RMO60TD

TAP CHANGER ANALYZER
&
WINDING OHMMETER

Manual

DVpower

Contents

Manual Version: RMO60TD. MV.RT6D-8.10
This Manual refers to the firmware version RT6D-8.10

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1 Introduction

This Manual contains helpful instructions on how to use RMO60TD in a safe, proper and efficient way.

Following these instructions can help you avoid dangerous situations, repair costs and other miss happenings due to incorrect operation. Furthermore it ensures the reliability and life cycle of your RMO60TD.

RMO60TD must be used in observance of all existing safety requirements and regulations from national/local standards for accident prevention and environmental protection.

Reading the RMO60TD Manual alone does not exempt the user from the duty of complying with all national and international safety regulations relevant for working with RMO60TD.

2 Safety Instructions

Before operating RMO60TD, please read carefully the following safety instructions.

It is not recommended that the RMO60TD is used (or even turned on) without the understanding of this Manual.

RMO60TD should only be operated by trained and authorized personnel.

Rules for Use

- RMO60TD should only be used when in a technically fit condition. Its use should be in accordance with the safety regulations for the actual working site and application. Always be aware of the dangers of high voltages and currents associated with this equipment and its environment. Pay attention to the information provided in the Manual.
- RMO60TD is intended exclusively for the application areas specified in ”Designated Use”. The manufacturer and distributors are not liable for damage resulting from wrong usage. The user alone assumes all responsibility and risk.
- The instructions provided in this Manual are considered part of the rules governing proper usage.
- Do not open RMO60TD. All service and maintenance work must be performed by qualified personnel.

Orderly Practices and Procedures

- The Manual should always be available on the site where the RMO60TD is used.
- Before using RMO60TD, all personnel (even personnel who only occasionally, or less frequently, work with RMO60TD) assigned to RMO60TD should read the operations Manual.
- Do not undertake any modifications, extensions, or adaptations to the RMO60TD.
- Use RMO60TD in conjunction with original accessories only.
- Use both RMO60TD and its original accessories for its designated use only.

Cleaning

To clean RMO60TD, use a cloth dampened with isopropanol alcohol or water.

Operator Qualifications

- Testing with RMO60TD should only be carried out by authorized and qualified personnel.
- Personnel receiving training, instruction, direction or education on the RMO60TD should remain under the constant supervision of an experienced operator while working with the test set and the test object.

Safe Operation Procedures

- Hazardous voltages of up to 400 V can occur inside RMO60TD. Therefore, it is not permitted to open RMO60TD.
- Do not insert objects (e.g., screwdrivers, etc.) into the ventilation slots.
- Before putting RMO60TD into operation, check the test set for any visible damage.
- Do not operate RMO60TD under wet or moist conditions (condensation).
- Do not operate RMO60TD when explosive gas or vapors are present.
- The serial interface of RMO60TD should only have external devices connected that meet the requirements for SELV equipment according to EN 60950 or IEC 60950.
- When setting up RMO60TD, make sure that the air slots of the test set remain unobstructed.
- If RMO60TD is opened by the customer, all guarantees are invalidated.
- If RMO60TD seems to be functioning improperly, please contact the DV-Power (refer to section ”Manufacturer Contact Information”) after first checking the section Error Messages.
- Do not use RMO60TD without the extra protective ground cables for RMO60TD and winding connection.
  Always establish this connection as the first one before you do any other connections, and separate this connection as the very last one.
- Never open the measuring circuit while current flows as dangerous high voltage may occur. This is indicated by the red discharge LED and the beeper.

Power Supply

- Supply RMO60TD only from a power outlet that is equipped with protective ground.
- Instead of supplying RMO60TD 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 240 V AC, please refer to the section Technical Data.

Warning

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.

3 Designated Use

The Winding Ohmmeter RMO60TD is designed for measuring resistances of inductive test objects used in the electric power industry or similar industries. It is employed for resistance measurement during manufacturing, commissioning and testing of:

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

Any other use of the RMO60TD than the ones mentioned above is to be considered improper and will not only invalidate all customer warranty claims but also exempt the manufacturer from its liability for repair or exchange.

4 Functionality

4.1 Current Test

The RMO60TD generates a filtered (true) DC current.

RMO60TD test set can measure the winding resistance of any transformer; small or very large, single or three phase, star, delta or zig-zag connected. There are two independent measuring channels which can be used to simultaneously measure resistance of up to two windings at the same time.

Choose the test current so that the maximum value is obtained for the expected resistance (refer to section 6.1).

The inductance value of a transformer depends on the current injected in the windings. When the transformer is saturated the inductance is minimized. A transformer is normally designed to reach saturation when the current is 1,2 times the peak value of the no-load current. The no-load current is normally in the range of 0,2 % to 5 % of the nominal winding current.
When measuring the DC resistance, the test current should be at least 1,2 times the no-load current of the transformer. This is to ensure that the transformer core is saturated. Note also that the test current is NOT to exceed approximately 10 % to 15 % of the nominal winding current.

Note: The Voltage sense measuring channels are automatically selected connecting measuring cables to those channels.

At the start of each test a check of cable continuity is done. In case of open circuit, an alarm is activated, and the error message is shown on the display.

The test is started by pressing the ***START*** button. The RMO60TD injects current with a voltage as high as 60 V. This ensures the test to be as short as possible and that the desired test current is reached faster.
When the current is stabilized, RMO60TD measures the resistance of the test object. The test result is displayed as R=U/I. During the testing period, a new result is shown on the display approximately each second.

Tests could be finished or interrupted two ways:

- Pushing the ***STOP*** button,
- Automatically, after the selected time has expired.

In both cases, upon completion of the test, a measured value of the resistance is recorded to pre-selected internal memory location.

Each time the ***Ω*** button is pushed, results of the resistance, the ripple and the test current value are stored into the internal memory of RMO60TD, and memory location changes to the next one.

Minimum measurement time is 30 seconds.

By pushing the ***STOP*** button test could be completed at any time. When the ***STOP*** button is pushed, the last measured result will remain saved in the internal memory.

After the selected test time has expired, the last result remains saved at selected memory location.

Note: Using DV-Win the results could be stored to a PC, where reading interval of results is adjustable. Results will be shown in a table in Excel format with an option to perform additional edit and graphic presentation.
Using DV-Win after the test in order to transfer the results from selected internal memory location to a PC, will allow transfer of the last test result only.

When the measurement is complete, RMO60TD starts discharging the energy from the inductance. During current discharging, the red discharge LED is lit and the buzzer is ON. Discharge is complete when the discharge LED and the buzzer are OFF and when discharging message is disappeared from the display.

Both, injection of current and discharging energy from the inductance is fully automatically regulated. An intrinsically safe discharge circuit, with indicator, dissipates the stored magnetic energy rapidly after the test. The discharging circuit is independent of power supply.

Cooling of RMO60TD is supported by a built-in fan that is automatically activated when the device is turned on.

4.2 Tap Changer Test

The TapC menu offers a user friendly way of measuring winding resistance in tap changers. The RMO60TD test set measures the winding resistance of individual taps of a power transformer's tap changer, and checks whether the On-Load Tap Changer (OLTC) switches without a discontinuity. In the moment the tap is changed from tap to tap, the device detects the sudden, very short drop of the current flow. A properly working tap changer differs from a malfunctioning one in a discontinuity during the change, by the magnitude of the current ripple value.

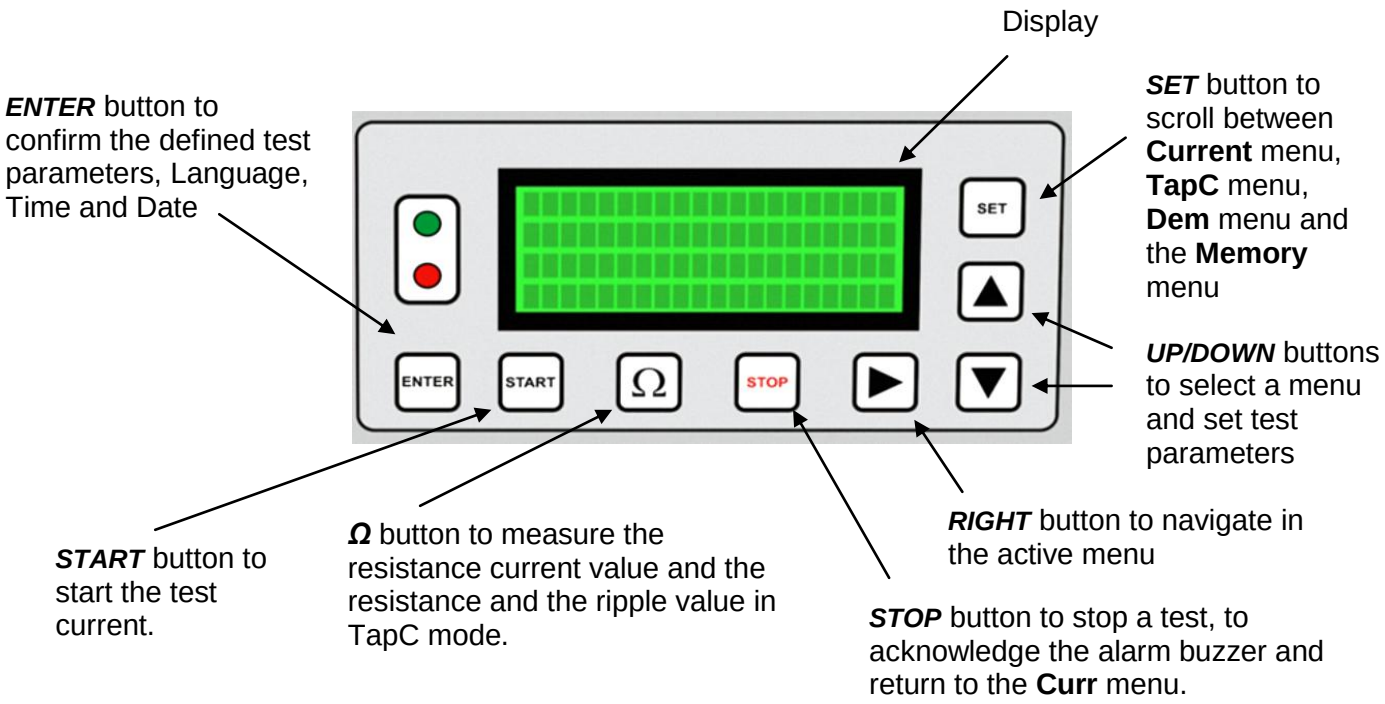
Comparison with ''fingerprint'' results, which were taken when the unit was in a known (good) condition, and comparing with other phases, allows for an efficient analysis. Disposition of all current ripple changes (or of the current flow on the graph) depends on a particular transformer and OLTC design, so it is always recommended to compare results obtained on the same unit with previous measurements.

Note: In **TapC** menu only Ch:1 is the active channel. Maximum test current selected in the **TapC** mode is 20 A.
At the start of the test a check of cable continuity is performed. In case of disconnection, an alarm is activated, and the error message is shown on the display.

Note: Using DV-Win in **TapC** menu the results could be stored to a PC. By pushing the **Ω** button a resistance result and current ripple value are stored in internal memory location, and the memory location is automatically increased to the next one.

5 Description

5.1 Front Panel Components

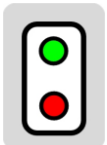


STOP
Press to stop a test or stop the alarm buzzer.

START
Press to start a test
Test parameters must be selected beforehand
Pressing ***START*** at the same time with ***SET*** allows you to go to setting menu for the language, time and date settings.

Ω
Press to measure the resistance current value.
Press to measure the resistance value in TapC mode

Green LED
• Lights continuously when RMO60TD is turned on.
• Flashes when a 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 discharging process.
• Flashes alternately with the green LED during the Current test.
• Flashes shortly during resistance measurement in the TapC test.
• Flashes alternately with the green LED during the TapC test.

Red LED - Discharge
• The red LED just above the red output connector remains lit until the accumulated energy of the measured object is reduced to a harmless level

CAUTION
Within the period when the discharge LED lights it is prohibited to disconnect measuring cables.
The discharge diode cannot be switched off by pressing ***STOP.***

5.2 Mains power and ground connectors

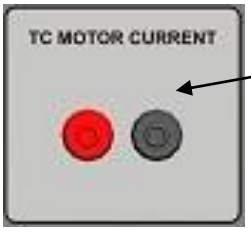
Connector for mains power supply

Power switch
I In this position, RMO60TD is connected to the mains power supply.
0 In this position, RMO60TD is separated from the mains power supply with both poles.

Earth/ground connector.
For protection against parasitic currents or voltages, always connect RMO60TD earth/ground connector to protective ground (PE). Use only the original cable.

For safety reasons, always establish this connection as the first one before you do any other connections, and separate this connection as the very last one.

Motor Current connector



AC current monitoring channel is intended for monitoring and recording the OLTC mechanical-drive motor-current during 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.

5.3 Settings

To set RMO60TD's language, time and date press ***START*** at the same time with ***SET***, to select the **Setting** menu.

Figure 5-1:
The **Settings** menu

Setting RMO60TD's Language

To set RMO60TD's language, use ***RIGHT***, and then ***ENTER*** to select the **Set Language** menu.

Figure 5-2:
The **Language** menu

Move the cursor to the bottom line using ***RIGHT***, and select the language with ***ENTER***.

Pressing ***ENTER*** to confirm returns you to the Main menu.
Pressing ***STOP*** to cancel returns you to the Main menu.

Setting RMO60TD's Time and Date

To set RMO60TD's internal time and date, use ***RIGHT***, and then ***ENTER*** to select the **Set Time and Date** menu.

Figure 5-3:
The **Time** menu showing RMO60TD's internal time and date

Move the cursor to the position of your choice using ***RIGHT*** and change the value with ***ENTER***.

Pressing ***ENTER*** to confirm, returns you to the Main menu.
Pressing ***STOP*** to cancel, returns you to the Main menu.

6 Getting Started

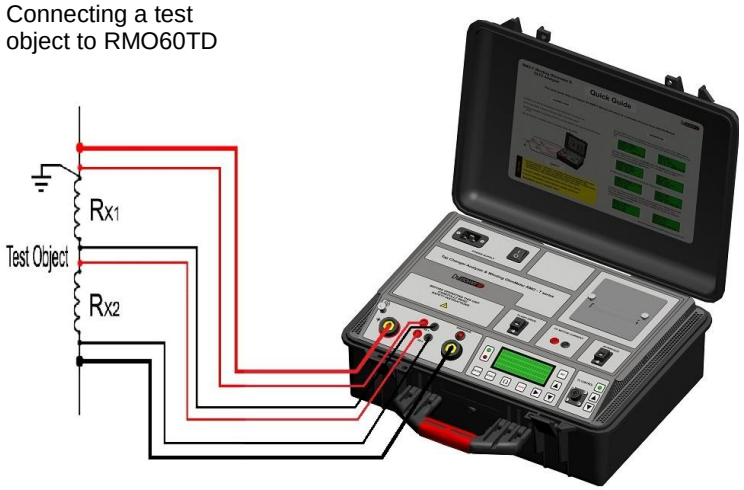
6.1 Current test

Connecting a Test Object to the RMO60TD

Before you connect a test object to RMO60TD, 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.
- RMO60TD itself is properly grounded. To do so, connect the grounding screw to PE using a grounding cable.
- One end of measured windings is properly grounded. An only exception is the case when YN connection is tested and Neutral and Earth bonds are connected between each other. Only in this case one side of the measurement circuit must not be earthed because it is not necessary and it will affect the RMO60TD reading incorrectly.
- See example of a two channel setup in the figure below (6-1).

Figure 6-1: Connecting a test object to RMO60TD



With RMO60TD turned off, connect RMO60TD to the test object in such a way that the measuring cables from the "Voltage Sense" sockets are attached as close as possible to R_X, and in between the current feeding cables. That way, resistance of both cables and clamps is almost completely excluded from the resistance measurement. **Pay attention to polarity while connecting measuring cables.**

To maximize accuracy and measurement repeatability; make sure that all clamps have a good connection to the test object and avoid any connection between Sense and Current clamps.

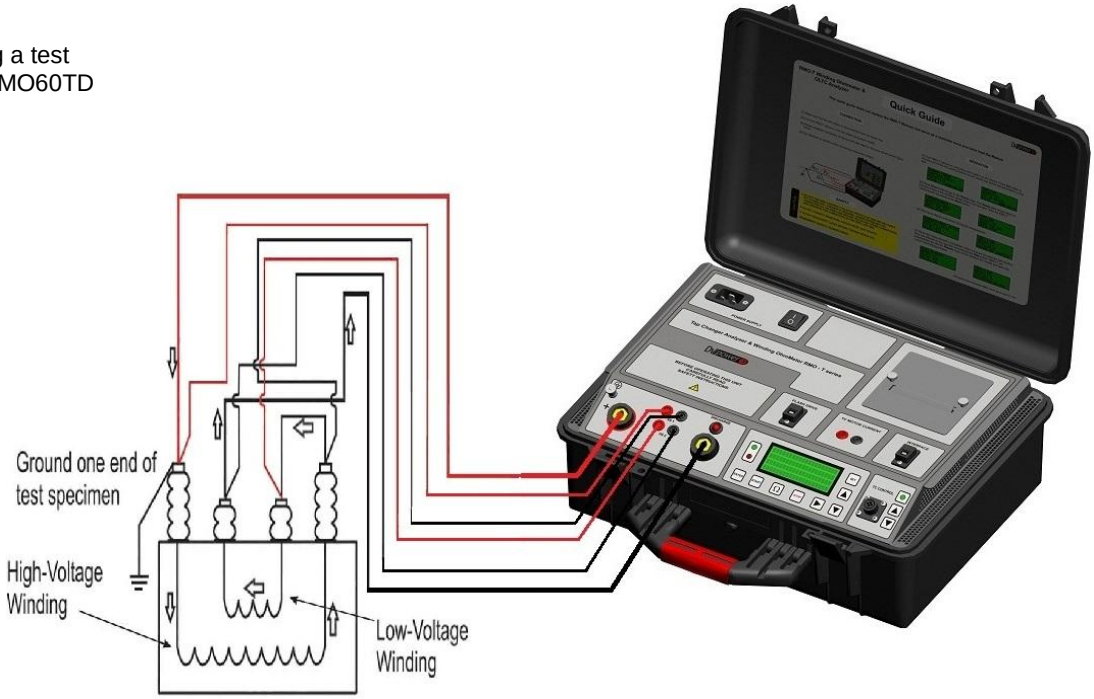
C A U T I O N

- **FOR SAFETY REASONS, ALWAYS ESTABLISH A CONNECTION OF THE DEVICE WITH TEST OBJECT IN THE WAY AS DESCRIBED IN THE FIGURE 6-1.**
- **DO NOT CONNECT MEASURING CABLES AFTER TEST STARTS.**
- **DO NOT DISCONNECT ANY LEADS BEFORE THE LED DISCHARGE AND THE BUZZER ARE OFF.**

The Figure 6-2 shows simultaneous testing of both windings (high and low) on a single-phase transformer. In such a way, it is possible to speed up the measurement when two channels are used to test both windings of the transformer.

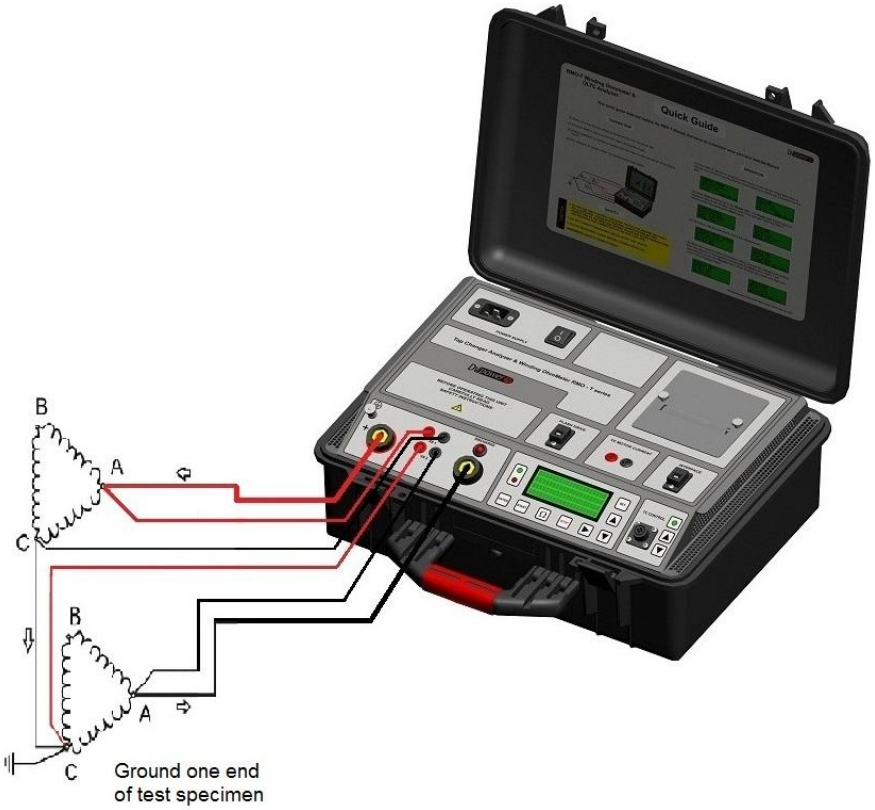
When performing a two channel measurement; connect the Current connection cable as in the example below (Figure 6-2.) and outside the Sense leads.

Figure 6-2:
Connecting a test object to RMO60TD



Testing of a Delta-delta winding resistance is usually a very time consuming procedure. This is because the two windings resemble two closed loop inductors. When energy is brought into the inductors, this energy (in the form of DC current) continually circulates within each winding. A method to quickly test this configuration requires that both the high side and low side are connected in series with the Winding Ohmmeter. By having these two windings in opposing polarity, the internal circulating currents settle very quickly to obtain a balance, and discharge with the same speed. Even if only one side of the transformer needs to be tested, connecting both high and low windings in series will speed up the test considerably.

Figure 6-3:
Connecting a test object to RMO60TD



On/Off

Connect the earth/ground lead first before doing any connections to the test object.

Connect the mains lead to a mains outlet 100 V – 240 V AC and turn on RMO60TD with the power switch on the back of the test set. The first shown on the display is the name of the product followed by the instrument model type and the internal firmware version.

Setting the Measurement Parameters

Directly after the first display RMO60TD automatically changes to the **Current** menu and the green LED lights up.

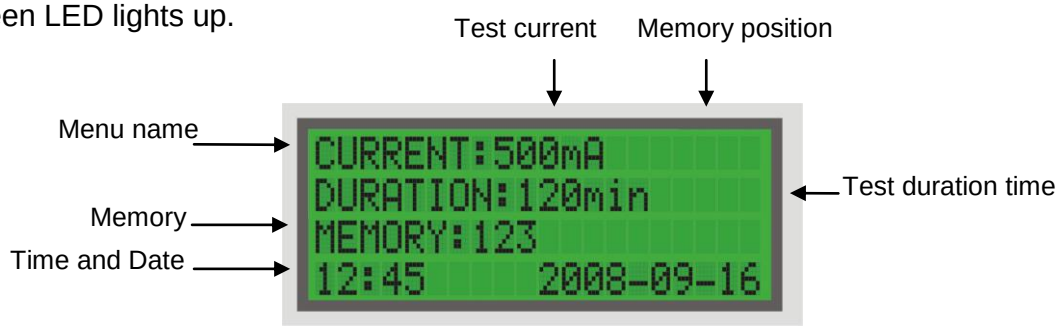


Figure 6-4: The **Current** menu

Before a test can be started, the following needs to be defined in the **Current** menu:

- Test current; the following values can be chosen:
  5 mA, 10 mA, 50 mA, 100 mA, 500 mA, 1 A, 2 A, 5 A, 10 A, 15 A, 25 A, 30 A, 40 A, 50 A and 60 A.
- Memory position, 000-499
- Test duration time.

In the **Current** menu, define a test current for the test (here **500 mA**). To do so, set the value of your choice by means of the ***UP/DOWN*** buttons. Define the test duration time and then the memory position (here **MEMORY:123**).

Using ***RIGHT*** move the cursor to the memory location position, and using ***UP/DOWN*** select the desired memory position to which obtained results would be saved. Once the test is completed (either due to time expiration or when pushing ***STOP***) the last measured result will remain registered in RMO60TD, and the memory position is automatically switched over to the next memory position. The result can be recalled later by selecting that position number.

Using ***RIGHT*** button move the cursor to the test duration position, and using ***UP/DOWN*** select desired value.

Measuring with RMO60TD

Before a test can be started, test current, memory position and the test duration time need to be defined using the **Current** menu.
Once these parameters are defined, press ***ENTER*** to change to the **Ready** state.

Figure 6-5: The **Ready** state before the test

The **Ready** state displays the selected test current and its duration is defined. If one of these values has to be changed, press ***STOP*** to return to the **Current** menu.

The flashing green LED indicates that RMO60TD is now ready to start the test. Press ***START*** to run a test. At the start of the test, a cable connection check is done. In case of e.g. a disconnection, an alarm is activated and the error message is shown on the display.

During the test, both the green and the red LEDs flash alternately. When the current is stabilized, RMO60TD starts the measurement of the test object resistance.

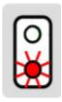
Figure 6-6:
The **Current** menu during

The display shows test current (here **498 mA**) and the effective value of the measured resistance (here **567,2 mΩ on channel 1** and **567,3 mΩ on channel 2**). The time remained until the end of test procedure is also shown on the display (here **119 min and 49 sec**). It is also shown deviation of resistance ΔR.

Test could be completed in two ways:

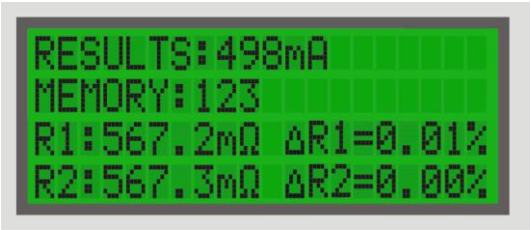
- Pushing the ***STOP*** button,
- Automatically after the selected time has expired.

When the test is finished either because selected time has expired or the *STOP* button is pressed, the RMO60TD switches to the **Results** menu and starts current discharging process. During current discharging, the discharging LED lights and the alarm beep.



Discharge is completed when LED discharge and the buzzer are OFF. Also, during that period "Discharging" message is shown on the display. During discharging process it is not possible to start another measurement.

Figure 6-7:
The **Results** menu showing the test results



Once the test is completed the last measured result will remain registered at a selected memory location (000-499 memory locations).

Discharge Current

The voltage at the RMO60TD output generation is immediately stopped, but current still flows, because of the inductivity of test objects.
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 transformer that is under test. Never remove the leads during the testing process and always allow enough time for the transformer being tested to completely discharge. Large transformers can require several minutes to discharge.

C A U T I O N

- **DO NOT DISCONNECT LEADS BEFORE "DISCHARGING" MESSAGE IS DISAPPEARED FROM THE DISPLAY AND THE DISCHARGING DIODE IS OFF.**

Figure 6-8:
Discharging message

Note:
Using DV-Win the results could be stored to a PC, where reading interval results is adjustable. Results will be shown in a table in Excel format with an option to perform additional edit and graphic presentation.
Using DV-Win after the test in order to transfer the results from selected internal memory location to a PC will allow transfer of the last test result only.

Measurement parameters

Typical accuracy given below is valid if the maximum possible current is used.

Range	Test Current	Resistance	Full Range Display	Resolution
1	60 A	1 mΩ	999,9 µΩ	0,1 µΩ
2	60 A	10 mΩ	9,999 mΩ	1 µΩ
3	60 A	100 mΩ	99,99 mΩ	10 µΩ
4	60 A	166 mΩ	166,6 mΩ	0,1 mΩ
5	50 A	290 mΩ	290,0 mΩ	0,1 mΩ
6	40 A	375 mΩ	375,0 mΩ	0,1 mΩ
7	30 A	667 mΩ	667,0 mΩ	0,1 mΩ
8	20 A	1,25 Ω	1,250 Ω	1 mΩ
9	10 A	2,5 Ω	2,500 Ω	1 mΩ
10	5 A	5 Ω	5,000 Ω	1 mΩ
11	2 A	5 Ω	5,000 Ω	1 mΩ
12	1 A	15 Ω	15,00 Ω	10 mΩ
13	500 mA	20 Ω	20,00 Ω	10 mΩ
14	100 mA	100 Ω	99,99 Ω	10 mΩ
15	50 mA	200 Ω	199,9 Ω	0,1 Ω
16	10 mA	1 kΩ	999,9 Ω	0,1 Ω
17	5 mA	2 kΩ	2000 Ω	1 Ω

The highest resolution of the reading is always displayed; resistance range selection is performed automatically and therefore is not necessary to be set by the operator.

Accuracy

Typical accuracy of RMO60TD is ± (0,2 % rdg + 0,2 % FS). 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. Guaranteed accuracy is ± (0,4 % rdg + 0,4 % FS).

Viewing the Test Results

Once a test is finished, RMO60TD automatically changes to the **Results** menu to display the test results.

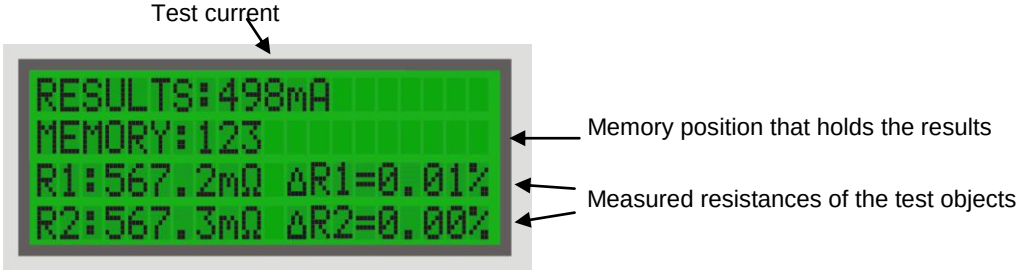


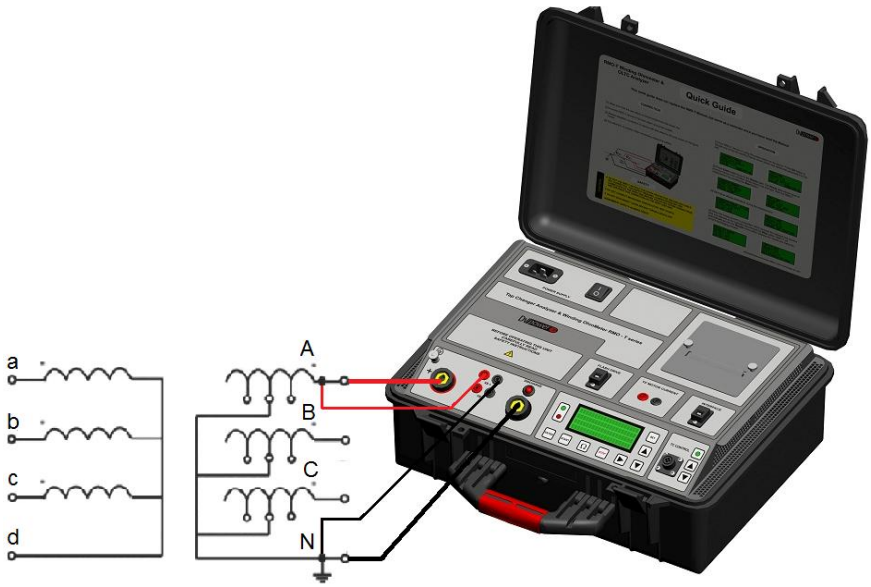
Figure 6-9:
The **Results** menu showing the test results

6.2 Tap Changer test

The winding resistance of individual taps of a power transformer's tap changer can be measured by using RMO60TD's Tap Changer (TapC). Also, it can be used to control the transformer tap changer. This is a user-friendly way of winding resistance measurement and tap changer control, since automatic measurement is possible without need to remove the current between each tap change. If the tap changer is faulty, this may cause damage to the instrument. In order to avoid this, the inputs of the instrument are protected during switching.

From the Current outputs, RMO60TD injects a constant current into the power transformer. From this current value and the voltage measured, the winding resistance is calculated. An interruption caused by a defective tap changer results in a comparatively high measured values of current ripple.

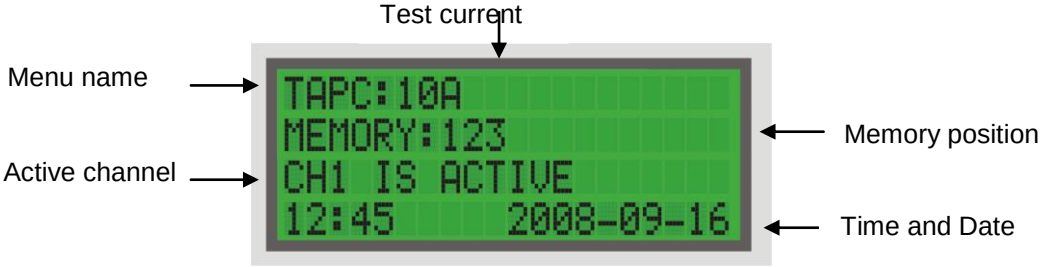
Figure 6-10: Connecting a test object to RMO60TD



Setting the Measurement Parameters

Turn on RMO60TD with the power switch on the back of the test set. The display shows the **Current** menu and the green LED lights up. Press ***SET*** to go to the **TapC** menu.

Figure 6-11: The **TapC** menu



- In the **TapC** menu, define a test current for the test (here **10 A**). The following values can be chosen: 1 A, 2 A, 5 A, 10 A, 20 A.

To do so, set the value of your choice by means of the ***UP/DOWN*** buttons. In the TapC menu of RMO60TD, current output value is rated continuously at 20 A or less. Define the memory position (here **MEMORY:123**). Using ***RIGHT*** move the cursor to the memory location position, then using ***UP/DOWN*** select desired memory position to which obtained results would be saved.

By pushing ***Ω***, resistance and current ripple measured results will remain registered in internal memory of RMO60TD, and the memory position is automatically switched over to the next memory position. These results can be recalled later by selecting that position number.

Note: Only Ch:1 (left channel) is active channel.

Tap Changer test with RMO60TD

Before a test can be started, test current and memory position need to be defined using the **TapC** menu. Once these parameters are defined, press ***ENTER*** to change to the **Ready** state.

Figure 6-12:
The **Ready** state before the test

The **Ready** state displays the selected test current and memory location. If one of these values has to be changed, press ***STOP*** to return to the **TapC** menu.

The flashing green LED indicates that RMO60TD is now ready to start the test. Press ***START*** to run a test. At the start of the test, a cable connection check is done. In case of e.g. a disconnection, an alarm is activated and the error message is shown on the display

During the period of current stabilization, both the green and the red LEDs flash alternately and message “WAIT” is shown on display.

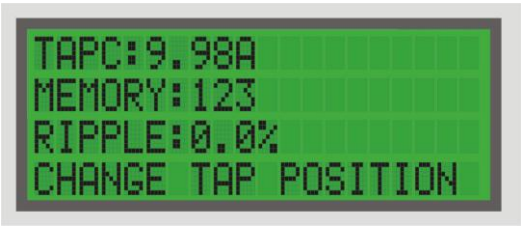
When the current is stabilized, the device shows test current (here **9,98 A**) and the value of the measured resistance (here **567,2 mΩ**).

Figure 6-13:
The **TapC** menu when the test current is stabilized

At the moment the resistance result is stable, press ***Ω*** to save the resistance result of the Tap Changer starting position. The memory position is automatically switched over to the next one and device is ready to record the current ripple.

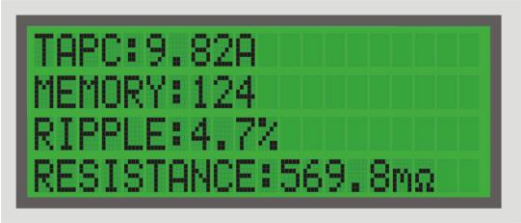
During saving the resistance the red LED flashes shortly and beeper sound is speeded up.

Figure 6-14:
The **TapC** menu, change the tap position



Change the Tap Changer position to the next tap by pushing "Up" or "Down" of the tap changer control. Because the resistance is changed, current will be unstable and RMO60TD will sample and hold the largest measured current ripple that occurred in the actual measuring cycle. It is indicated as RIPPLE (%) with reference to the test current.

Figure 6-15:
The **TapC** menu, memory position is increased for one



The display shows the value of the test current in new tap position (here **9,82 A**), and the value of the current ripple occurred during the change from previous position to the new one (here **4,7 %**). At the moment the test current shown on the display is stable, the RMO60TD shows the resistance value in new tap position (here **569,8 mΩ**). Press ***Ω*** to save the resistance and the ripple in the new position of Tap Changer.

Repeat this procedure as often as needed until the results for RIPPLE and RESISTANCE are obtained for all Tap Changer positions.
Test is completed pushing ***STOP***.

When measurement is completed (after pressing ***STOP***) RMO60TD switches to the **TapC** menu and starts current discharging. During the current discharging process, the discharging LED lights and alarms beep.

Discharge is completed when LED discharge and the buzzer are OFF. Also, during that period "Discharging" message is shown on the display. During discharging process it is not possible to start another measurement.

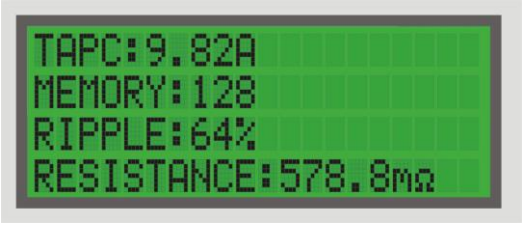
Figure 6-16:
The **TapC** menu during discharging

A properly working tap changer differs from malfunctioning one in a current discontinuity during the tap change, by the magnitude of the current ripple value. A discontinuity will result in much higher current ripple value (99 % or 100 %) than a properly functioning tap changer.

Note: Current ripple value depends on the construction of the tap changer. It is recommended to compare current ripple values between each other got on one transformer. Also, it is recommended to compare current ripple results on one transformer with results from some previous test in order to follow conditions of that tap changer.

Figure 6-17 shows indication about possible tap changer bad conditions during the change from tap to tap.

Figure 6-17:
The **TapC** menu showing much higher current ripple value



If current circuit is opened during the change from tap to tap, message „Discontinuity" will be shown on the display, red LED will light and buzzer will beep continuously. Discharging process starts.

Figure 6-18: Message "Discontinuity"

Discharge Current

The voltage at the RMO60TD output generation is immediately stopped, but current still flows, because of the inductivity of test objects.

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 transformer that is under test. Never remove the leads during the testing process and always allow enough time for the transformer being tested to completely discharge. Large transformers can require several minutes to discharge.

C A U T I O N

- **DO NOT DISCONNECT LEADS BEFORE "DISCHARGING" MESSAGE DISAPPEARS FROM THE DISPLAY AND THE DISCHARGING DIODE AND BUZZER ARE OFF.**

Note:

Using DV-Win the results could be stored to PC, where reading interval results is adjustable. Results will be shown in a table in Excel format with an option to perform additional edit and graphic presentation.

Using DV-Win after the test in order to transfer the results from selected internal memory location to PC will allow transfer of the last test result only.

Using DV-Win software it is possible to draw a graph which represent dynamic resistance during the change from tap to tap (refer to section 7.6).

6.3 Demagnetization feature

Note: Before using the demagnetization feature, you must unplug the voltage sense cables from the device.

After the test is done, there is a feature to demagnetize the transformer under test.

To do so, press ***SET*** consecutively until the **DEM** menu is selected. Once you are in the **DEM** menu, you can select the starting current for the demagnetization process by pressing ***UP/DOWN***. We recommend that the starting current is the same as what was used for the measurement of the transformer under test. Therefore, the test current used for the last test is displayed as default.

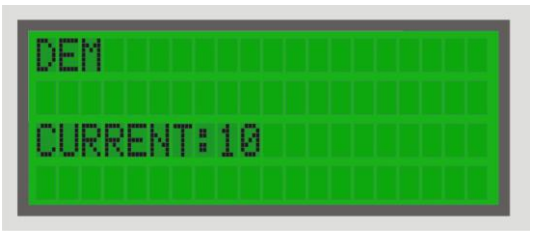


Figure 6-19: Demagnetization starting current"

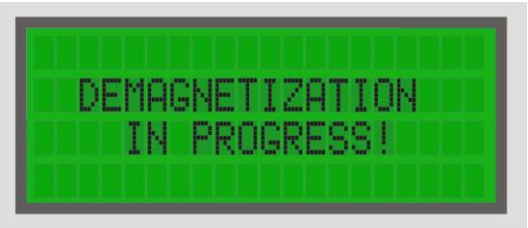
When the current is selected, press ***ENTER*** to confirm selection.

Figure 6-20: The "Ready" state before the test

Press ***START*** to start the demagnetization process. The demagnetization of the transformer under test will be carried out automatically. It is necessary to disconnect the voltage sense cables before the

process begins. If it is not done before ***START*** is pressed, a warning message will be displayed and demagnetization will not start. During the demagnetization process there will be visible message on the display showing the progress of the demagnetization.

Figure 6-21:
Demagnetization menu during demagnetization



Note:
Never remove the current leads during the demagnetization process and always allow enough time for the transformer being tested to completely demagnetize. Large transformers can require several minutes to demagnetize. During the demagnetization process the transformer will be charged and discharged several times. Once the demagnetization process is finished, the RMO60TD device displays the message “Demagnetization done!”

Figure 6-22:
The demagnetization menu after the process is finished

Attention:
When the demagnetization process is manually stopped by pressing **STOP**, it is highly recommended to follow the discharging LED and the buzzer and to be aware of the danger during the discharging process.

6.4 Tap Changer Control Unit

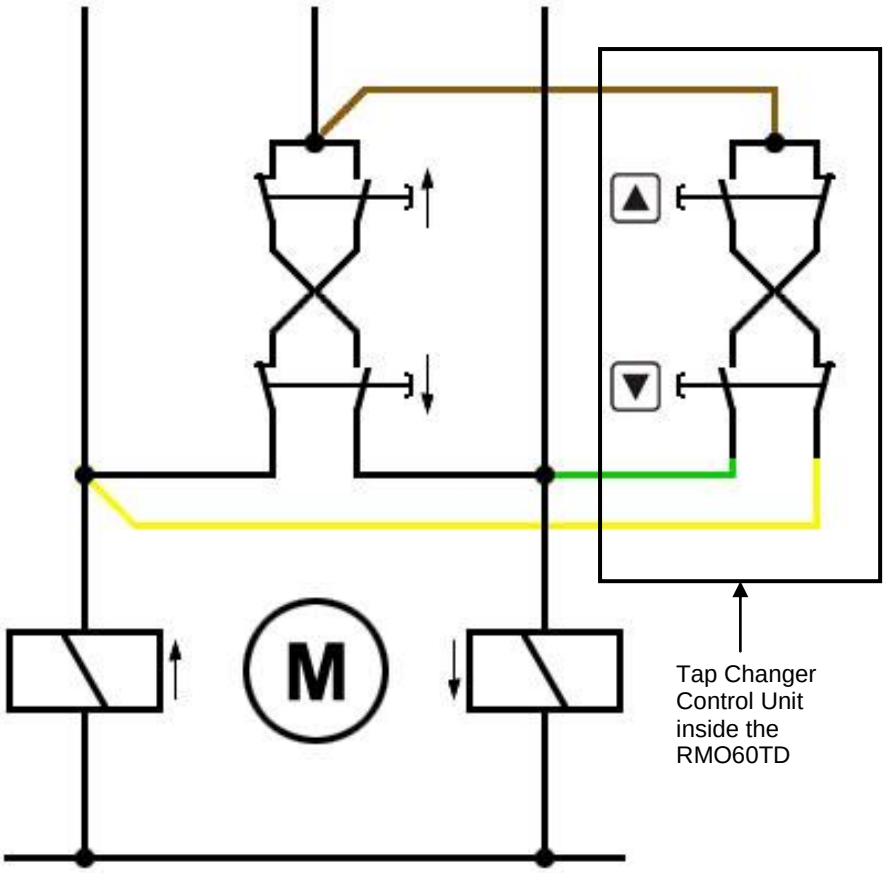
The external Tap Changer Control cable is used for convenient tap changer testing.

After the RMO60TD has measured a tap it stands by waiting for the operator to move the transformer tap changer to the next tap position and continue the measurement by pressing ***OMEGA*** on the unit.

The tap changer operation box on power transformers is normally not placed at the same place where the RMO60TD is placed. The Tap Changer Control Unit block allows the operator to continue the next tap measurement from the RMO60TD position. It is performed by pressing ***UP/DOWN*** on the Tap Changer Control Unit.

The operator has to connect the Tap Changer Control cable from the RMO60TD to the tap changer operation box. An example of that connection is shown on the figure below.

Figure 6-23: Connecting Tap Changer Control cable



The Tap Changer Control Unit is actually a pair of relays, one for the UP direction, and one for the DOWN direction. The brown wire is common for both relays. 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.

When the appropriate connection is done, the operator has just to press ***UP/DOWN*** on the Tap Changer Control Unit to change the tap position.

6.5 External data exporting to USB flash drive

To export the data from internal memory of RMO60TD device to the USB flash drive, plug in the USB flash drive into the RMO60TD device and press ***PRINT*** button. The RMO60TD will display the USB flash drive menu is it is shown on the screen below.

Figure 6-24: **USB FLASH DRIVE** menu

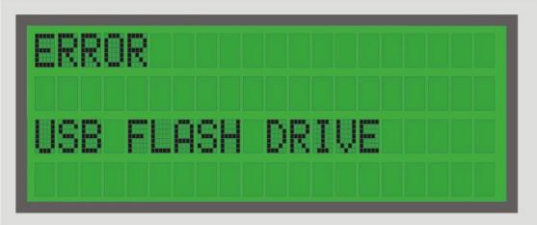
Move the cursor from the Test Record position to the Test Reading position pressing ***SET***. Select the Test Reading/Record in between the result will be exported to the USB Flash drive. The results that are located in the range between these memory locations (Test Readings/Records), including the chosen memory locations, will be transferred to the USB Flash drive.
The file which is saved to the USB Flash drive is automatically named by the date of the test.

After that, choose which file formats do you want to save. Move cursor to FORMATS position by pressing ***SET*** and pressing ***UP*** and ***DOWN*** choose between TXT, CSV format or both of them to be saved.
Start exporting data by pressing ***ENTER***. The progress of exporting is displayed on the screen.

Figure 6-25: Exporting data to 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 6-26: Error USB flash drive



After the data exporting progress is finished, the RMO60TD device returns you to the USB flash drive menu. Plug out the USB flash drive from the RMO60TD device. Press ***STOP*** to return from the USB flash drive menu to the **CONFIGURATION** menu.

6.6 Viewing Results of Previous Tests

RMO60TD stores up to 500 test results. They can be viewed using the **Memory** menu at memory positions from 000 to 499.
Go to **Memory** menu using ***SET***.

Selecting a memory position on the **Memory** menu displays:

- the current fed into the test object,
- the memory position of these results,
- the test object's measured resistance R1 (left channel/channel 1) or R2 (right channel/channel 2),
- the test object's measured results RESISTANCE and RIPPLE,
- the date and the time of this particular test.

Figure 6-27: The **Memory** menu showing the previously saved test results measured in **Curr** mode saved in memory position **123**

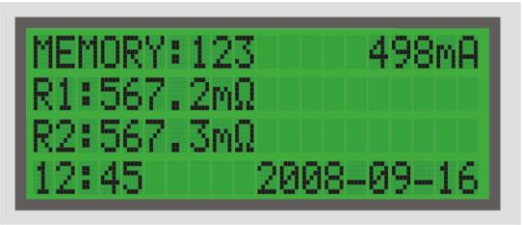


Figure 6-28: The **Memory** menu showing the previously saved test results measured in **TapC** mode saved in memory position **124**

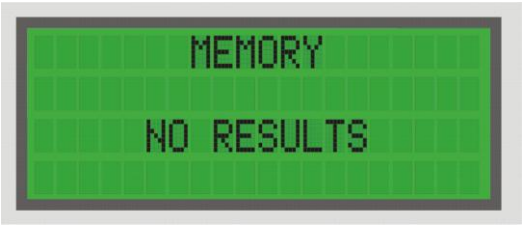
6.7 Deleting Results of Previous Tests

In the **Memory** menu, press ***ENTER***.

Figure 6-29: The **Memory** menu showing an option to delete all saved measurements from the memory positions

Press ***ENTER*** once more to delete saved measurements from all the memory positions. Press ***STOP*** to leave the **Memory** menu without deleting any measurements.

Figure 6-30: The **Memory** menu showing no results



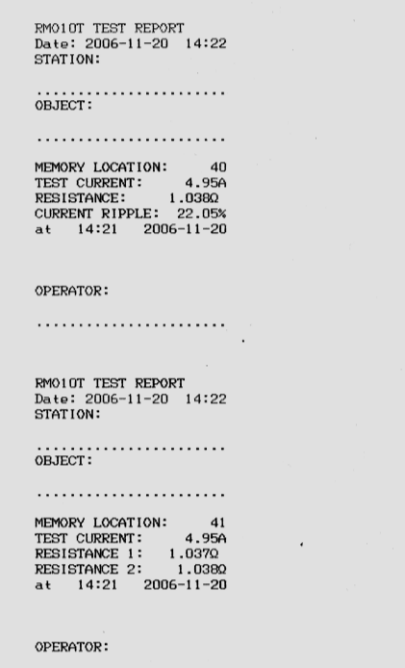
6.8 Printing the Test Results

RMO60TD stores up to 500 test results. They can be printed using the **Print** menu at memory positions 000 ... 499.

Go to **Print** menu by pressing ***RIGHT*** repeatedly from **Current** menu as well as from **TapC** menu. Select first and last memory position with ***UP/DOWN*** and press ***ENTER***. The results that are located in the range between these memory locations, including the chosen memory locations, will be printed.

Figure 6-31:
The **Print** menu showing first and last memory position, test current and test duration of the first measurement

Note: It is not possible to print test results using the built-in printer from DV-Win Software.
If printing is attempted the device will be blocked and a reset of the device is necessary.



Settings of the printer as well as look of the RMO60TD Test Report are given at figure above.

6.9 Duty Cycles

During tests, RMO60TD generates a high DC current that heats up the test set. For the test performed at ambient temperature (25 ^{o}C), maximal test duration times are unlimited for each test current. If the tests are applied at higher ambient temperature, there is possibility that a built-in thermo switches prevents RMO60TD from overheating.

Table 6-32: Maximum test duration times

C u r r e n t T e s t		
Test current (A)	**Maximum test duration time (min)**	**Cooling time for maximum test duration time (min)**
5 mA, 10 mA, 50 mA,100 mA, 500 mA, 1 A, 2 A, 5 A, 10 A, 15 A, 20 A, 25 A, 30 A, 40 A, 50 A, 60 A	unlimited	0

The following test duration times can be applied at each test current: 30 sec, 60 sec, 90 sec, 120 sec, 180 sec, 240 sec, 300 sec, 360 sec, 420 sec, 480 sec, 540 sec, 600 sec, 660 sec, 720 sec, 780 sec, 840 sec, 900 sec, 1200 sec, 1800 sec, 3600 sec, unlimited.

7 DV-Win Software

DV-Win is a Windows program developed to work with RMO60TD Tap Changer Analyzers & Winding Ohmmeters. It enables the two-way communication between RMO60TD and a PC over the USB.

DV-Win supports the following functions:

- Controlling and starting RMO60TD when tests are performed from the PC; the results could be stored to PC; results reading interval is adjustable,
- Transfer of test parameters from internal RMO60TD memory to the PC.

Note: While using DV-Win software, RMO60TD can only be operated from DV-Win. All buttons on the front panel of RMO60TD device are locked, except the ***STOP*** button.

Data transferred from RMO60TD can be:
- Downloaded in the grid in the form of a table,
- Saved as a PDF, XLS, DOC or RTF file,

Every test reading contains:
- The date and the time of the test,
- The transformer connection (if selected),
- The test mode,
- The real test current,
- The measured resistance values,
- The measured voltage values,
- The measured ripple values,
- The transition time values,
- The tap changer positions,
- The memory location.

7.1 System Requirements

7.1.1 Minimum Configuration

Processor:	Intel Pentium IV 1GHz
Memory:	1 GB
OS:	Windows XP, Windows Vista or Windows 7

7.1.2 Recommended Configuration

Processor:	2 GHz
Memory:	2 GB
OS:	Windows XP, Windows Vista or Windows 7

7.2 DV-Win installation

To install the DV-Win software do the following:
- Connect the RMO60TD to the PC via USB cable and turn the RMO60TD on
- Insert the DV-Win installation CD into the CD-ROM drive,
- Click ”Start”,
- Click ”Run”,
- Click ”Browse”,
- Select the CD-ROM drive,
- Highlight the ”DV-Win.exe” file,

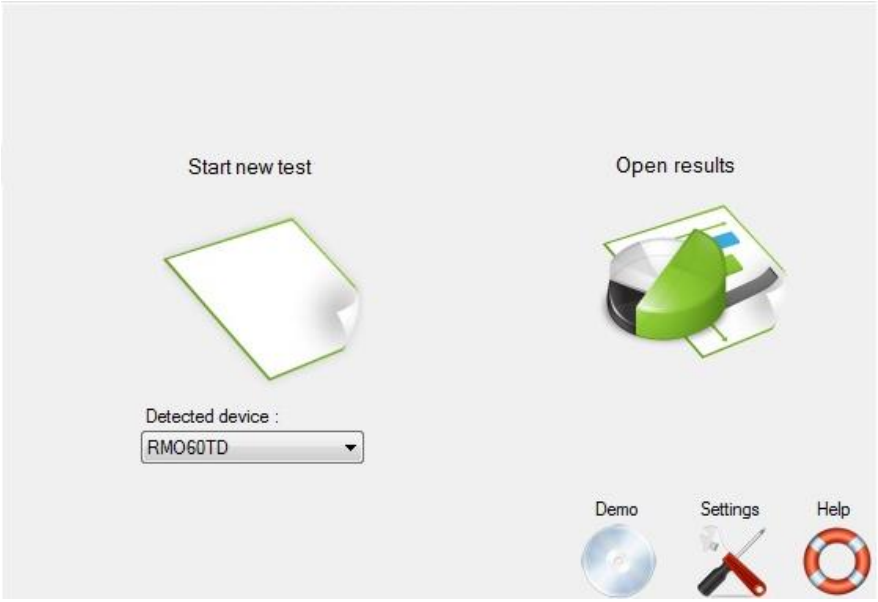
- Click ”Open”,

- Click ”OK”,
- Follow the instructions displayed on the screen,
- When the installation process has been completed,
- Exit the program.

7.3 Starting DV-Win

Turn RMO60TD on.
Start DV-Win:
- Click ”Start”,
- Click ”Programs”,
- Click ''DV-Win'',

or double click at the DV-Win icon on the desktop.
The look of the DV-Win main menu is shown in the following illustration.

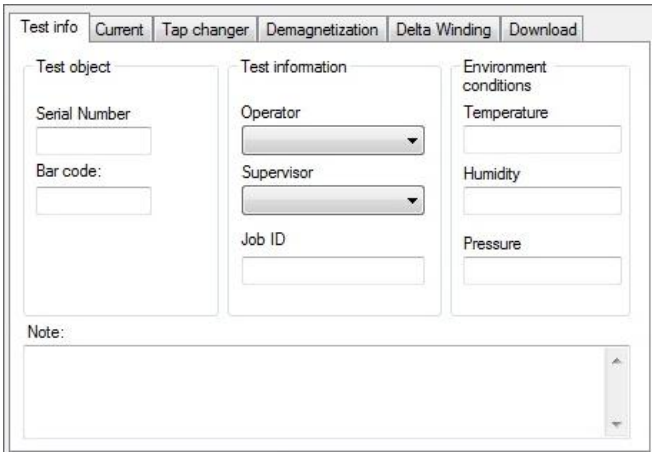


Now the RMO60TD can be controlled from the PC. The test is started by pressing icon “Start new test” or selecting the “Test” button and then selecting “New” test.

In case that there is some communication problem, it is necessary to check the following:
- Is the green led diode on the RMO60TD lit?
- Is the RMO60TD signaling any error?
- Is the serial cable connected tightly?

Once the communication is successfully established, click OK to select the test device.

When the device is selected, the DV-Win shows the following tabs: Test info, Current mode, Tap Changer mode, Demagnetization mode, Delta Winding, Download.



7.4 Test info

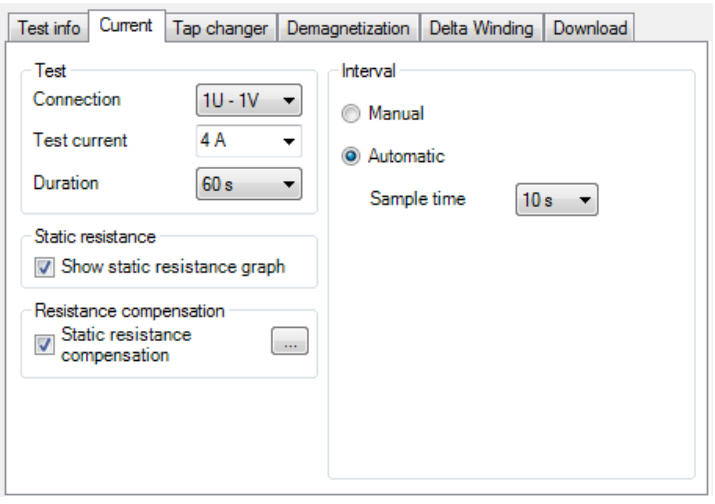
Test object
You can use the Test object field to store test results in a database, so that they could later be recalled for analysis and comparison with previous test results.

Test information
In this field you can enter basic information about the operator, supervisor and the Job ID of a certain test.

Environment conditions
In this field you can enter information about environment conditions such as temperature, humidity, and pressure.

7.5 Current Mode

The way to measure the winding resistance is described in details in the RMO60TD Manual.
The winding resistance measurement can be performed using DV-Win software. If you want to analyze these results later, you should save them on the hard disk. The table can be saved in various formats, including XLS, so it can be later used with all Excel functions.

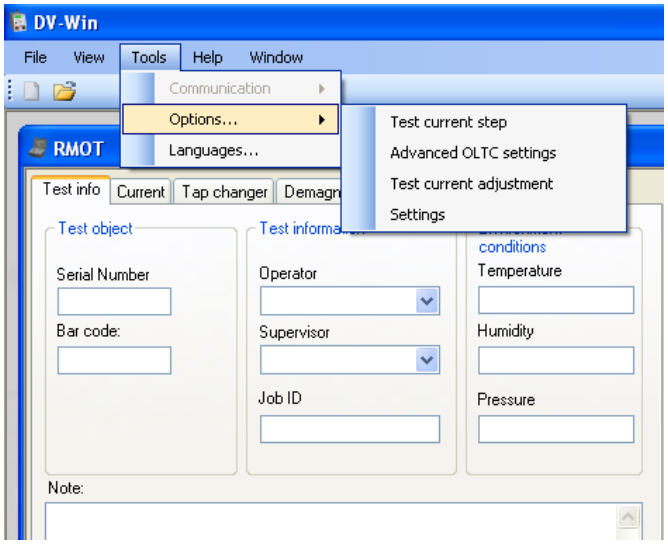


After all connections are properly done and DV-Win is turned on, choose the Current mode by clicking on the **Current** tab.
Set the measurement parameters such as:
- Connections - marking of the winding of the transformer under test
- Test current

- Test duration time

Test current

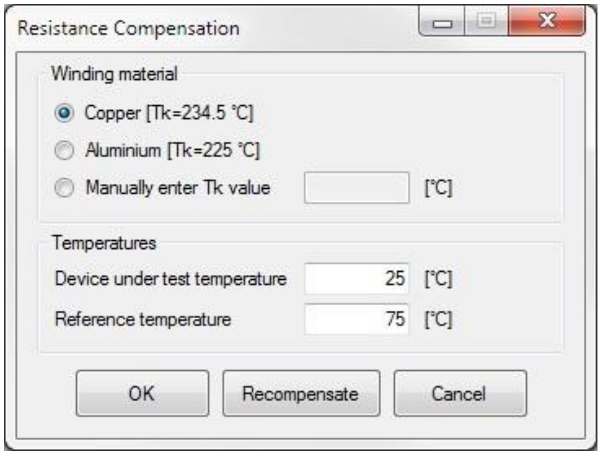
It is possible in DV-Win software to enter test current values in two ways. The first way is drop down menu where you can choose test currents like they are set in device (5 mA, 10 mA, 50 mA, 100 mA, 500 mA, 1 A, 2 A, 5 A, 10 A, 15 A, 25 A, etc). The second option is to choose “Tools”, then “Options” and then by checking “Test current step 1 A” and OK button it is possible to set all test current from 4 A to 60 A in 1 A step.



Resistance compensation

Resistance compensation is a feature which enables displaying of measured resistance compensated to reference temperature. This feature is available when controlling RMO60TD from the PC. Two additional columns of resistance results are displayed in the data table (grid), denoting the compensated resistance values.

Default temperature values are 25 [°C] for the device under test temperature and 75 [°C] as a reference temperature. The operator can change resistance compensation parameters such as temperatures or winding material.



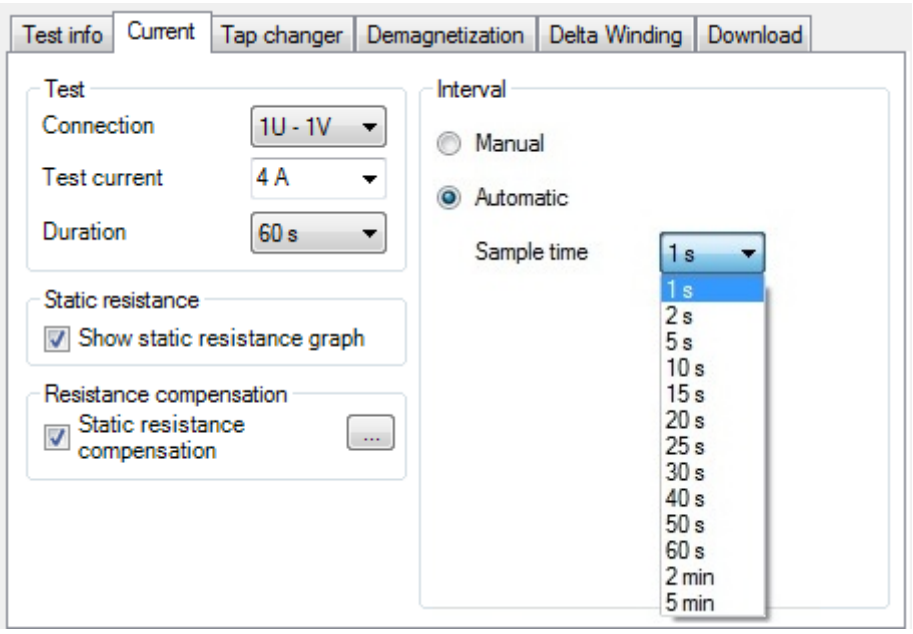
Regarding the winding material, you can choose between Copper, Aluminum, and manually entered “Tk” value. The values are entered in degrees Celsius.

Static resistance graph

By enabling “Show static resistance graph”, the DV-Win will show the graph of the measured resistance stored in the grid in the measuring process.

Interval

Its purpose is selection of time interval for reading results from RMO60TD to PC. At the expiration of this interval, DV-Win reads the last measured result from RMO60TD, and this process repeats at the expiration of the next period.



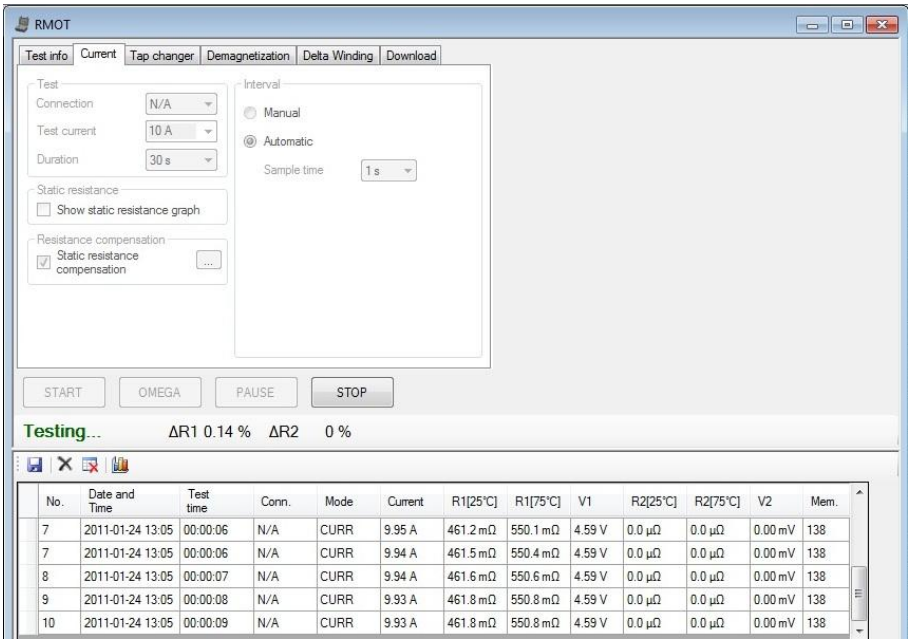
Possible interval options are “Automatic” and “Manual”.

By selecting “Automatic” option and time interval (sample time), the last measured result will be transferred from RMO60TD to PC at the chosen time intervals.

By selecting “Manual” option, the last measured result will be transferred from RMO60TD to PC upon pressing the **Ω** (***OMEGA***) button.

Measurement

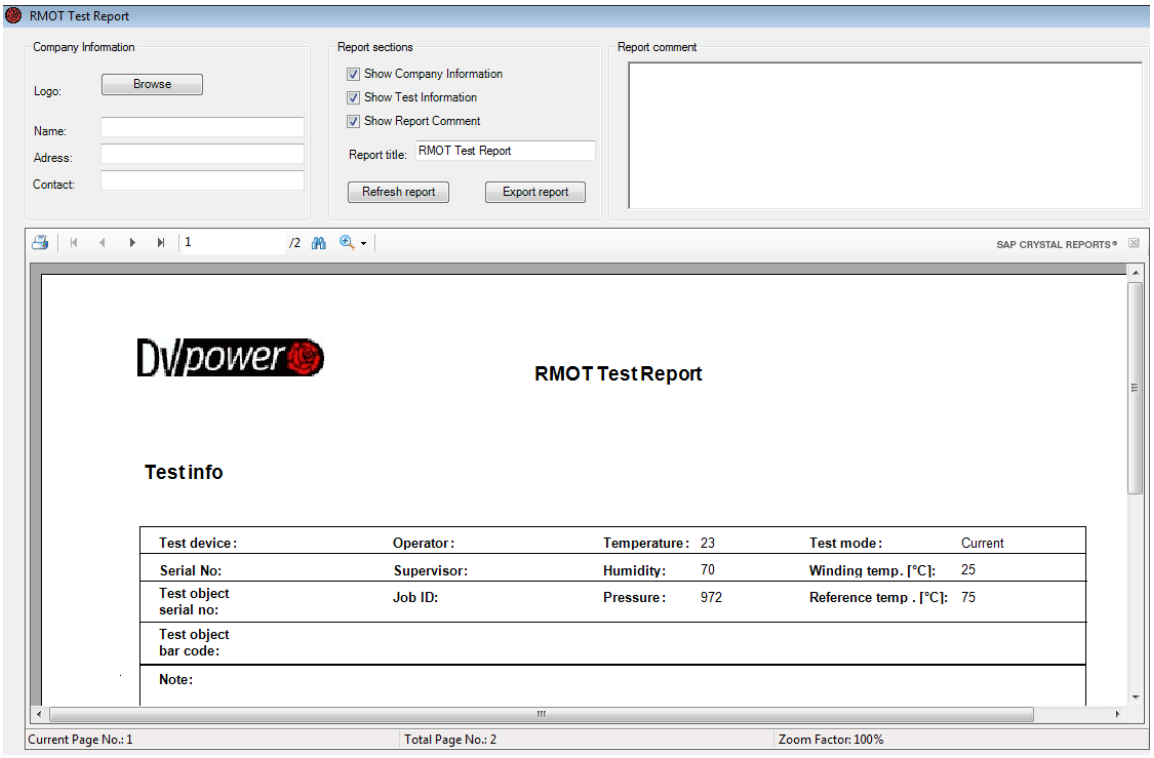
Once the test is started, test results are saved in the data table. The new test results are appended to the end of the table, therefore the first line represents the oldest obtained result.



It is possible to follow stability of resistance results during the measurement since DV-Win displays ΔR1 and/or ΔR2 values. Once the measurement is completed click on the save button to save results.

Save

DV-Win enables the user to create Test Reports which contain all the necessary testing information. When Save button is selected, a new window will appear which shows a report preview.



In this window, various additional data can be added, such as company logo and contact information, as well as any comments the user wants to add to the report. All the data from the grid will be displayed in the report.

“Refresh report” button generates a different report preview. “Export report” button saves the report in one of several available formats (PDF, XLS, DOC or RTF).

Static resistance graph
Creates a static resistance graph from the measured resistance values in the grid.

Delete selected rows
Erase all data from selected rows in the grid.

Delete All
Erase all the data from the grid.

Note: Security features of Windows Vista and Windows 7 prevent saving data to default DV-Win working directory under Program Files directory. While on Windows Vista it may be possible to circumvent this behavior by disabling User Account Control, in which case the data is saved to Virtual Store directory, which is hidden and may prevent user from finding saved files. For Windows 7 this is no longer an option. We recommend that you save the data in other directories under ownership of the user, like Documents or some other user created directory.

7.6 Tap Changer Mode

Using a PC together with RMO60TD device in the Tap Changer mode it is possible to assess the tap changer condition by analyzing a graph which represents dynamic resistance during tap changes.

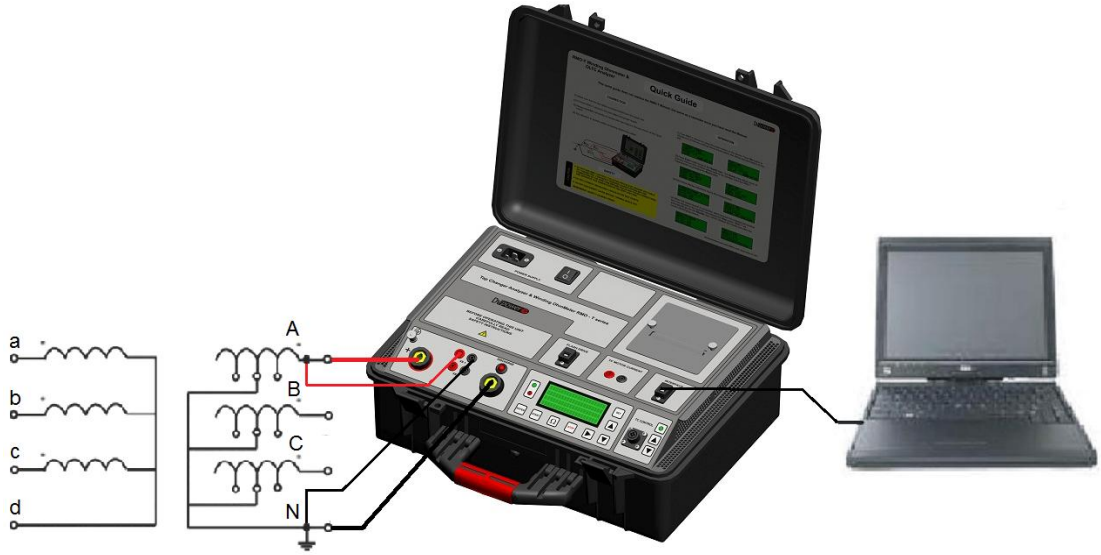
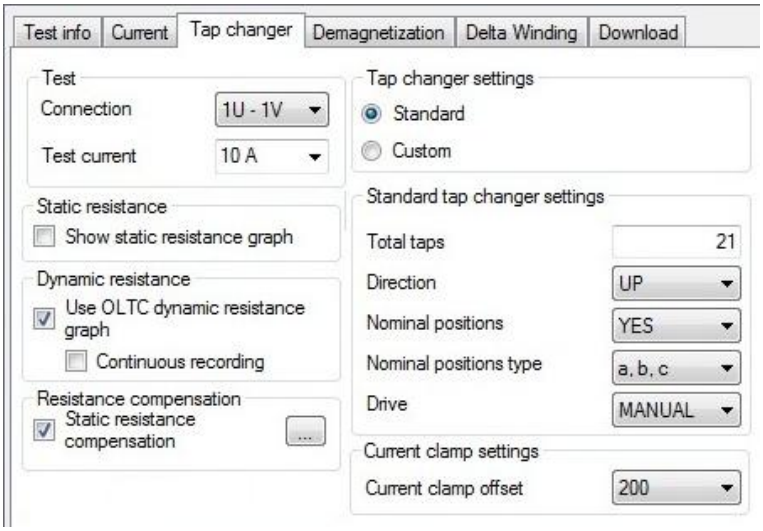


Figure above shows connections between a PC and RMO60TD and also connection to the transformer under test.

After all connections are properly done and DV-Win is started, chose TapC menu clicking on the Tap Changer tab.



Set the measurement parameters such as:
- Connections - marking of the windings of the transformer under test
- Test current

Test current is described in the Current mode.

Resistance Compensation is described in the Current mode.

DV-Win software enables recording of the test current values during the change of the tap changer position and plotting recorded values. If this function is not needed, please uncheck the option "Use OLTC Dynamic Resistance graph".

Graphic function is available in the “on-line” or “off-line” mode. Using both off-line and on-line modes, test current values during the transition from tap to tap are shown on the graph.

Graph control window contains options and commands to control graph display. Graph is displayed in separate window, where user can zoom in and zoom out interesting parts of the graph. Test current values are shown on the vertical axis, and tap transitions are shown on the graph.

Before the test is started it is necessary to set the following tap changer parameters:

Standard tap changer
Before the beginning of the test it is necessary to set tap changer to the first or the last tap changer position.

Total taps
Indicates the number of tap positions, excluding nominal positions. This could also be interpreted as the last tap position number.

Direction
It specifies the direction of changing tap positions.

Nominal positions
It specifies whether the tap changer has nominal positions or not.

Nominal positions type
It specifies the type of nominal positions.

Drive

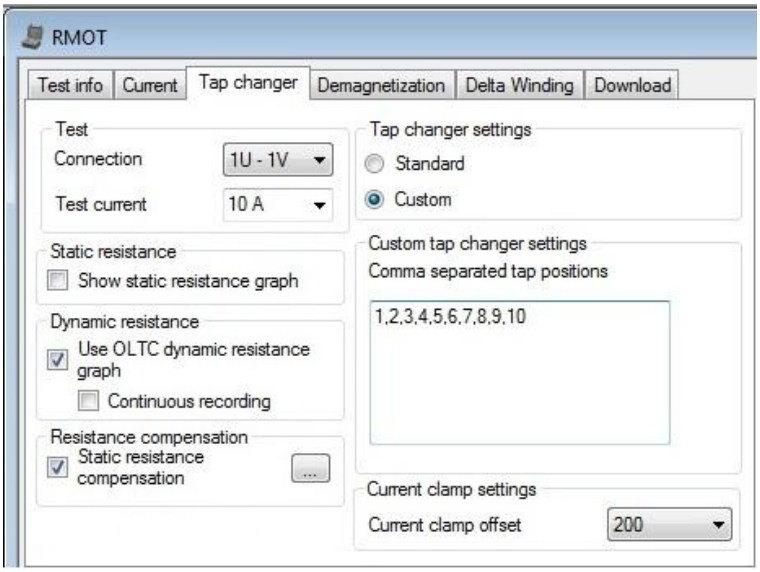
Motor drive or manual cranking - means of changing the tap changer positions.

Current clamp offset

This value needs to match the offset value on the current clamp (for example, the clamp is set to 200 A offset, it is necessary to set this value in DV-Win).

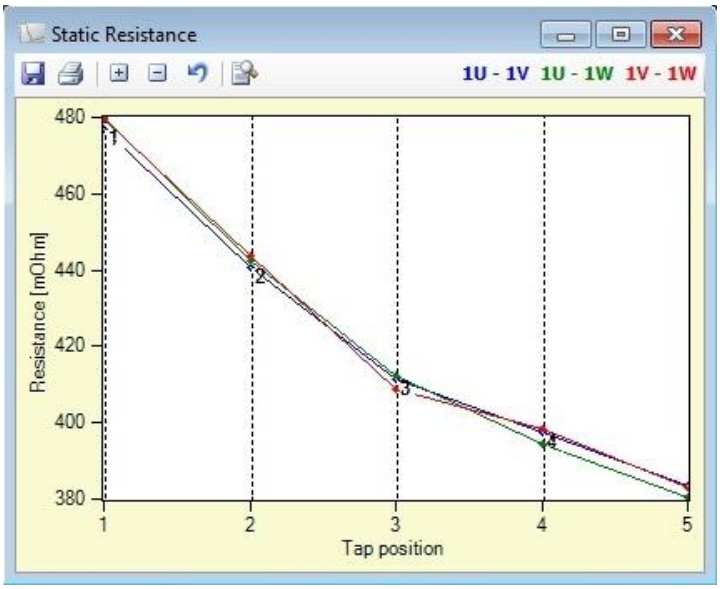
Custom tap changer

This option is more flexible and intended if you want to manually enter tap positions. Notice that the list of tap changer positions shall be comma separated.



Static resistance graph

Selecting “Show static resistance graph” option enables drawing a graph with resistance value in each tap position. It is possible to have a graph of all three phases on the same diagram. To do so it is required not to delete results from the table after first measurement of one phase.

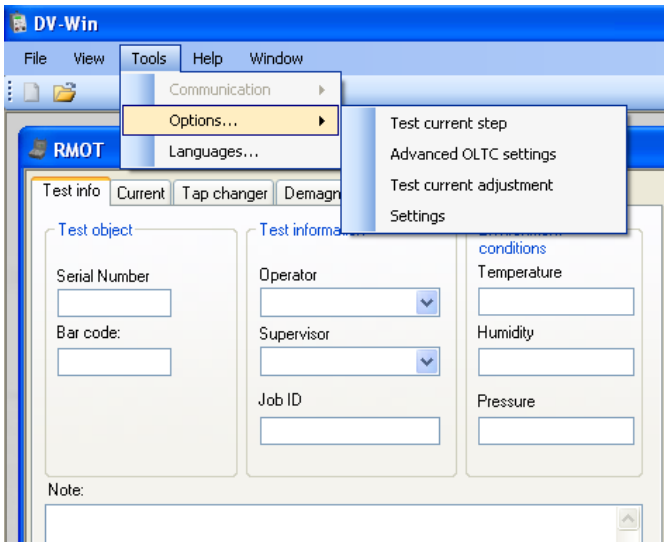


Continuous recording

Selecting continuous recording option enables recording of all transitions without pressing OMEGA in each tap position. After initial resistance measurement is done and a message is shown, it is necessary to change the tap positions. The graph is displayed after the first measurement is done and it shows dynamic resistance value in real-time during the test. At any time, the last 20 seconds of measurement will be shown. Once STOP is pressed, all the transitions (OLTC dynamic resistance graph) will be displayed. The DV-Win measures transition time for each transition and displays results in the results table.

Tools - Options

Advanced settings for the tap changer graphic function. These settings are recommended for advanced users.

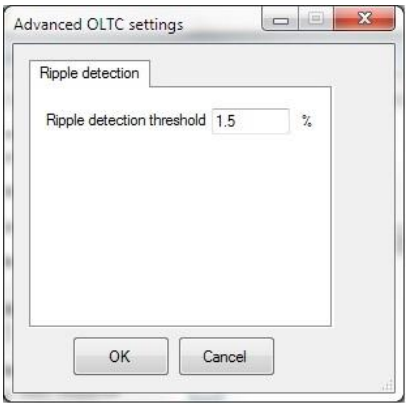


Test current

It is possible in DV-Win software to enter test current values in two ways. The first way is drop down menu where you can choose test currents like they are set in device (5 mA, 10 mA, 50 mA, 100 mA, 500 mA, 1 A, 2 A, 5 A, 10 A, 15 A, 25 A, 40 A, 60 A). The second option is to choose “Tools”, then “Options” and then by checking “Test current step 1 A” and OK button it is possible to set all test current from 4 A to 60 A in 1 A step.

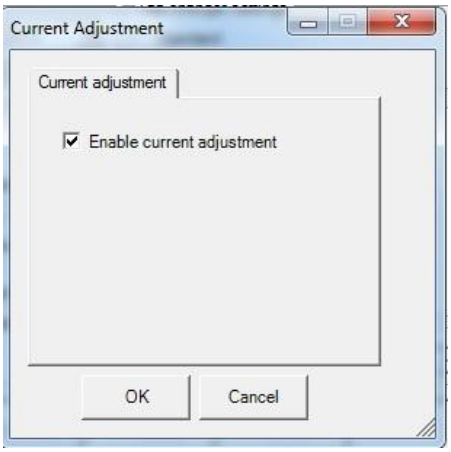
Advanced OLTC settings

To set sensitivity of the on load tap changer transition detection. Default value is 1,5%. Decrease this value in order to increase sensitivity. In this case possible noise could be detected instead of the transition.



Test current adjustment

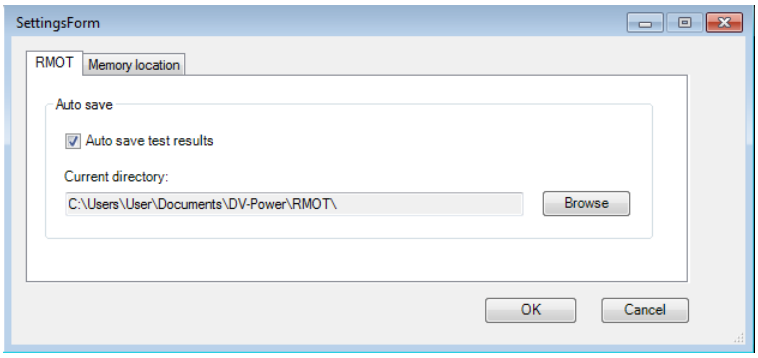
Selecting “Enable current adjustment” option enables resetting of test current to selected value. In that way it is possible to test desired tap changer position with specified test current. This is useful when the stabilization process settles at the current value different from the selected. The procedure is as follows: click ***ADJUST*** and then ***OMEGA.*** Afterwards click ***PAUSE*** and delete the last result from table. Then return to previous tap position at the tap changer, and by pressing ***OMEGA*** again the new tap position is measured with the adjusted test current.



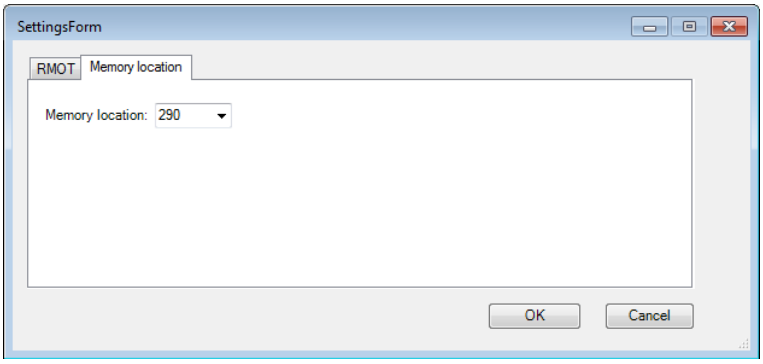
Settings

During every tap changer test with DV-Win, the dynamic resistance graph is automatically generated. This graph will be named *auto_save_date_and_time.tcp* and it will be saved in \\My Documents\DV-Power\RMOT folder by default. In case the test is interrupted for any reason, this file will show the dynamic resistance graph until the last successfully completed tap changer transition. If Continuous recording mode is selected, the file will be named *auto_save_date_and_time_cont.tcp*

In the Settings menu of DV-Win it is possible to turn off the Auto Save feature. This menu also allows to change the folder where Auto Save files are saved.

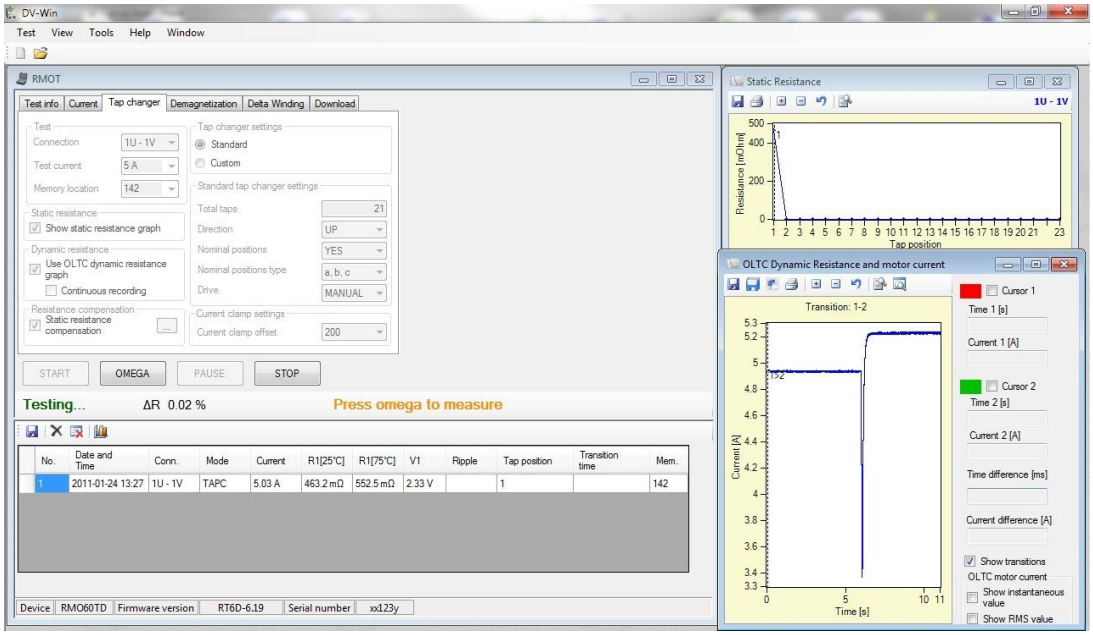


The “Memory location” tab in the Settings menu enables the user to set a different device memory location where the results will be saved.

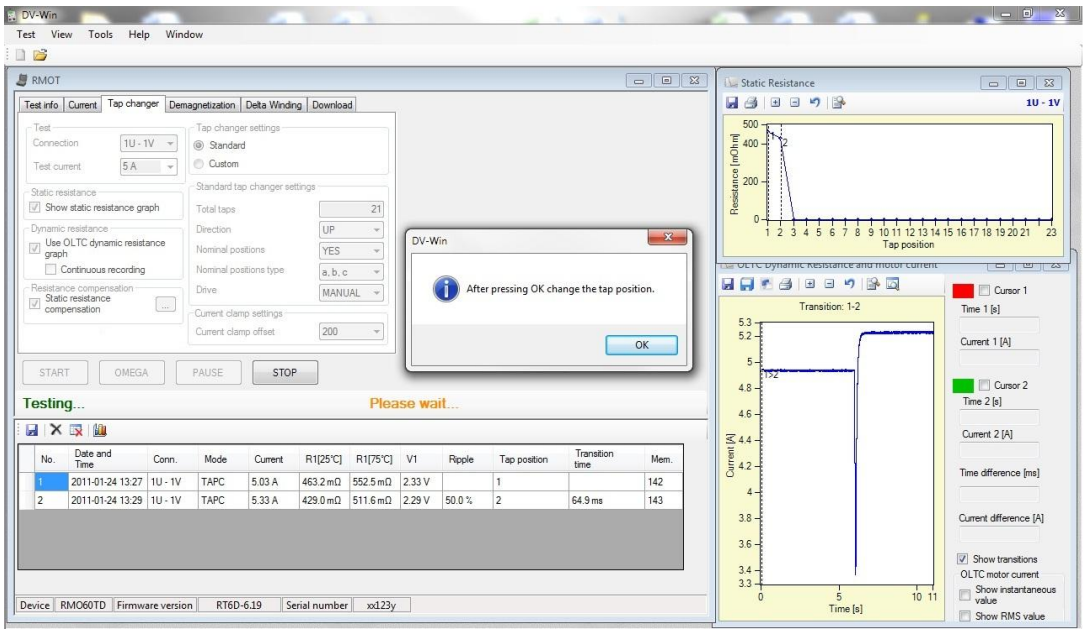


Measurement

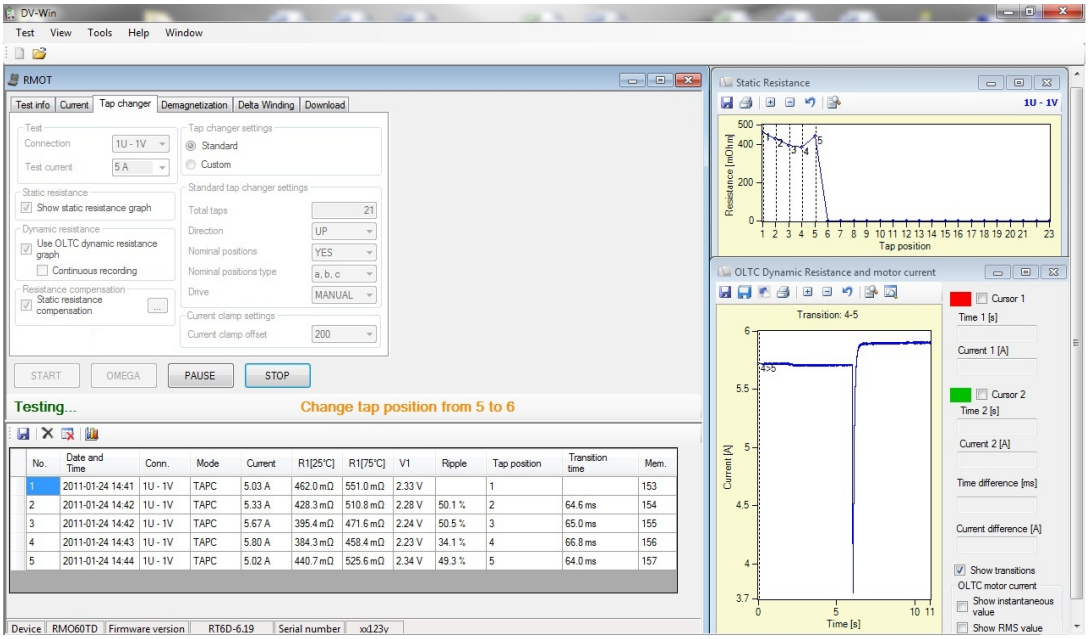
Press ***START*** to start the test current. When the test current is stabilized, ΔR (resistance change) value is displayed. At the moment when ΔR has a value close to zero, it means that measured resistance has stabilized. Once the resistance is stable, the operator has to press ***OMEGA*** to record resistance in the first tap changer position. Measured resistance value is saved in current memory location and memory location is automatically changed to the next position.



After the message appears press ***OK***.



When the message “Change tap position” appears on the main window, change the tap position.

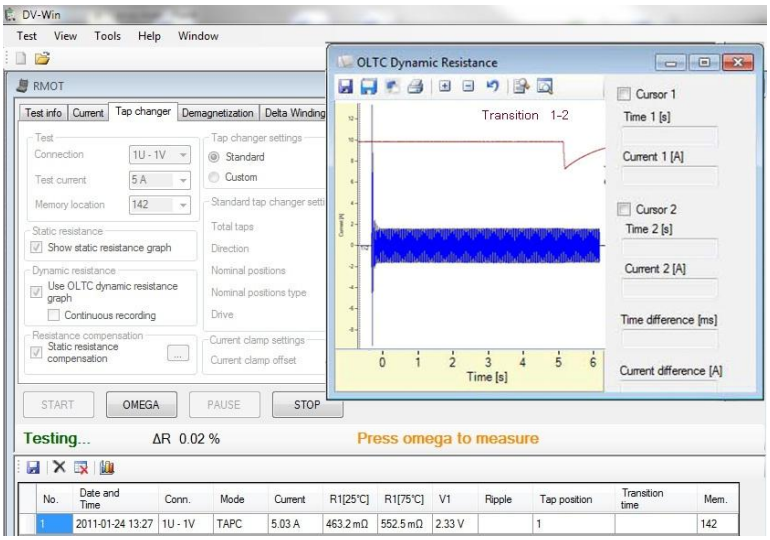


When the tap position is changed the graph with the test current during the change will be displayed. The graph shows two diagrams. The first diagram shows the „dynamic resistance“, represented by the test current waveform during the transition, while the second diagram shows the AC current of the tap changer motor drive unit.

Tap Changer Motor Current Measurement

RMO60TD has a feature for measuring the current in the tap changer motor drive unit. This feature can be used only during those tests when the RMO60TD unit is controlled by the DV-Win software.

This feature is always active in the DV-Win, which means that two diagrams will always be visible on the graph.



When the graph is displayed and ΔR is stable press ***OMEGA*** to measure resistance in the new tap changer position.

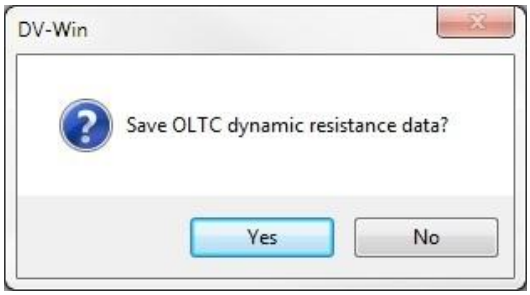
Repeat this procedure until you get the diagram for each transition and the resistance result in each tap position.

When the tap changer measurement has started, the DV-Win software performs automatic compensation of current clamps. This compensation is performed between the moment when the measurement is initiated by pressing ***OMEGA*** for the first time and the moment when the tap changer

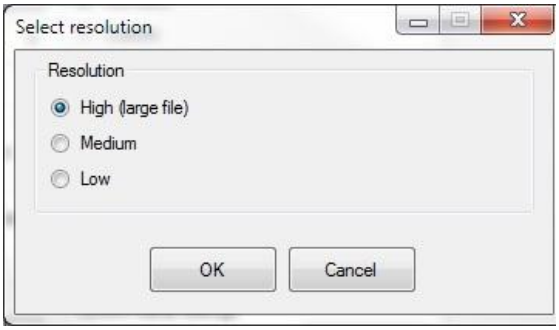
position is changed for the first time. There should not be any current present in the tap changer motor drive circuit during this short period of time. Otherwise, the current clamp compensation will be incorrect, and it will generate incorrect measurement results.

At the end of the test you have to stop the test by pressing ***STOP***. The RMO60TD will go to the "discharging" mode. There will be a question to save the graph.

Note:
The ***PAUSE*** button is intended for the situations when some occur during the test, in order to handle the test easier. When ***PAUSE*** is pressed, at that moment the DV-Win stops recording the graph. Whenever you release ***PAUSE***, the DV-Win continues to record the graph/transitions (dynamic resistance).



Once the measurement is completed, save the data. The graph can be saved as the graph with three different resolutions:



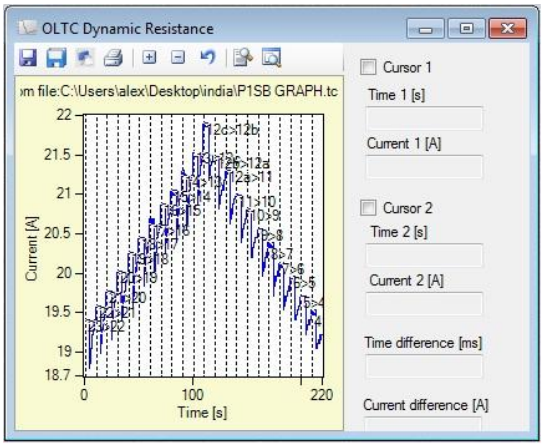
- High (resolution is 0,1 ms)
- Medium (resolution is 1 ms)
- Low (resolution is 4 ms)

The graph analysis

The graph can be analyzed "online" and "offline". It is possible to zoom in a part of the graph of the interest by dragging the left mouse button around the required area.

Toolbar of the graph

Save
Save OLTC graph as a TCP, BMP or JPEG file. If the file is saved as a TCP file, after the test is finished it is possible to recall the graph and analyze it using DV-Win. If the graph is saved as BMP or JPEG it can be opened using any picture viewer.



Print
Prints the graph to the local printer.

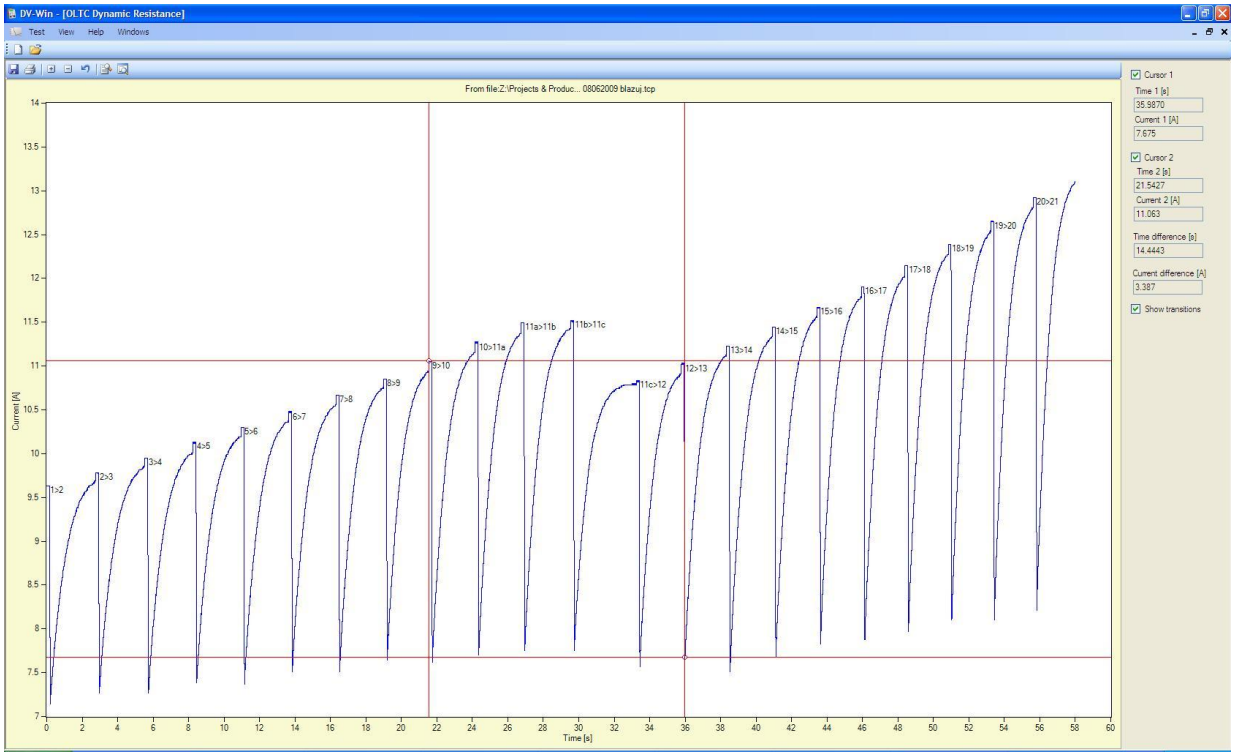
Zoom In
To zoom in the graph, each click will zoom in the graph for 20 % related to the center of the graph.

Zoom Out
To zoom out the graph, each click will zoom out the graph for 20 % related to the center of the graph.

Undo
To return to previous zoom level.

Default scale
Enables to see complete graph from zero to the maximum value.

Auto scale
Enables to see complete graph from minimum to the maximum value.
An example of one complete graph is shown on the picture below.



Merge files

In the case when the operator wants to merge two .tcp files into one master file (one diagram) it is possible by using the Merge files button. Firstly open one .tcp file (if it is not already open), then press Merge files button and browse and select the second file from your PC. When you save the new file under the new name, those two files/diagrams will be merged in one diagram. The new graph will open in a new window. This function is useful when the test is stopped for some reason and the user later wishes to continue the test from the point (tap position) where it is stopped.

Cursors

The cursors are enabled by checking Cursor 1 and/or Cursor 2 check boxes. When enabled, each cursor shows time and current values of the cursor position. If both cursors are enabled, then the time and current difference are also displayed. Cursor's movement is done by holding the left mouse button and dragging the cursor along the graph.

Using mouse for Zoom function

Zoom In/Zoom Out function is possible using the mouse. If no cursors are displayed, then drag around the area on the graph using the left mouse button. If cursors are displayed Shift + left mouse button is used.

Using keyboard for Zoom function

Zoom In/Zoom Out function is possible using the keyboard. The up arrow is used to zoom it in, although down arrow is used to zoom out the graph.

Pan function

Pan function is enabled by holding the Ctrl key, holding the left mouse button and dragging the plot area to desired direction. The same function can be accomplished using the Ctrl key and using the left/right/up/down arrow keys.

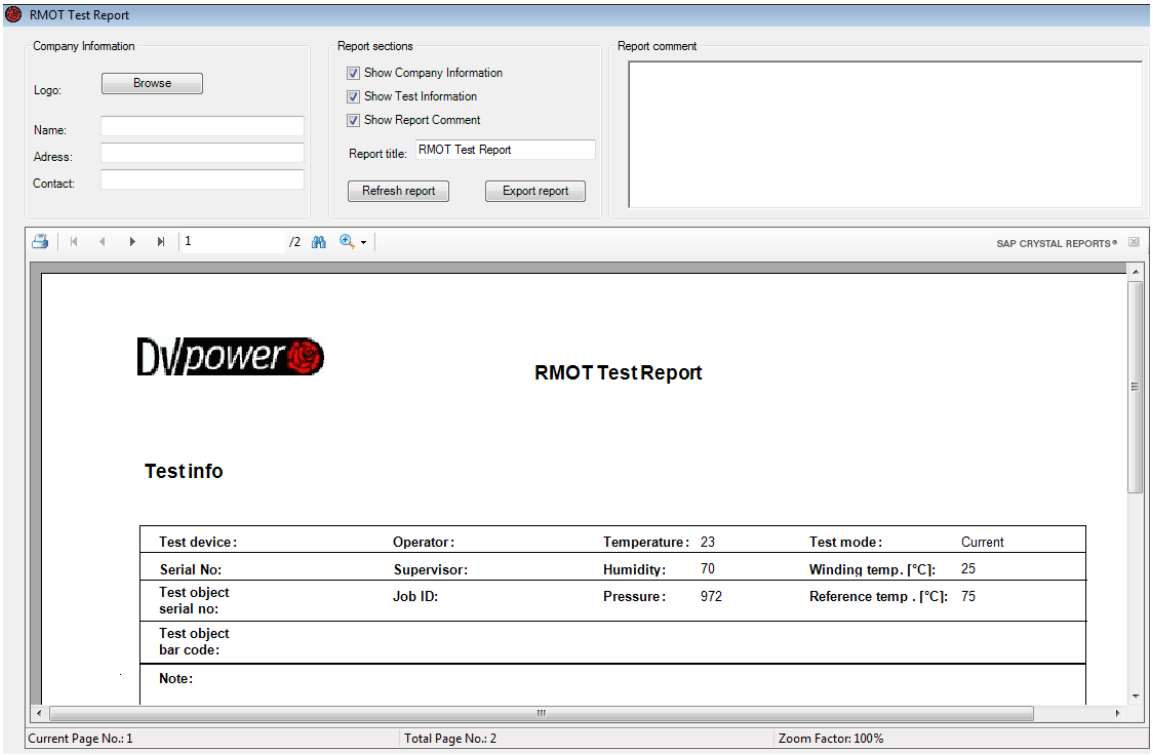
Overlay graphs

Overlay graphs feature allows DV-Win to the AC motor current graph vertically. By moving the slider left or right, the graph can be moved closer or further away from the dynamic resistance measurement graph.

Toolbar of the grid

Save

DV-Win enables the user to create Test Reports which contain all the necessary testing information. When Save button is selected, a new window will appear which shows a report preview.



In this window, various additional data can be added, such as company logo and contact information, as well as any comments the user wants to add to the report. All the data from the grid will be displayed in the report.

“Refresh report” button generates a different report preview. “Export report” button saves the report in one of several available formats (PDF, XLS, DOC or RTF).

Delete selected rows
Deletes all the data from one or more selected rows.

Delete all
Deletes all the data from the grid, press delete all.

Static resistance graph
Creates a static resistance graph from the measured resistance values in the grid.

Open

1. In your DV-Win program, click on the **Open** tab.
2. In the **Look in** list, click the drive, folder that contains the file you want to open.
3. In the folder list, locate and open the folder that contains the file.
4. Click the file which you want to open, and then click **Open**.

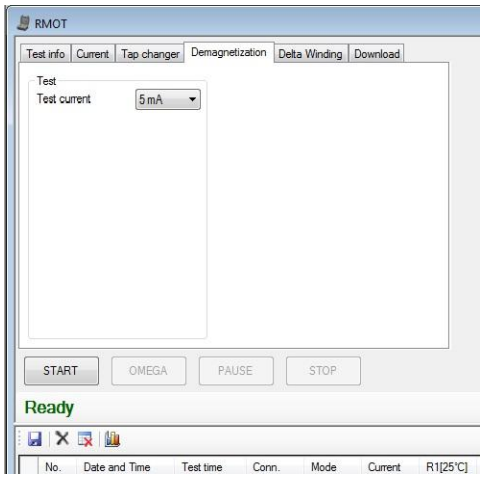
Saved files containing graph data can be opened using the Open button and selecting file.tcp to open tap changer plot - graph from the "Files of type" select list in the opened dialog. After existing file.TCP is opened, all operations on the graph are the same as operations on the on-line graph mode.

7.7 Demagnetization

Note: Before using the demagnetization feature, you must unplug the voltage sense cables from the device.

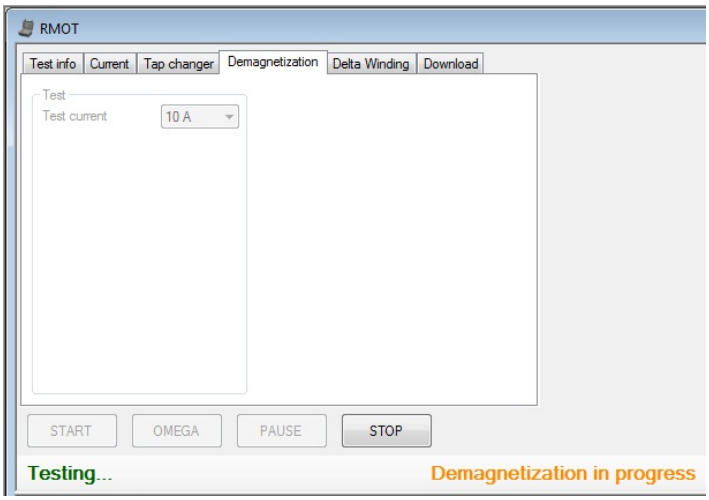
The process of the demagnetization with the RMO60TD could be controlled with the DV-Win software.

The Demagnetization function is selected by choosing the “Demagnetization” tab. Selection of the starting current is carried out in the drop-down list “Test current”.

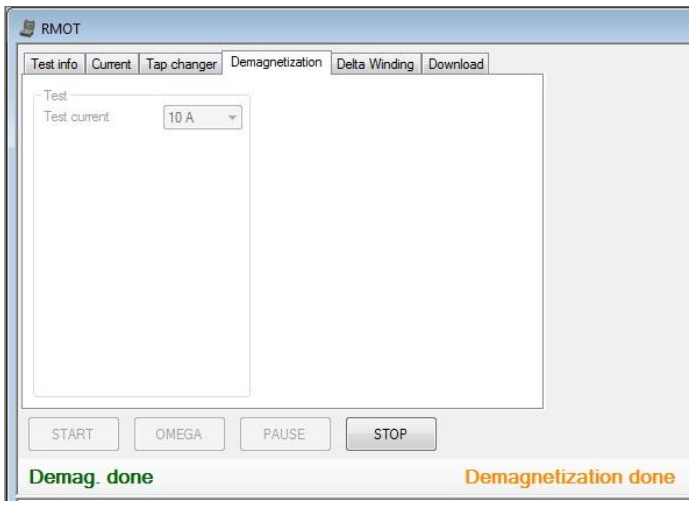


We recommended that the starting current is the same as what was used for the measurement of the transformer under test. Therefore, the test current used for the last test is displayed as a default one.

The demagnetization is performed by pressing **START**.



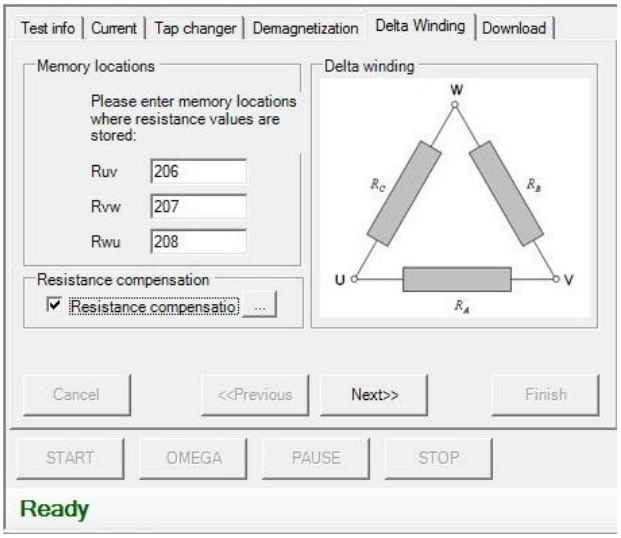
Note:
Never remove the current leads during the demagnetization process and always allow enough time for the transformer being tested to completely demagnetize. Large transformers can require several minutes to demagnetize. During the demagnetization process the transformer will be charged and discharged several times. Once the demagnetization process is finished, the DV-Win displays the message “Demagnetization done!”



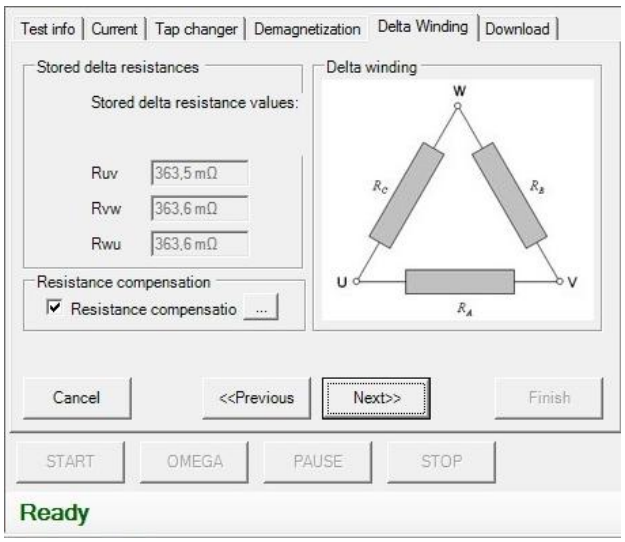
Attention:
When the demagnetization process is manually stopped by pressing **STOP**, it is highly recommended to follow the discharging LED and the buzzer on the RMO60TD device and to be aware of the danger during the discharging process.

7.8 Delta Winding

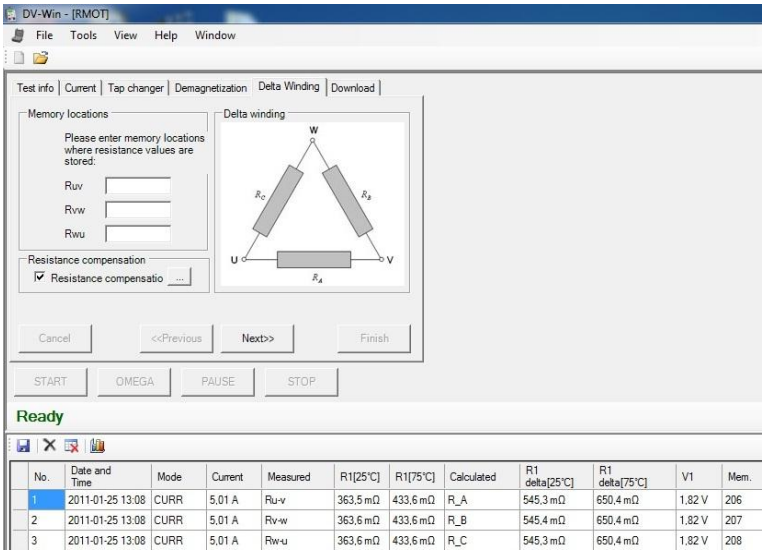
The winding resistances of the transformers with delta configuration cannot be directly measured, since when connected between two terminals you will always measure combination of one winding in parallel with two in series. However, the DV-Win software allows simple and precise calculation of exact winding resistance values.



First, it is necessary to measure the resistance values between two corresponding terminals of the transformer. Three measurements are necessary; between U and V, U and W, and finally, between V and W. These measurements are performed in the Current tab of DV-Win, and the results are stored in three different memory locations of the device (in the example above, those locations are 206, 207 and 208). Memory locations where the resistance values are stored need to be entered manually.



After pressing Next, the stored delta resistance values will be shown. After pressing Next again, values of R_A, R_B and R_C will be calculated.



Finally, after pressing Finish, the results will be shown in the table below. This table will include both the measured and calculated resistance values.

7.9 Download

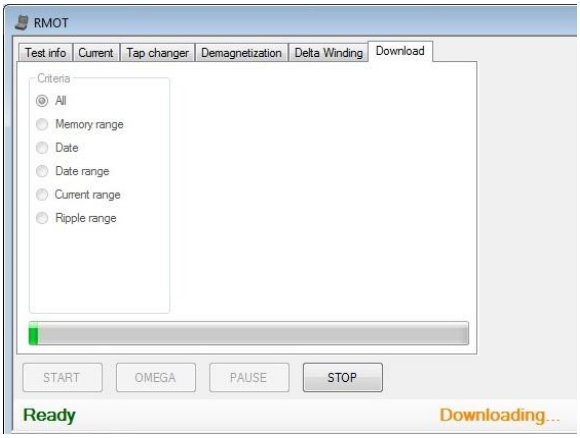
With this command the results from the internal RMO60TD memory can be transferred to the PC. The transfer is possible only if the serial port RMO60TD is connected with the appropriate cable to the PC.

Note: OLTC graph or dynamic resistance cannot be downloaded from internal memory of the RMO60TD since they are not saved in the instrument, but on a PC hard drive.

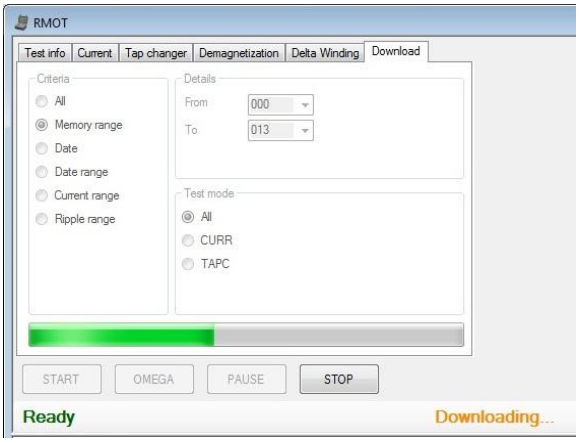
You can select the results you want to transfer from the RMO60TD memory to the PC according to following criteria:

All

All the test results are being transferred from the internal RMO60TD memory to the PC.

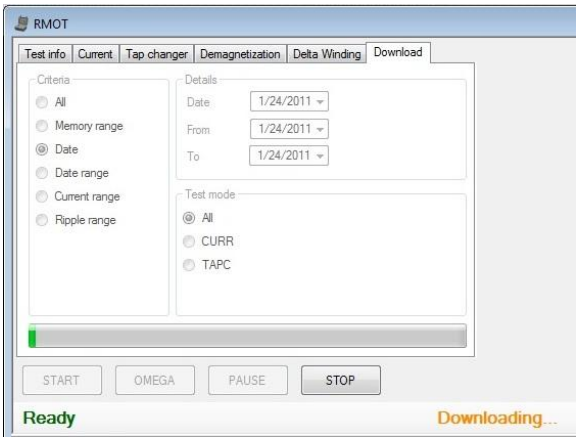


Memory range



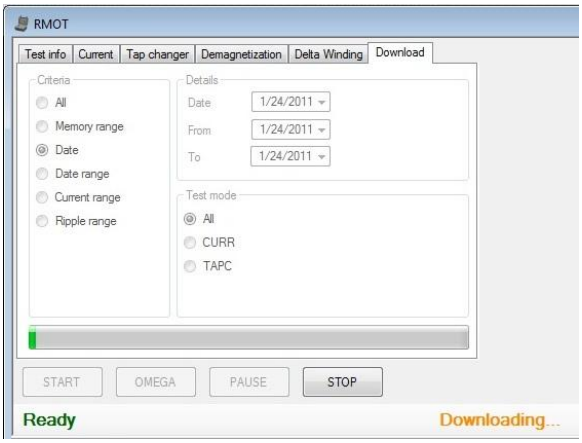
It opens a new window that allows a choice of memory locations to be transferred to the PC. The results that are located in the range between these memory locations, including the chosen memory locations, will be transferred to the PC. The more detailed description on how to use the memory locations can be found in the RMO60TD Manual.

Date



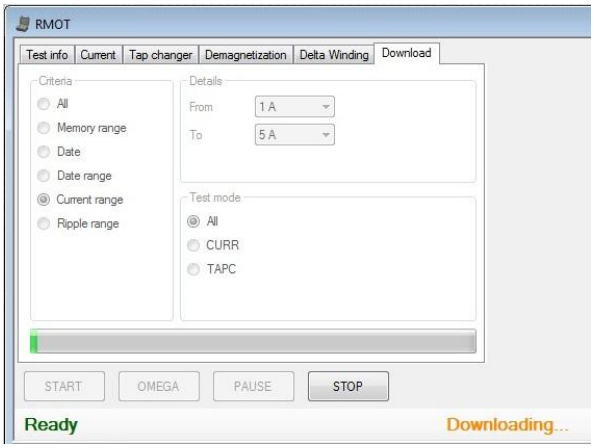
The results that are obtained on the chosen date are going to be transferred to the PC.

Date range



After choosing this option, a new window appears. It provides a choice to select a time interval when the measurements were done. The results obtained during the time period between the chosen dates, including the chosen dates, are going to be transferred to the PC.

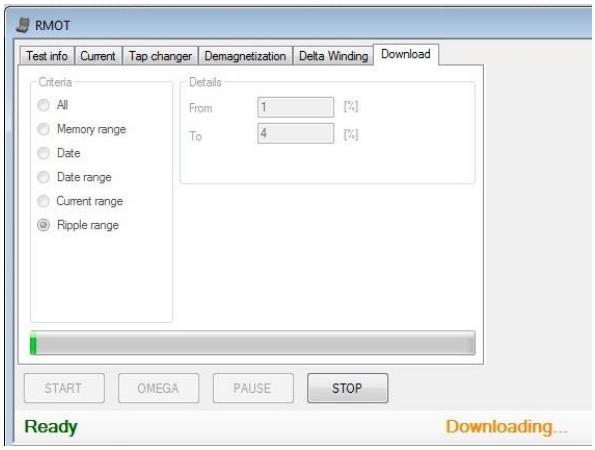
Current range



Selecting this option opens a new window, providing a selection of the currents that were used during the test. The choice of the current is made on the drop-down menu.
The range of the values that are between and including the selected values of the current, are going to be transferred to the PC.

Ripple range

Selecting this option opens a new window, providing a selection of the current ripple that occurred during the test. The results of selected current ripple are going to be transferred to the PC.



Start

When ***START*** is pressed, the selected results are transferred from the internal RMO60TD memory to the PC. Unless the user chooses some other option, all the results from the RMO60TD memory will be transferred (the option “All” is a default).

After pressing the command transfer, the progress bar is being displayed showing a status of the transfer.

Stop

A user should press “Stop” if for whatever reason he wants to interrupt the transfer. After pressing this key all the choices are being erased and the user will return back to the main menu.

The results table

The results from internal memory of RMO60TD are transferred to the PC in the data table; the following layout will be displayed:

Current mode

- Date and Time : the date and the time of the test
- Current : the real test current
- Voltage 1 : the measured voltage on the channel 1 (Ch:1)
- Resistance 1 : the measured resistance on the channel 1 (Ch:1)
- Voltage 2 : the measured voltage on the channel 2 (Ch:2)
- Resistance 2 : the measured resistance on the channel 2 (Ch:2)
- Ripple : the results are zeros
- Memory : the number of the memory location in the RMO60TD where test results are located

Tap Changer mode

All columns are the same except the following:

- Resistance 1 : the measured resistance (R)
- Ripple : the measured current ripple in percents
- The results in other columns, which are not relevant to the Tap changer mode, are zeros.

After the data is downloaded, you can save it as a PDF, XLS, DOC or RTF file on the hard disk of your PC.

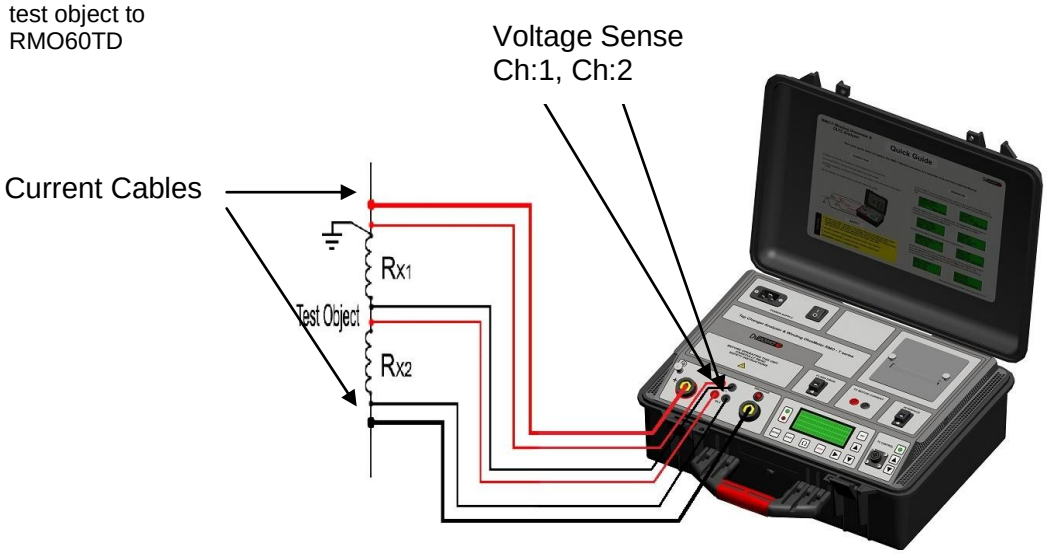
8 Error Messages

Any operational error is indicated by a red LED and accompanied by an alarm.
Furthermore, the display indicates an error status message.

To stop the alarm buzzer, remove the status message on the display, and return to the **Current** or **TapC** menu, press ***STOP***.

8.1 Error Message "Open connection"

Figure 8-1: Connecting a test object to RMO60TD

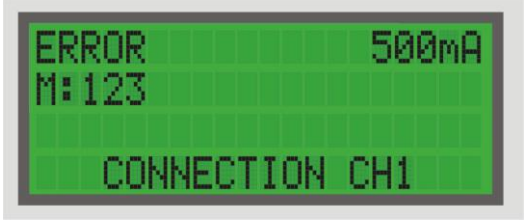


The Error message "Open connection" is displayed if:

- either + or – current cable, or both disconnected either on the side of device, or the side of test object.

8.2 Error Message "Connection CH1-2", "Connection CH1"

The Error message "Connection CH1-2" is displayed if both, CH1 and CH2 are not connected in the **Current** mode. This message is displayed if either + or – voltage sense cable or both are disconnected either on the device side, or the side of the test object.



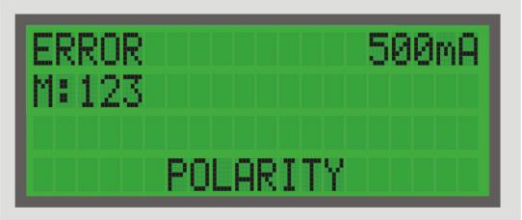
The Error message "Connection CH1" is displayed only if CH1 is not connected in the **TapC** mode. This message is displayed if either + or – voltage sense cable or both are disconnected either on the device side, or the side of the test object.

These messages are displayed only at the beginning of a test.

8.3 Error Message "Polarity"

The Error message "Polarity" is displayed if:

the Voltage sense cables are connected with opposite polarity either on the side of a device, or the side of test object, and the signal is higher than 60 mV.
In some cases discharge LED can light alternately.



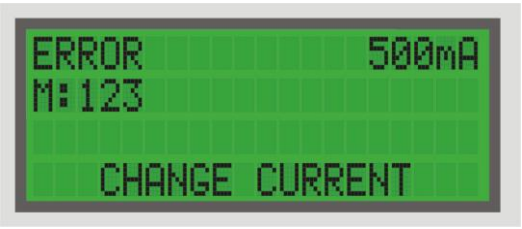
This message is displayed during a test. The DV-Win software displays “polarity” and continues measuring with erroneous test results.

Note: If the signal is lower than 60 mV the display will show result with lower accuracy.
If some of the cables are disconnected after starting the test, error message will not show up and the received results will be erroneous.

8.4 Error Message "Change Current"

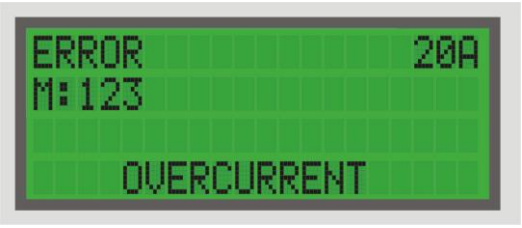
This message is displayed if during the test the voltage at the test object is too high. In this case reduce the test current and repeat the test.

Figure 8-2:
Error message
"Change Current"



In case when test voltage is not higher than 10 V per channel but test current is still improperly high for that resistance error message „Overcurrent“ is shown on the display. Red LED will light continuously.

Figure 8-3:
Error message
"Overcurrent"



8.5 Error Message "Overheat"

This message is displayed when RMO60TD’s operating temperature rises too high.

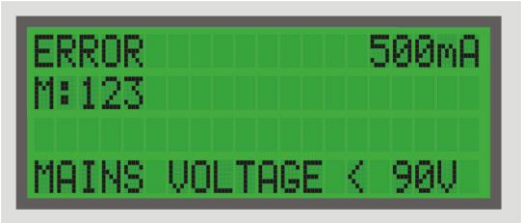
Figure 8-4:
Error message
"Overheat"

In this case, wait for the test set to cool down and repeat the test.

8.6 Error Message "Mains Voltage < 90V"

This message is displayed when RMO60TD's mains voltage is below 90 V.

Figure 8-5:
Error message
"Mains Voltage < 90V"

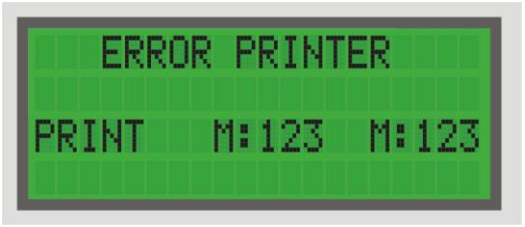


In this case, to reset the status message you must restart RMO60TD.

8.7 Error Messages "Error printer" and "Check paper"

The message "Error printer" is displayed if hardware error is apparent at the printer. Check weather black shaft is in proper position. If yes and the error occurs repeatedly, please contact DV-Power (refer to section "Manufacturer Contact Information").

Figure 8-6:
Error messages
"Error printer" and
"Check paper"



The message "Check paper" is displayed if the printer is out of paper.
The paper roll should be aligned with the paper intake without horizontal offset, and central axis of the paper roll must be parallel with the printer, as shown at Figure 8-7. Also, pay attention to insert paper in proper way to the printer, since it must enter paper intake from the lower side of paper roll.
In case that the paper is not properly aligned, black shaft should be pulled up to loose the paper (see Figure 8-7). After that, align the paper and push down black shaft in proper position.

Figure 8-7:
Paper loading

9 Technical Data

9.1 Mains Power Supply

- Connection	according to IEC/EN60320-1; CSA 22.2
- Voltage	90 V – 264 V AC, 50 / 60 Hz, single-phase
- Input power	2250 VA
- Fuse	15 A / 250 V, type F

9.2 Output data

- Test current	5 mA – 60 A DC
- Measuring range / 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 mΩ
100,0 Ω - 999,9 Ω	0,1 Ω
1000 Ω - 2000 Ω	1 Ω
- Typical Accuracy	± (0,1 % rdg + 0,1 % FS)

9.3 AC Current monitoring channel

- Current monitoring resolution:	0,1 ms
- Amplitude resolution:	16 bit

9.4 Environmental conditions

- Operating temperature -10 °C - +55 °C / 14 F - 131 F
- Storage temperature -25°C - +70 °C / -13 F - 158 F
- Relative humidity 5 % - 95 %, non-condensing

9.5 Dimensions and Weight

- Dimensions	450 mm x 175 mm x 320 mm (W x H x D) 17,72 in x 6,89 in x 12,6 in
- Weight	13 kg / 28,6 lb

9.6 Warranty

three years

9.7 Applicable Standards

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

9.8 USB Interface

RMO60TD is equipped with an USB serial interface to connect to an external computer.

10 Accessories

Included	Article No
DV-Win PC software	RMO60TD-N-00
USB cable	CABLE-USB-00
Mains power cable	MPCXXA-XX-00
Built-in Tap Changer Control Unit + 5 m control cable	TAPCCU-05-00
Ground (PE) cable	CABLE-GND-00

Recommended	Article No
Current cables 2 x 10 m, 10 mm^2 and Sense cables 2 x 10 m with TTA clamps	CS-10-10LMWC
Sense cables 2 x 10 m with TTA clamps	S2-10-02BPWC
Current connection cable 1 x 5 m 10 mm^2 with TTA clamps	CX-05-102XWC
Current clamp 30/300A + cable set 5 m	CACL-0300-00
Cable bag	CABLE-BAG-00

Optional	Article No
Current cables 2 x 15 m, 10 mm² with TTA clamps	CS-15-10LMWC
Sense cables 2 x 2 x 15 m with TTA clamps	S2-15-02BPWC
Built-in Thermal printer 80 mm	PRINT-080-00
Cable plastic case	CABLE-CAS-00
Test shunt 150 A / 150 mV	SHUNT-150-MK

Manufacturer Contact Information

IBEKO Power AB

Box 1346, 181 25 Lidingö, Sweden
Fax: + 46 8 731 77 99
E-Mail: support@dv-power.com
Website: http://www.dv-power.com