual. TRT3x should only be operated by trained and authorized personnel.

1.1.1 Safety Terms and Symbols

Terms in this Manual

These terms may appear in the Manual:
WARNING: Warning indicates that potential hazard may occur.
CAUTION: Caution indicates that potential damage may occur to the instrument or to the test object connected to the instrument.

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 Device

The following symbols may appear on the device:

Refer to Manual

Protective Earth Terminal

1.1.2 Terms of Use

- TRT3x 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.
- TRT3x shall be used only for the application purposes described in the ”Intended Use” section. The manufacturer and distributors are not liable for damage resulting from wrong usage. The user bears responsibility for not following the instructions defined in this document.
- Do not remove the protective casing of TRT3x.

1.1.3 Orderly Practices and Procedures

- The Manual shall always be available on the site where TRT3x is used.
- Before using TRT3x, all personnel (even personnel who only occasionally, or less frequently, work with TRT3x) assigned to operate TRT3x should read the operations Manual.
- Do not make any modifications, extensions, or adaptations to TRT3x.
- Use TRT3x only with the original accessories provided by the manufacturer.
- Use TRT3x and its original accessories for the device's intended use only.

1.1.4 Instrument 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 TRT3x should only be carried out by authorized and qualified personnel.
- Personnel receiving any training or instructions on TRT3x should remain under 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 TRT3x. Therefore, it is not permitted to remove the protective casing of TRT3x.
- Hazardous voltages exist on the terminals of TRT3x when the "Red" LED is lit. Never assume connections are safe even if this LED is off. Switch off and unplug TRT3x before touching connections, particularly if a fault is suspected.
- Before putting TRT3x into operation, check the test set for any visible damage.
- Do not operate TRT3x under wet or moist conditions (condensation).
- Do not operate TRT3x if explosive gas or vapors are present.
- Only external devices that meet the requirements for SELV equipment according to EN 60950 or IEC 60950 should be connected to TRT3x through the serial interface.
- Removing theTRT3x protective casing will void the warranty. Any work inside the instrument without prior authorization from DV Power will also void the warranty.
- If TRT3x 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 TRT3x, ensure that a 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 TRT3x. Ground connections may be left in place.
- Do not use TRT3x without the extra protective ground cables supplied with TRT3x. It must never be operated in a non-grounded configuration as this may result in an electrical shock to the user or damage to TRT3x. Always establish this connection first before establishing any other connections and remove this connection as the very last one.
- 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).

- Never exchange connections to the HV and LV sides of the transformer. The “H” connections must always be connected to the High Voltage side of the transformer. The “X” connections must always be connected to the Low Voltage side of the transformer. Interchanging any or all of the connections may result in damage to the transformer or TRT3x and is a significant safety hazard to personnel.

1.2 Power Supply

- Supply TRT3x only from a power outlet equipped with a protective ground.
- Besides supplying TRT3x 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 section “Technical Data”.
- TRT3x 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 Measurement Category

TRT3x is intended to be used for measurements in Measurement Category I (CAT I) for voltages up to 250V. The device is also designed to withstand occasional transient overvoltage up to 1000Vpk.

WARNING / AVERTISSEMENT

This equipment is classified as measurement category I, and must not be used within measurement category II, III and IV.

Cet équipement est classée dans la I catégorie de mesure, et ne doit pas être utilisé pendant les catégories de mesure II ,III et IV.

1.4 Intended Use

The Three-phase Transformer Turns Ratio Tester TRT3x is designed specifically for performing measurements on power, distribution and measurement transformers as follows:

- turns ratio measurement
- phase shift measurement
- excitation current measurement

These three tests are performed at the same time. TRT3x applies test voltage to HV transformer terminals and measures induced voltage at LV transformer terminals. The ratio of these voltages is actually the turns ratio of a transformer. At the same time, TRT3x measures the excitation current at the HV transformer side, as well as the phase angle between the applied test voltage and induced voltage.

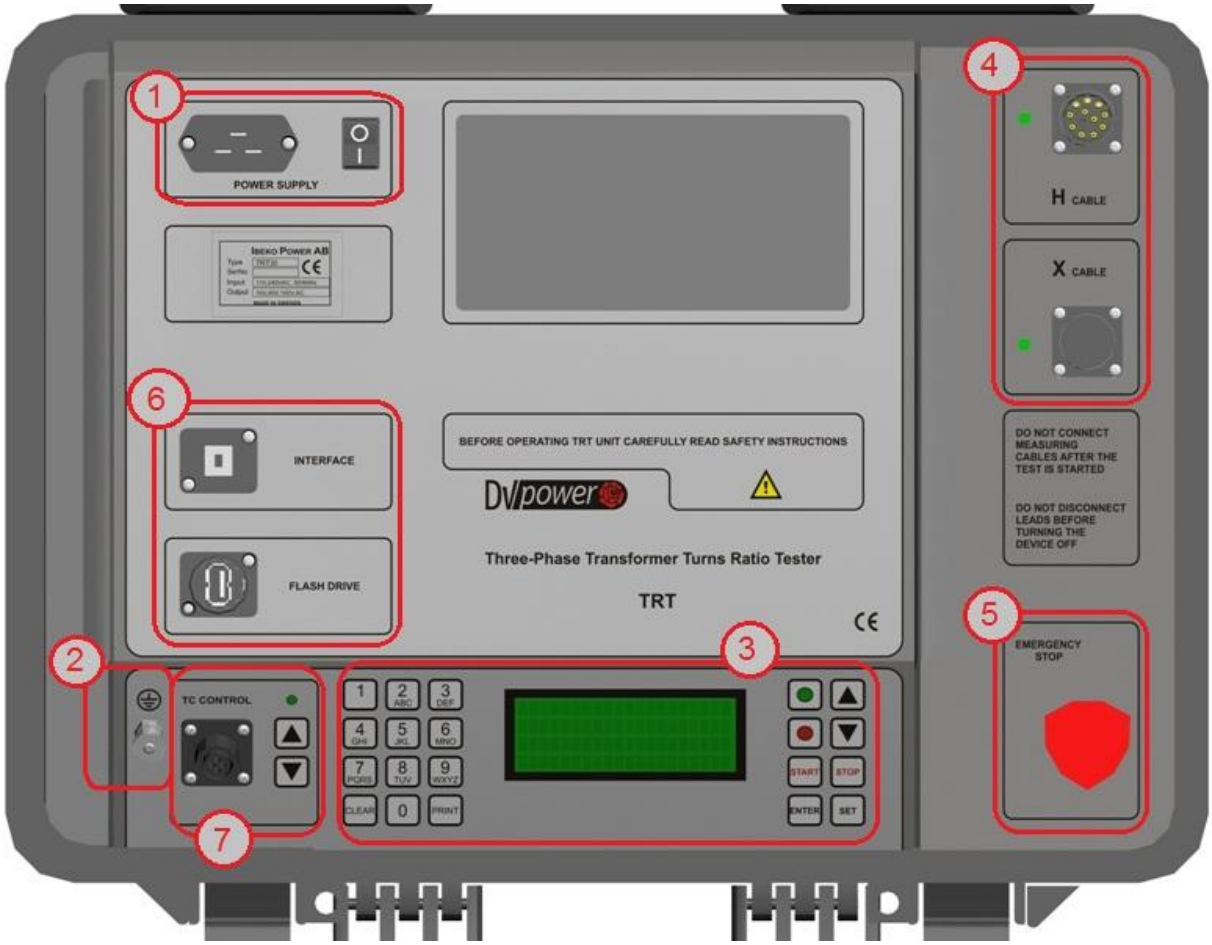
There are three ways to perform the measurements depending on the test object and a test voltage. If the test object is a single-phase transformer, a single-phase autotransformer or a current transformer, TRT3x provides a single-phase test voltage to the transformer’s primary side and measures the induced voltage at the transformer’s secondary side.

If the test object is a three-phase transformer or a three-phase autotransformer, TRT3x can apply either three single-phase test voltages in turns or a true three-phase test voltage to the transformer primary windings. Three induced voltages at the transformer's secondary side are measured.

Please note any use of TRT3x other than the ones described in this Manual are considered improper and will void the device warranty.

2 Description

2.1 Front Panel Components



1. Mains Power Connector and Power Switch

Mains power connector

Connect TRT3x to the mains power supply with a power cord.

Power switch – Double pole switch

- **I** In this position, TRT3x is connected to the mains power supply.
- **0** In this position, TRT3x is separated from the mains power supply.

2. Protective Earth Connector

For protection against parasitic currents or voltages, always connect TRT3x protective earth connector to the protective ground (PE). Use only the original cable.

For safety reasons, always establish this connection before establishing any other connection, and remove this connection as the very last step.

3. Operator Control

Display

Displays the settings during the device programming as well as the measured values during a test operation.

Keyboard

Used to control the device.

- Use the UP/DOWN button to navigate and set the test parameters.
- Use the ENTER button to confirm the defined test parameters, language, time and date.
- Use the STOP button to stop a test, to acknowledge the alarm buzzer and to return to the previous menu.
- Use the SET button to scroll between the two main menus and the START button to start the test.
- Use the PRINT button to print the results with the built-in thermal printer. The built-in thermal printer is an optional accessory.

Green LED

- Lights continuously when TRT3x is turned on.
- Flashes when a test can be started.

Red LED

- Lights continuously in case of an operational error.
- Lights continuously when a test is started and a test voltage is applied.

4. H and X Terminals

H cable terminal

The terminal for connecting the H test cable.

X cable terminal

The terminal for connecting the X test cable.

5. Emergency Stop

Turns off output voltage in case of an emergency.

6. Interface and Flash Drive Connectors

Interface

TRT3x is equipped with an USB serial interface to connect to external computer if required.

Flash Drive

TRT3x is equipped with a USB flash drive connector to save test results to a flash drive for additional analysis if desired.

7. TC Control

TC Connector

Output for the remote control of the transformer tap changer.

- Use the UP button to raise the tap changer position.
- Use the DOWN button to lower the tap changer position.

3 Getting Started

3.1 Connecting TRT3x to a Test Object

Before TRT3x has been connected to a test object (e.g. power transformer), the following steps have to be verified:

- The test object is disconnected from its circuit in accordance with the national safety regulations and is properly grounded to the protective earth.
- The transformer is completely de-energized.
- TRT3x itself should be properly grounded. To do this, the grounding screw on the top of TRT3x should be connected to PE using the provided grounding cable.

Note: ***Always connect measuring cables to TRT3x first and then to the test object terminals. Additionally, measuring cables can be connected to the test object terminals first, but only if the test object terminals are grounded.***

When disconnecting, always disconnect cables from the test object terminals first and then from TRT3x. Additionally, measuring cables can be disconnected from TRT3x first, but only if the test object terminals are grounded.
The grounding wire PE should be disconnected last.
Not following these instructions may cause life-threatening situations.

Cable test leads are terminated with the specially adjusted clips. The colors and markings of the test cables are shown in the Table 1.

Table 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

If the primary neutral connection does not exist, the 1N (H0; N) lead should be left isolated from the transformer (i.e. the test object) and from the other connection leads. It must be placed in such a way that it is completely isolated from other connections or earth. No personnel should be in a position to touch it!

To maximize the accuracy and measurement repeatability, make sure 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 the same way as the secondary. The transformer is energized using the high voltage windings. 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.

3.2 Setting the Measurement Parameters

Five seconds after the first (initial) message on the display, TRT3x automatically changes the display to the **CONFIGURATION** menu and the green LED lights up. By pressing ***SET*** the user can switch between the **CONFIGURATION** menu and the **MEMORY** menu.

Press ***UP/DOWN*** in the HV CONFIG field to select the test mode to be performed. A list of the available test modes is shown in the Tables 2 and 4.

Table 2: *Available options in the configuration menu*

HV Config.	***LV Config.***	***Ph Displacement***	***Comment***	***Test mode***
D	displayed	displayed	Delta winding	Phase by phase test using single-phase voltage in turns & the true 3-phase test using 3-phase voltage
Y	displayed	displayed	Star winding	
YN	displayed	displayed	Star winding with neutral point	
Z	displayed	displayed	Zigzag	
ZN	displayed	displayed	Zigzag with neutral point	
AVGD	hidden	hidden	Automatic vector group detection	
SINGLE	hidden	hidden	Single-phase transformer	Single phase test using single-phase voltage
CT	hidden	hidden	Current transformer (CT)	
TRUE 3~ TEST	hidden	hidden	Only true three-phase test	True 3-phase test using 3-phase voltage
AUTO	hidden	hidden	Autotransformer menu	See the Table 4

Press ***ENTER*** to choose one of the available options in the configuration menu.

1. If the vector group is selected, TRT3x will perform both the true three-phase test by applying true three-phase test voltage and the phase by phase test by applying single phase test voltages to all phases in turn.
2. If SINGLE is chosen, TRT3x will test a single phase transformer by applying the single phase test voltage between 1U/H1/A and 1N/H0/N.
3. If CT is chosen, TRT3x will test a current transformer by applying the single phase test voltage between 1U/H1/A and 1N/H0/N.
4. If AUTO is chosen, TRT3x will display the special menu for autotransformers to the user.
5. If the AVGD option is selected, TRT3x will automatically detect the vector group of the transformer under test.
6. If TRUE 3~ TEST is selected, TRT3x will perform the true three-phase test by applying the true three-phase test voltage.

Table 3 lists the available vector groups in this menu.

Table 3: *Available vector group configurations*

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

Available options in the **AUTOTRANSFORMER** menu are listed in the Table 4.

Table 4: *Available options in the autotransformer menu*

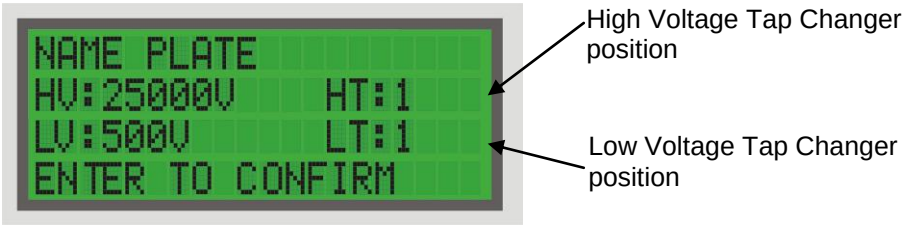
Config	*PH Displacement*	*Comment*	*Test mode*
Da	displayed	Delta winding	Phase by phase test using single-phase voltage in turns or true 3-phase test using 3-phase voltage, depending on a particular vector group.
Ya	displayed	Star winding	
YNa	displayed	Star winding with neutral point	
Za	displayed	Zigzag	
ZNa	displayed	Zigzag with neutral point	
AVGD	hidden	Automatic vector group detection	
TRUE 3~ TEST	hidden	Only true three-phase test	True 3-phase test using 3-phase voltage
SINGLE	hidden	Single-phase autotransformer	Single-phase test using single-phase voltage

Table 5: *Available autotransformer vector groups*

Configuration	*PH displacement*
Ya, YNa	0-4-8
Da, Za, ZNa	0-1-2,…11

If a ratio deviation calculation is enabled, the following menu is displayed to enter the name plate voltages and the tap changer positions:

Figure 3-1:
Input name plate voltages values



If the name plate voltages are not entered, TRT3x will perform the test and display the results, but it will not calculate or display the turns ratio deviation. After the name plate voltages and tap changer position(s) are entered, press ***ENTER*** to confirm a selection. The next display allows a selection of the test voltage.

Figure 3-2:
The test voltage selection

TRT3x generates both single-phase and true three-phase test voltages. When generating a single-phase excitation voltage, TRT3x supplies a single-phase excitation test voltage to each of the three transformer primary windings in turn. The induced voltages across each of the corresponding unloaded transformer windings are then measured. The ratio of these voltages is calculated and presented on the display. It is repeated for all three phases.

When generating a true three-phase test voltage, TRT3x generates a true three-phase excitation test voltage to three transformer primary windings. The induced three-phase voltages across the unloaded transformer windings are measured and the transformer turns ratio is calculated.

Test voltages of 1 V, 8 V, and 10 V are recommended for current transformers (CT) testing. For testing distribution or power transformers it is recommended to use the highest test voltage of 100 V or 80 V. Otherwise a test voltage of 40 V can also be used. Pressing ***UP/DOWN*** the user selects the value of his/her choice and then confirms it by pressing ***ENTER***.

TRT3x automatically detects if it is connected to a DC power supply. It also automatically detects if the power supply frequency is 50 Hz or 60 Hz. The frequency of the output voltage is the same as the frequency of the power supply of TRT3x. In case TRT3x is connected to a DC power supply, the user has to choose the frequency of the output voltage to be either 50 Hz or 60 Hz.

After the test voltage (and frequency) is selected, the user can select a memory location manually (Test Reading and Test Record). ***SET*** is used to scroll between the Test Reading and Test Record options. Selection of Test Reading or Test Record is performed by using ***UP/DOWN.*** Pressing ***ENTER*** confirms a selection.

Test Reading can contain, for example, all the test results obtained in one tap changer position of the transformer. Test Record can contain the results of all tap changer positions, or the complete results obtained from one transformer.

Note: Manual selection of record/reading will delete results from the existing memory locations.

Once these parameters are defined, pressing ***ENTER*** changes the status to the **READY** state.

Figure 3-3:
The **READY** state before the test

If one of the values has to be changed, press ***STOP*** to return to the previous menu.

The flashing green LED indicates TRT3x is now ready to start the test. Press ***START*** to run a test. During the test, the red LED glows continuously signaling that the test voltage is applied. Pressing ***STOP*** (the **CONFIGURATION** menu is displayed) will interrupt (abort) the test. When the test is completed, TRT3x displays the test results. To scroll between all the results press ***ENTER***. Once all the results are viewed, user can choose whether to test the next tap or to finish the test.

If the AVGD option is selected in the **CONFIGURATION** menu, TRT3x will try to automatically detect a vector group of the transformer being tested. The user will be asked whether to continue the test with a detected vector group or to select one of the available vector groups. If for some reason the vector group cannot be detected, the device will display the message “Unable to detect vector group” and the test will be aborted. Once the vector group is detected and confirmed, TRT3x continues with the test. After the test is finished, TRT3x displays the test results. To scroll between all the results, the user will press ***ENTER***. Once all the results are viewed, user can choose whether to test the next tap or to finish the test.

4 Error Messages

Any operational error is indicated by a red LED and an additional audio alarm. Furthermore, the display indicates an error status message. To remove the status message on the display and return to the main menu, press ***STOP***.

4.1 Error Message “Excitation current too high”

This message is displayed if the excitation current exceeds expected values. This value is set to 500 mA. The excitation current can be reduced by selecting lower test voltages from the device menu.

Figure 4-1:
Error message
"Excitation current too high"

Possible reason for this is the transformer is drawing too much current. In that case, the test should be repeated with a lower test voltage. Another reason may be the connections are reversed. If there are no connections errors found, there may be a short circuit within the transformer itself.

4.2 Error Message “Turns ratio too low”

This message is displayed if the turns ratio of the transformer under the test is lower than 0,8. In this case the user should check whether H and X cables are misplaced (reversed).

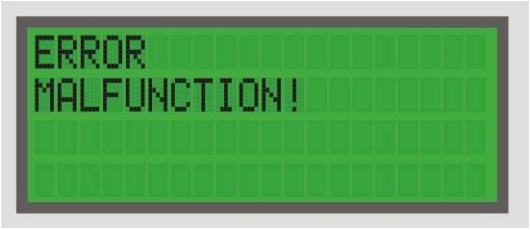
Figure 4-2:
Error message
"Turns ratio too low’’

4.3 Error Message “Malfunction”

In the case of an internal error, TRT3x will display the massage “Malfunction”. In this case, TRT3x device should be restarted.

If the error occurs repeatedly, please contact the DV POWER Support Team (refer to the Section ”Manufacturer Contact Information”).

Figure 4-3:
Error message
“Malfunction”

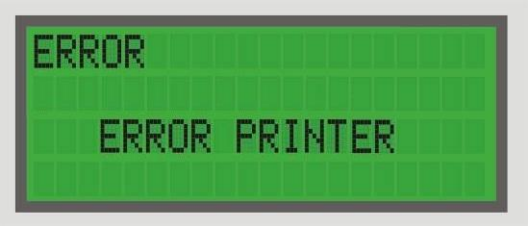


4.4 Error Message “Error printer”

This message appears related to a potential problem with the printer. In this case, please contact DV POWER Support Team (refer to the Section ”Manufacturer Contact Information”).

This message is also displayed if the user tries to print the results from the device which has no built-in thermal printer installed.

Figure 4-4:
Error message
"Error printer"



4.5 Error Message “Check paper”

The message “Check paper” is displayed if the printer is out of paper.

Figure 4-5:
Error message
"Check paper"

4.6 Error Message “USB flash drive”

If the USB flash drive is not plugged in while trying to export the data, the error message shown below will be displayed.

Figure 4-6:
Error message “USB flash drive”

4.7 Error Message “Connect both neutral cables”

If one of the neutral cables is not connected to the autotransformer during the AVGD test, this message will be displayed. User needs to connect both neutral cables to avoid this message.

Figure 4-7:
Error message “Connect both neutral cables”

4.8 Error Message “Emergency Stop”

This message is displayed when the “Emergency stop” button on the front panel of the device is pressed. Release the “Emergency stop” button by rotating it clockwise.

Figure 4-8:
Error message
"Emergency stop"

4.9 Error Message “Connections”

The “Connections” is displayed if the H or X cables are not connected properly to TRT3x. There are also green LED lights next the connectors that lights up to indicate these connectors are connected properly.

Figure 4-9:
Error message
"Connections"

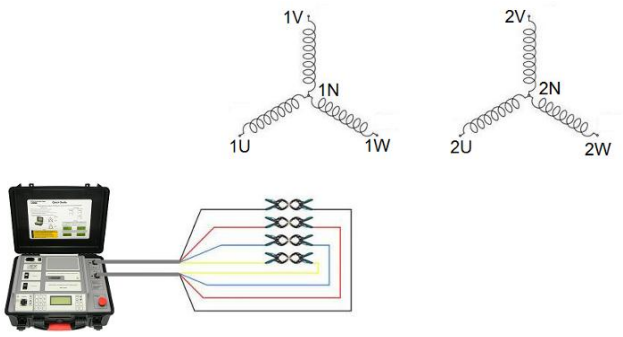
5 Troubleshooting Guide

In case the operator experiences problems with wrong results while measuring a three-phase transformer, a recommendation is to perform the steps listed below:

Check that all connections to the transformer side are properly done. If everything is OK and still have wrong results, continue with the next 3 steps.

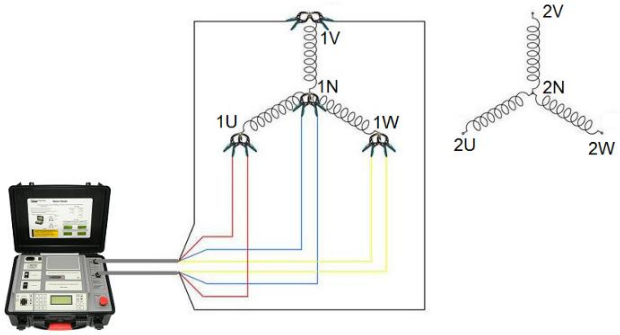
1. Disconnect all test cables from the transformer side. Connect the primary side clamps (red color marked) to the secondary side clamps (white color marked) matching the colors of the cables; red to red, black to black, yellow to yellow (white to white) and blue to blue as shown on the figure below. After that select the TRUE 3~ TEST from the menu and perform the test three/four times, using each test voltage. Save all results.

Figure 5-1:
TRUE 3~ test
Short circuited clamps



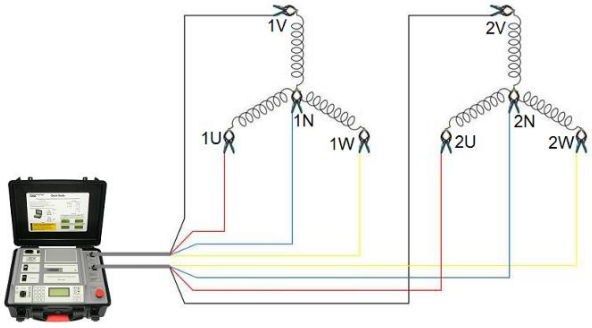
2. Connect the shorted primary and secondary cables (clamps) of TRT3x instrument to the primary side of the transformer as shown in the figure below. Perform the test three/four times, using each test voltage. Save all results.

Figure 5-2:
TRUE 3~ test
Short circuited clamps connected on the transformer primary side



3. Take the secondary cables (clamps) of TRT3x instrument from the primary side of the transformer and connect them to the secondary side of the transformer as shown in the figure below. Perform the test three/four times, using each test voltage. Save all results.

Figure 5-3:
TRUE 3~ test



Send all results to the manufacturer via e-mail address **support@dv-power.com** together with the description of the operating conditions and all relevant information during the test, to be able to analyze the

6 Customer Service

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

- Check all cable connections.
- If possible, try testing on another instrument of the same type
- Perform the troubleshoot procedure as described above in the Section “Troubleshooting Guide”.
- Provide following information: instrument serial number, instrument's installed software revision number, details about a PC configuration used and operating system installed.
- 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

for the return instructions.

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 the instrument for shipment:

- Disconnect and remove all external cables. Do not include manuals and cables unless recommended by the DV Power Customer Service.
- 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 (2 inch) thick poly foam padding, or a wooden crate with minimum of 5 cm (2 inch) thick poly foam pads wrapping the instrument completely.

8 Technical Data

8.1 Mains Power Supply

- Connection: According to IEC/EN60320-1; UL498, CSA 22.2
- Voltage: 90 – 264 V AC, or 110 – 350 V DC
- Frequency: 50 – 60 Hz
- Input power: 200 VA
- Fuse: 2 A / 250 V, type F, but not user replaceable

8.2 Output data

Model	Output voltages available
TRT30A	8, 40, 100 V AC 3 x (8, 40, 100)√3 V AC
TRT30B	10, 40, 100 V AC 3 x (10, 40, 100)√3 V AC
TRT30C	8, 40, 80 V AC 3 x (8, 40, 80)√3 V AC

Model	Output voltages available
TRT33A	1, 8, 40, 100 V AC 3 x (1, 8, 40, 100)√3 V AC
TRT33B	1, 10, 40, 100 V AC 3 x (1, 10, 40, 100)√3 V AC
TRT33C	1, 8, 40, 80 V AC 3 x (1, 8, 40, 80)√3 V AC

8.3 Measurement

- Turns ratio measuring range: 0.8 to 15 000
- Turns ratio resolution: 5 digits
- Typical turns ratio accuracy:

0.8 - 999: ±0.05 %	1000 - 3999: ±0.05 %	4000 - 15000: ±0.1 %	@80 or 100 V AC
0.8 - 999: ±0.05 %	1000 - 3999: ±0.1 %	4000 - 15000: ±0.2 %	@40 V AC
0.8 - 999: ±0.05 %	1000 - 3999: ±0.1 %	4000 - 15000: ±0.2 %	@8 or 10 V AC
0.8 - 999: ±0.05 %	1000 - 1999: ±0.1 %		@1 V AC

- Guaranteed turns ratio accuracy:

0.8 - 999: ±0.125 %	1000 - 3999: ±0.125 %	4000 - 15000: ±0.25 %	@80 or 100 V AC
0.8 - 999: ±0.125 %	1000 - 3999: ±0.25 %	4000 - 15000: ±0.5 %	@40 V AC
0.8 - 999: ±0.125 %	1000 - 3999: ±0.25 %	4000 - 15000: ±0.5 %	@8 or 10 V AC
0.8 - 999: ±0.125 %	1000 - 1999: ±0.25 %		@1 V AC

- Excitation current range 0 – 2 A
- Typical excitation current accuracy ± (0.25% + 500 µA)
- Guaranteed excitation current accuracy ± (0.25% + 1 mA)
- Excitation current resolution

0 – 9.9999 mA	0.1 µA
10 – 99.999 mA	1 µA
100 – 999.99 mA	10 µA
1 – 2 A	100 µA

- Phase angle range 360 Degrees
- Typical phase angle accuracy ± 0.05 Degrees
- Guaranteed phase angle accuracy ± 0.1 Degrees
- Phase angle resolution 0.01 Degree

8.4 Environmental conditions

- Operating temperature	-10 °C – +55 °C / +14 °F – +131 °F
- Storage temperature	-40 °C – +70 °C / -40 °F – +158 °F
- Maximum relative humidity	95% non-condensing

8.5 Dimensions and Weight

- Dimensions (W x H x D)	480 x 197 x 395 mm / 18.9 x 7.75 x 15.55 in
- Weight	8 kg / 17.5 lbs

8.6 Applicable Standards

- Installation/overvoltage category:	II
- Pollution degree:	2
- Safety	LVD 2006/95/EC (CE Conform) Standard EN 61010-1:2001
- EMC	Directive 2004/108/EC (CE Conform) Standard EN 61326-1:2006

9 Accessories

Included	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	Article No
H winding test cable 5 m, three-phase connection, with TTA clamps	HC-05-03MCWC
H winding test cable extension, 5 m, shielded	HE-05-03MCWC
X winding test cable, 5 m, three-phase connection, with TTA clamps	XC-05-03FCWC
X winding test cable extension, 5 m, shielded	XE-05-03FCWC
Cable bag	CABLE-BAG-00

Optional	Article No
H winding test cable extension, 10 m, shielded	HE-10-03MCWC
X winding test cable extension, 10 m, shielded	XE-10-03FCWC
H winding test cable extension, 15 m, shielded	HE-15-03MCWC
X winding test cable extension, 15 m, shielded	XE-15-03FCWC
H winding test cable 3 m, 3~ connection, with TTA clamps	HC-03-03MCWC
X winding test cable 3 m, 3~ connection, with TTA clamps	XC-03-03FCWC
H winding test cable 10 m, 3~ connection, with TTA clamps	HC-10-03MCWC
X winding test cable 10 m, 3~ connection, with TTA clamps	XC-10-03FCWC
H winding test lead, 3 m, 1~ connection, with TTA clamps	HC-03-01MCWC
X winding test lead, 3 m, 1~ connection, with TTA clamps	XC-03-01FCWC
H winding test lead, 5 m, 1~ connection, with TTA clamps	HC-05-01MCWC
X winding test lead, 5 m, 1~ connection, with TTA clamps	XC-05-01FCWC
Cable plastic case – small size	CABLE-CAS-01
Cable plastic case – medium size	CABLE-CAS-02
Cable plastic case with wheels – medium size	CABLE-CAS-W2
Transport case	HARD-CASE-D1
Built-in thermal printer	PRINT-112-00
Bluetooth communication module	BLUETOOTH-00
Inverter 12 V DC to 230 V AC, 50 Hz	IN650-12-230
Verification Calibrator TRTC	TRTC-05-4800
H winding test lead, 1 m, 3~ connection with banana plugs	HC-01-03MCBP
X winding test lead, 1 m, 3~ connection with banana plugs	XC-01-03FCBP

Manufacturer Contact Information

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