

INSTRUCTION MANUAL

ENGLISH



WR14
Winding Resistance Meter 15A



WR50-12 / 13
Winding Resistance Meter 50A



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1 Safety Precautions

The following safety precautions must be observed during all phases of operation, service, and repair of this instrument. By purchasing this equipment the purchaser assumes all liability for the operation and use of this equipment. The intended use of the instrument, its design and manufacture, is to be conducted within the precautions or other specific warnings located within this manual. Failure to comply with these precautions and other specific warnings violates safety standards of design, manufacture, and intended use. Raytech USA, Inc. assumes no liability for the operation and use of this equipment.

SAFE OPERATION

Only qualified knowledgeable persons should be permitted or attempt to operate this test equipment. All test personnel should fully familiarize themselves with the correct application and operation of this and all test equipment prior to operation. Persons directly and indirectly engaged in the operation of this test equipment should keep clear of all high voltage apparatus while conducting tests and measurements.



WARNING!

⇒ **Never connect the instrument to an energized transformer.**

GROUND THE INSTRUMENT

The power cord supplied with the equipment must be connected an electrical receptacle with an electrically grounded terminal (Earthed Ground). To minimize shock hazard, the Ground Terminal on the instrument must be properly connected to an Earth grounded point. In many cases, the quality of the safety ground terminal provided by the power cord does not fulfil the safety requirements.

Non grounded instruments are dangerous and may cause Personnel and instrument damage.

BEFORE APPLYING POWER

Read this manual carefully before operating the system. The WR14 is battery operated, the WR50-12 and the WR50-13 are line operated. They operate from a wide range power input from 90 to 264Vac and 47...63Hz with automatic ranging.



KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal repairs must be made by qualified service personnel. Do not replace components or service this instrument with the power cable connected. To avoid injuries, always discharge circuits, disconnect power and remove external voltage sources before touching components.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE:

Do not operate the instrument in the presence of flammable gases or fumes.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT:

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Raytech service department for service to ensure proper operation and that safety features are maintained.

Instruments, which appear damaged or defective, should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.



2 Unpacking

2.1 WR50

The Instrument consists of the following items:



The Instrument



Power Cord
(depending on country
of distribution)



Accessories:
2 Paper Rolls
and 2 fuses



Current cables



Jumper cable
(2 cables with WR50-13)



Cable Bag



Potential cables: Channel 1



Potential cables: Channel 2



Potential cables: Channel 3
(only WR50-13)



USB Memory Stick



Instruction Manual



2.2 WR14

The Instrument consists of the following items:



The Instrument



Power Cord
(depending on country
of distribution)



Accessories:
2 Paper Rolls



Current cables



Jumper cable



Cable Bag



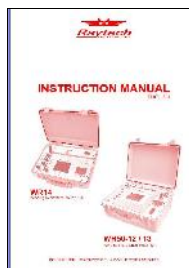
Potential cables: Channel 1



Potential cables: Channel 2



USB Memory Stick



Instruction Manual

If any of the above items are missing or damaged contact your local representative or Raytech USA, Inc. immediately. Optional test leads may be ordered (other than shown).



3 Introduction

3.1 General

Raytech Digital Winding Resistance meters are the enhanced version winding resistance system with a most advanced demagnetizing circuit. They are designed for high degree of accuracy for the measurement of very low resistance of inductive loads.

Ease of use: This intelligent system has an easy to use operation screen, which allows quick selection of the current level to be measured. This system incorporates a touchscreen which allows the user easy access to change or activate a feature.

Impressive Accuracy: The WR series of instruments have high precision, fully automatic, multi-microprocessor based architecture. These systems are designed for highly accurate readings on-site with laboratory precision.

Unique Measuring Technique: This newly designed technique of measurement incorporates a high precision measurement circuit, a unique power source and the fastest discharge unit on market. Extensive filtering and high precision standards are used within the test system. The WR50 is capable of precision measurements up to 50A, The WR14 up to 15A.

Operation: The WR series of instruments apply a preset current level, selected by the user, from 0.025A to 50A (WR50) or 0.025A to 15A (WR14). The 50V¹ power source quickly charges the load and the results of the test are displayed within a few seconds automatically. The results are reported on the easy-to-read color LCD display and can be stored or printed.

Compact Design: The WR50 and the WR14 are lightweight systems designed with their own rugged waterproof field cases.



NOTE

⇒ The WR field case is a waterproof design. When the case is unlocked, a small hole automatically opens, to compensate atmospheric pressure changes.

Simple Maintenance: There is no maintenance required. There is no calibration procedure (no potentiometers to turn). This is due to the utilization of high precision components in the design.

Advanced Protection: Upon powering on the system initializes itself with a self-calibrating, circuit checking sequence. If any problems are detected during this initialization period, or during operation, the operator is immediately notified. The system constantly monitors the condition when turned on. The WR series have extensive protection built in to the circuitry. This is one of the many reasons we can extend our warranty to 5 years.

¹ WR14: 30V



3.2 Advantages & Features

- Highest Accuracy and Precision of any high current test system
- Automatic measurements of Low Resistance from $0.00\mu\Omega$... $100k\Omega$
- Demagnetizing Circuit (Advanced design)
- Microprocessor based system with internal storage for over 10000 test results
- Data exchange via USB-Key
- Storage and Printing of test results while the test system is measuring
- Complete automatic calibration system and system diagnostics
- Temperature channels with automatic resistance correction
- Standard USB 1.1 & RS232 (serial) Interface
- Pure filtered DC Power source for the highest accuracy readings
- Automatic, high efficiency cooling system to dissipate internal temperatures
- Automatic shut off for over-temperature condition
- Color LCD with backlighting and touch screen
- Panel mounted Emergency Stop Switch
- Mounted in rugged case for field testing
- Fully automatic cooling curve analysis (option AHRT 01)
- Fastest discharge time in the market
- 5 Year standard warranty



3.3 System Details

System Check:

The instruments are line operated¹. The systems are designed to be used with AC Voltage power sources between 90 to 264VAC 47...63Hz. The systems perform a self-check each time that they are powered on. The User should always visually inspect all connectors, cables and devices to be measured to avoid any safety issues.

Limitations of Winding Resistance Testing:

In general, there are no limitations on testing low or high inductive windings of transformers. The test systems are specially designed to test all transformer windings.

Discharging the Transformer windings:

The WR systems are specialized systems designed to measure Transformer windings. These systems are equipped with heavy-duty discharge circuits that are very unique in design. The internal discharge circuit dissipates the stored energy in the transformer windings with a "Constant Power Discharge Circuit" that is unique to all transformer winding test systems. That is the reason why Raytech systems can discharge transformers more than 10 times faster than any other system on the market. If a cable happens to fall off during test, the system will STILL discharge the test object safely with the automatic Constant Power Discharge Circuit. The Potential Test Leads are part of the safety circuit and have the ability to discharge a transformer should one of the current leads become detached.

DO NOT USE A SMALLER GAUGE POTENTIAL CABLES (Channel 1, 2, or 3) THEN THE ORIGINAL RAYTECH CABLES SUPPLIED!

Low Resistance Testing:

The WR series of test instruments utilize a 4 wire measuring technique for each Channel. The points where the potential leads are connected determine the resistance reading.

The test set employs a very simple principle of Ohm's law:

$$R = \frac{U}{I}$$

R = Resistance

U = Voltage

I = Current

¹ The WR14 is also battery operated additionally to the line operation

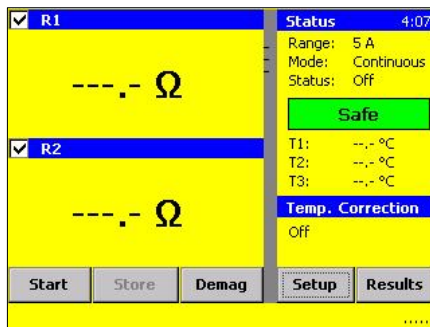


4 Quick Start Guide

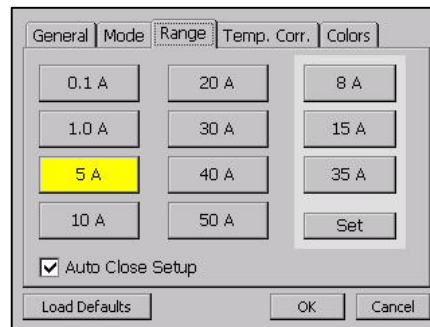
4.1 Instrument operation

For examples of Transformer connections; See next page

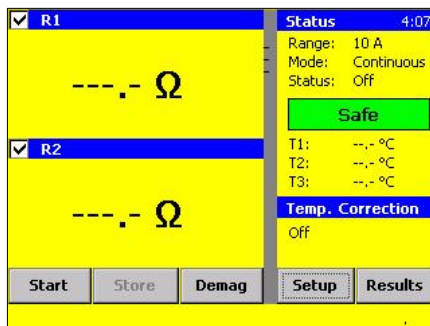
1. Power on the instrument



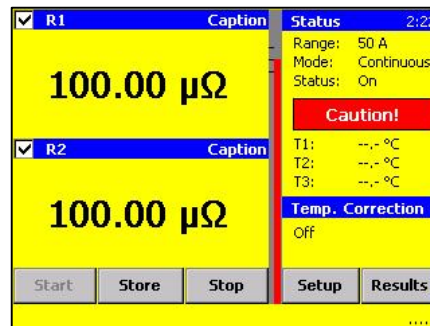
2. Select the Test Current:
press Range or Setup / Range



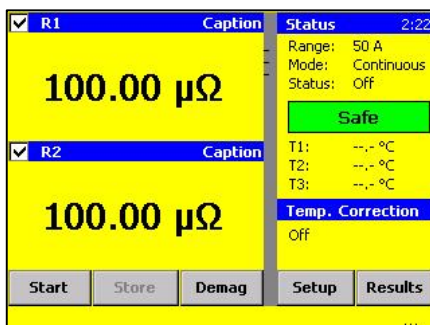
3. Press start button



4. Get the results



5. Press stop button



WARNING!

Wait until the green light shows
"Safe" before disconnecting the
cables



4.2 Selecting the proper current range

Ensure that the test current does not exceed 10% of the rated winding current. This could cause erroneous reading due to heating in the winding.

4.3 Connection to Test Object

Always check the winding schematic on the nameplate and trace the current path through the windings.

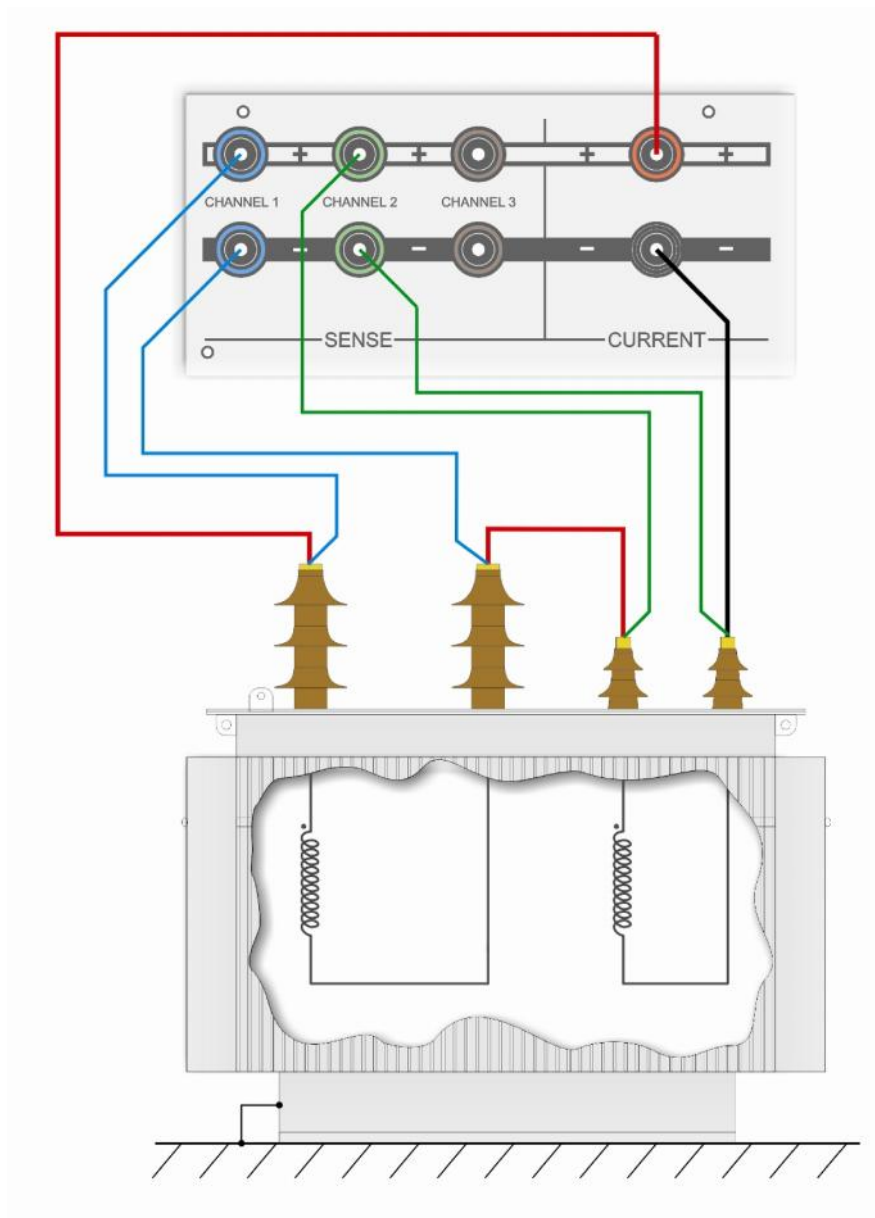
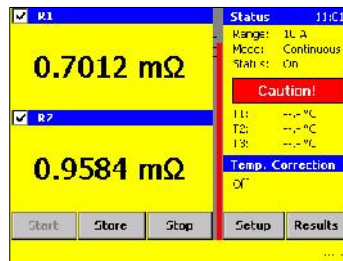
You can save time if you measure the high voltage side in series to the low voltage side from the same magnetic core. Because there are more turns on the high voltage side, you reach much faster saturation flux in the core. This helps to stabilize the measurement and saves much time.

The potential leads must be connected between the current leads. Do not clip the potential leads to the current leads.



Single Phase Transformer, Vector Group 0

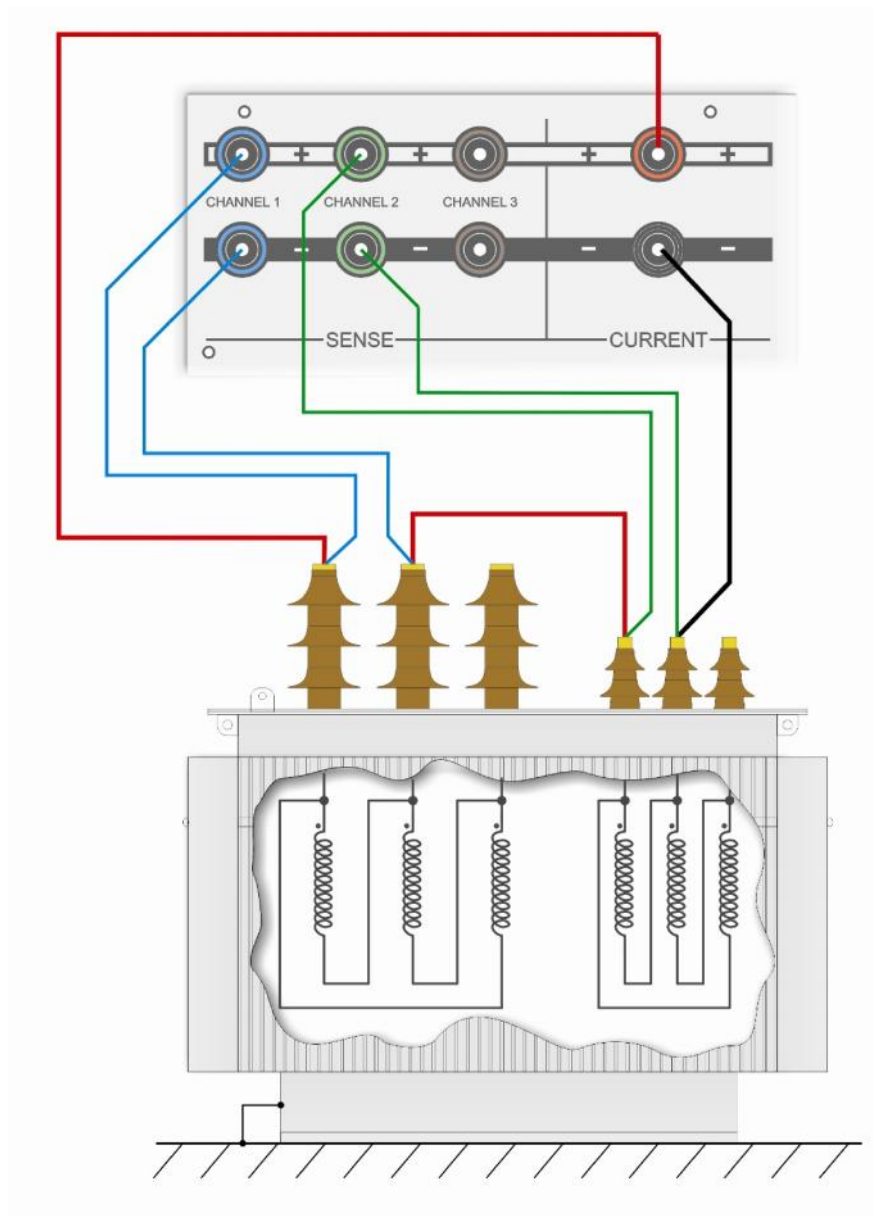
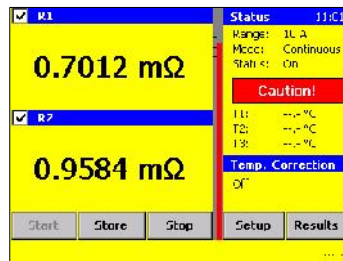
Measurement of HV and LV Winding





Three Phase Transformer, U - U Vector Group 0

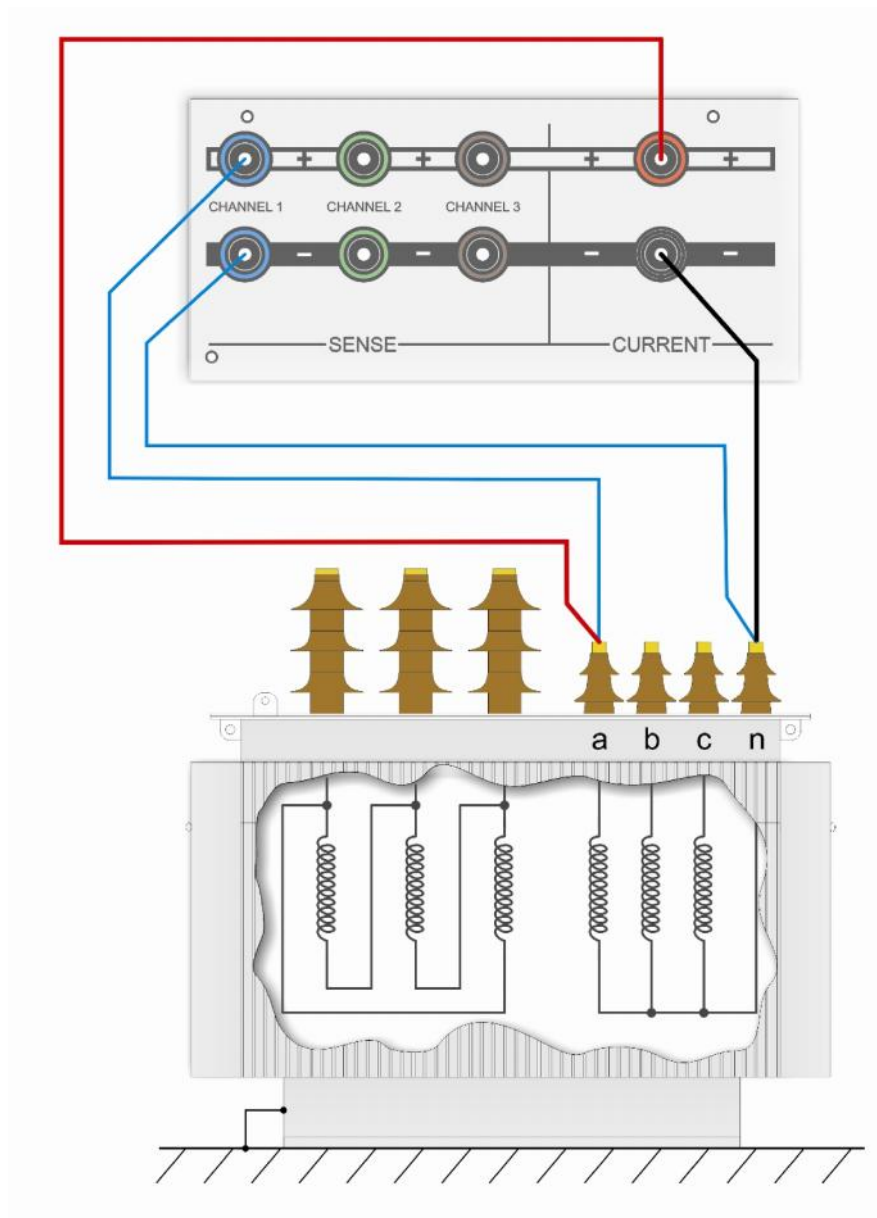
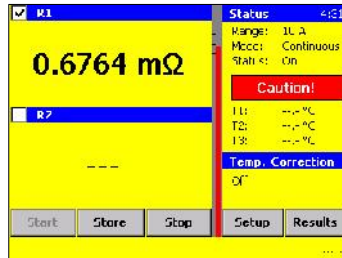
Measurement of HV and LV Winding





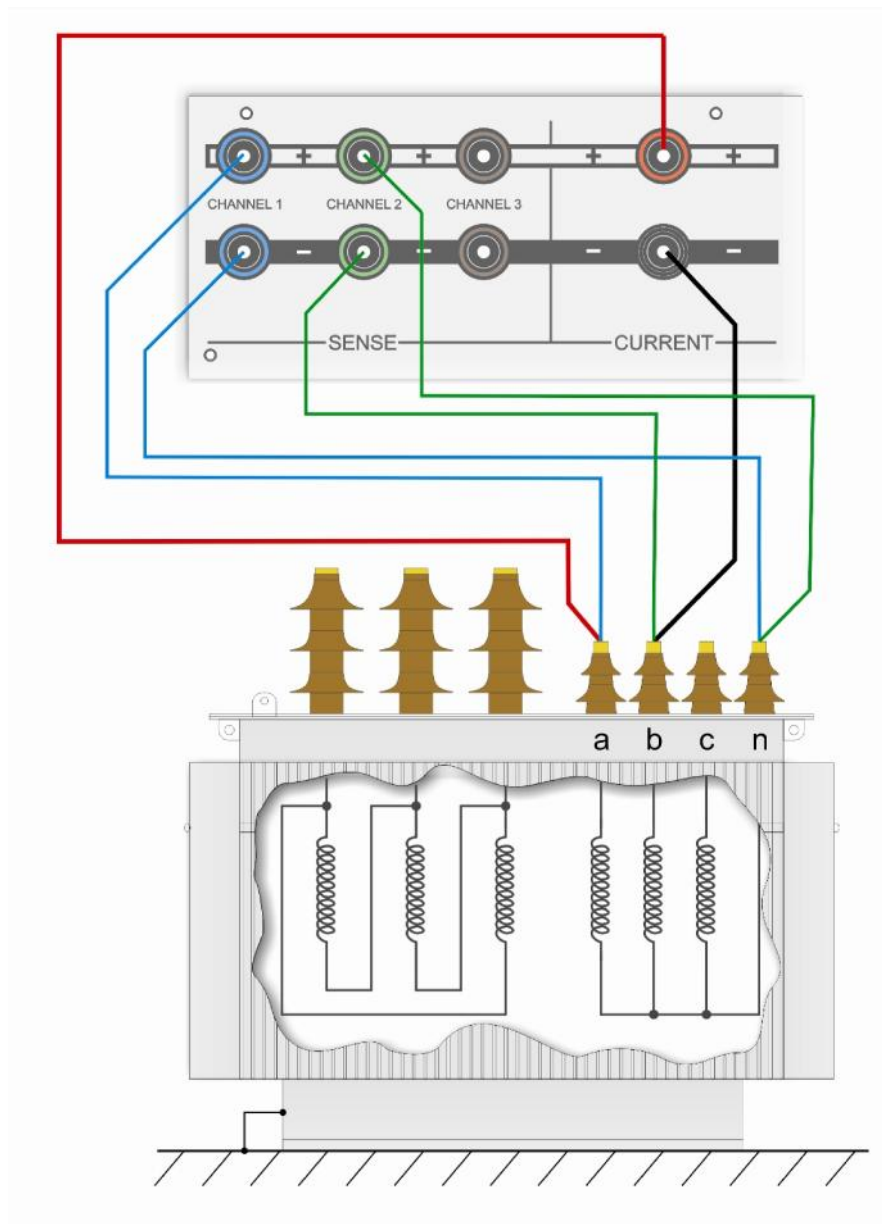
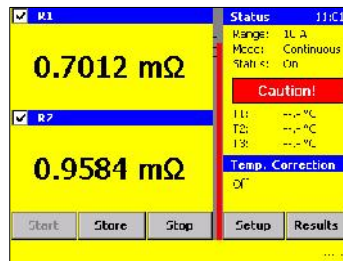
Three Phase Trafo U - f

Measurement of one LV Winding





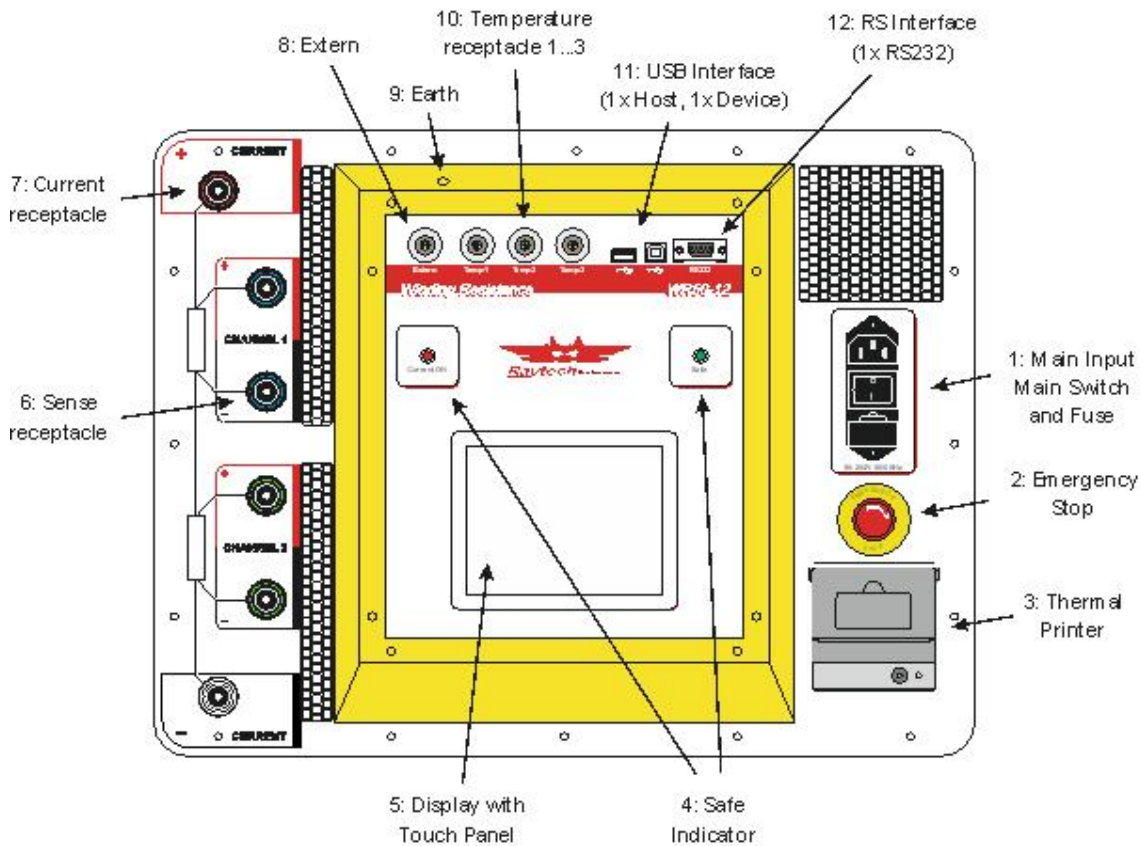
Three Phase Transformer, U - f
Measurement of two LV Winding





5 Operation Elements

5.1 WR50¹



¹ The picture is from a WR50-12, the WR50-13 additionally has a 3rd channel



1: Main Input, Main Switch, Fuses

Connect the power cable to the Main Input.

Press the Main Switch to switch the WR50 on / off.

A 10A T (slow blow) fuse protects the device. Use only the correct fuse type to replace it.

2: Emergency Stop

Press to stop: The measurement will stop and immediately start to discharge the Transformer.

Turn clockwise to release. The device will remain in a safe mode state.

3: Thermal Printer

Allows you to quickly get your results on paper by using the built-in thermal printer.

4: Safety Indicator

Green Light on: System is in safe mode. Ready for handling connections.

Red Light on: Unsafe mode! Don't remove any cables, there is current flowing and voltage on the test leads!
The Transformer is not discharged!

5: Display with Touch Panel

The instrument can be easily manipulated and fully controlled by the touch screen panel. If preferred, an external mouse or keyboard can be connected to the USB Port to control the system.

6: Sense receptacle

Connect + and – Sense Cable for each channel to test object.

(Channel 3: only WR50-13)

7: Current receptacle

Connect + and – Current Cable to test object.

8: Extern

This port can be used for an external warning device.

See chapter "9.1.4 Extern" on page 64 for details.



9: Earth

Use this terminal to connect an additional ground line.

10: Temperature receptacle

Each receptacle accommodates an external temperature probe. (maximum 3)
(Optional 10m Accessory 2021N-26001)

11: USB Interface

1 x USB Host

1 x USB Device

See chapter “9.1.2 USB” on page 63 for details.

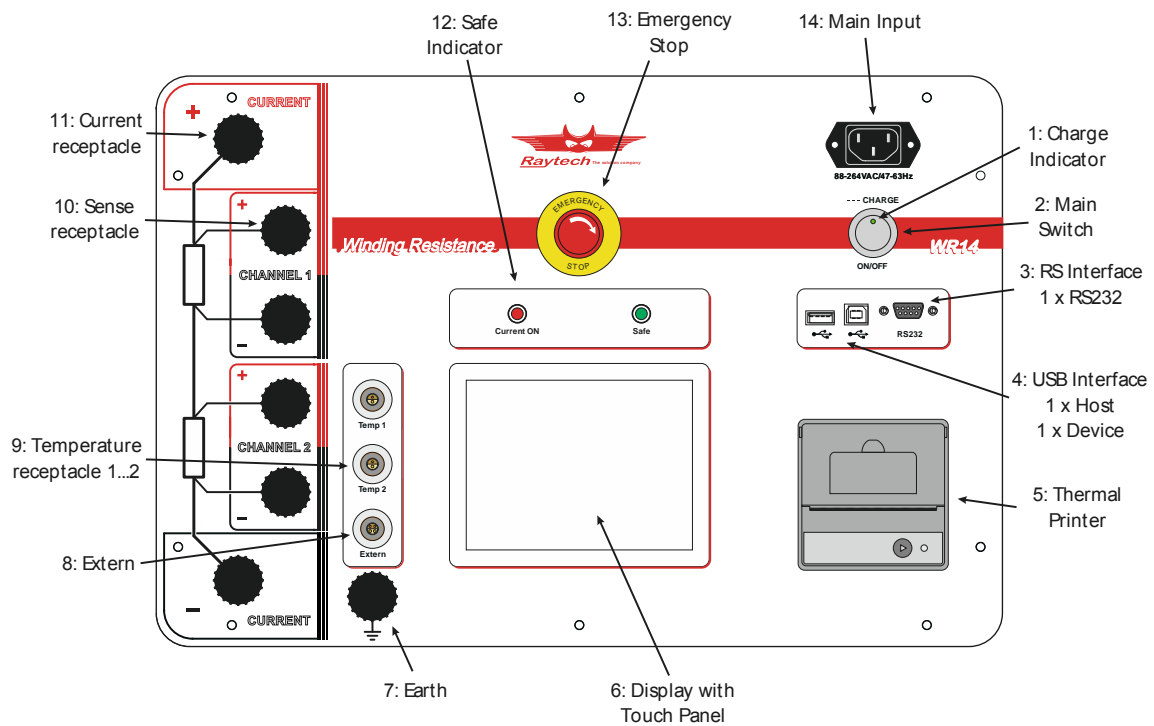
12: RS Interface

RS232

See chapter “9.1.1 RS 232” on page 63 for details.



5.2 WR14





1: Charge Indicator

This LED is blinking if the battery is charging, although if the WR14 is switched off. If the instrument is switched on and the battery is not charging, the LED is on.

2: Main Switch

Press to switch the WR14 on / off.

3: RS Interface

RS232

See chapter "9.1.1 RS 232" on page 63 for details.

4: USB Interface

1 x USB Host

1 x USB Device

See chapter "9.1.2 USB" on page 63 for details.

5: Thermal Printer

Allows you to quickly get your results on paper by using the built-in thermal printer.

6: Display with Touch Panel

The WR14 can be easily manipulated and fully controlled by the touch screen panel. If preferred, an external mouse or keyboard can be connected to the USB Port to control the system.

7: Earth

Use this terminal to connect the ground line.



WARNING!

⇒ **Unit must be connected to Earth Ground for operator Safety**



8: Extern

This port can be used for an external warning device.
See chapter “9.1.4 Extern” on page 64 for details.

9: Temperature receptacle

Each receptacle accommodates an external temperature probe. (maximum 2)
(Optional 10m Accessory 2021N-26001)

10: Sense receptacle

Connect + and – Sense Cable for each channel to test object.

11: Current receptacle

Connect + and – Current Cable to test object

12: Safety Indicator

Green Light on: System is in safe mode. Ready for handling connections.

Red Light on: Unsafe mode! Don't remove any cables, there is Current flowing and
Voltage on the test leads!
The Transformer is not discharged!

13: Emergency Stop

Press to stop: The measurement will stop and immediately start to discharge the
Transformer.

Turn clockwise to release. The device will remain in a safe mode state.

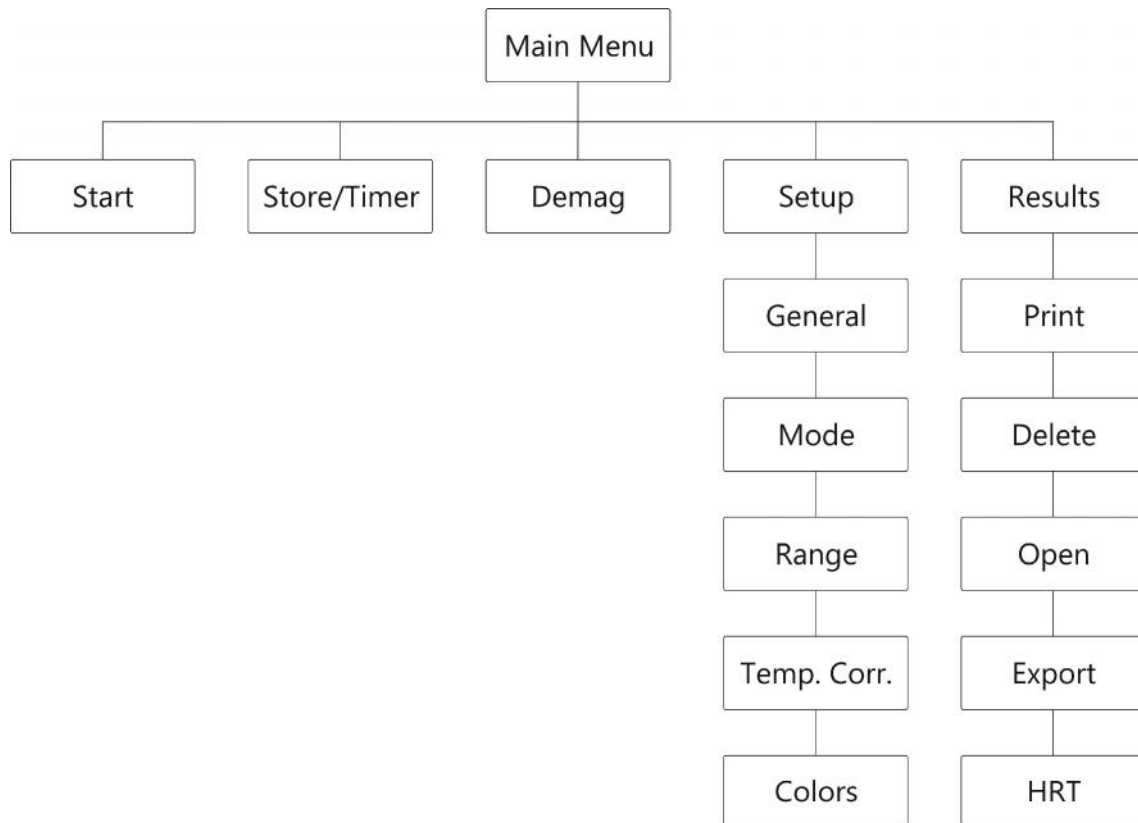
14: Main Input

Connect the power cable to the Main Input.



6 Operating Menu

6.1 Menu Structure



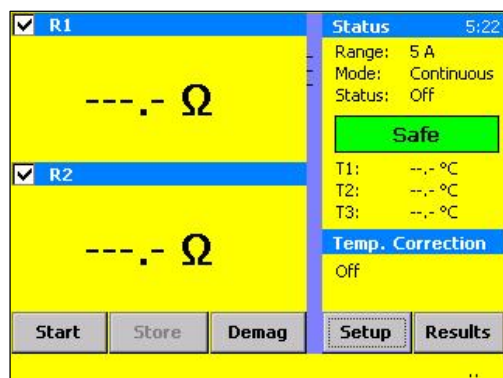
Start up screen: Example WR50





6.2 Main Menu

6.2.1 Main Menu Screen



The Touch screen enables quick navigation by pressing directly on the screen.

E.g. if you would like to change the current range, just press with your finger on the text "Range" and the Menu Range will open directly, it's not necessary to go the way over the Setup.

R1

Enable or Disable measuring channel 1 by touching the small box (next to caption R1) or rename the caption (R1) in the Setup General screen. Press the caption (R1) to change.

R2

Enable or Disable measuring channel 2 by touching the small box (next to caption R2) or rename the caption (R2) in the Setup General screen. Press the caption (R2) to change.

Status

Shows the measurement parameters

Temp. Correction

Shows the temperature parameters, Temperature variables can be modified by pressing the Setup Button or directly in the text (--.-°C). See chapter 6.2.10.

Start

Starts the measurement and the selected current is applied.

Store

Stores the results while measuring current is on.

Stop (This button is only active when current is on)

Stops the measurement; DO NOT disconnect the measuring cables BEFORE the Green light is on and the indication Safe appears.

Demag

Demagnetizes the core of a test object. See chapter 6.2.5

Setup

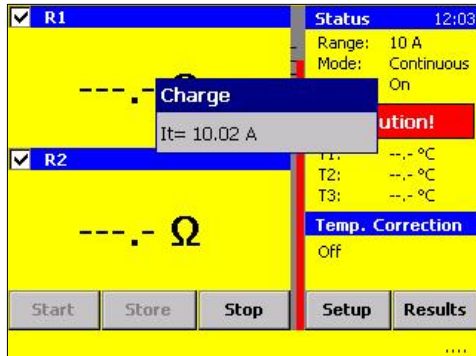
Goes directly to the Setup Menu. See chapter 6.2.6

Results

Goes directly in the Results Menu. See chapter 6.3



6.2.2 Start

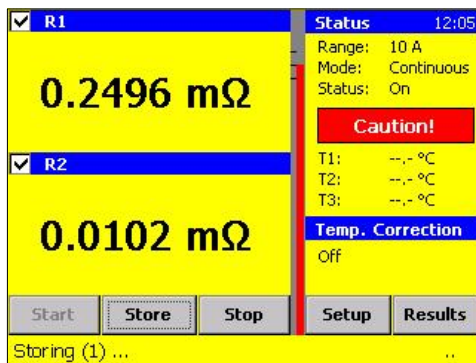


Press Start

Instrument starts to charge test object with the selected current.

Maximum current is shown on the Range Status.

6.2.3 Store

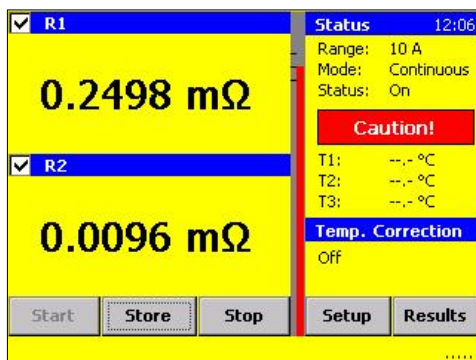


Press Store

Instrument stores the value shown in the Display (R1, R2).

The Measurement doesn't stop.

6.2.4 Stop



Press Stop

Instrument stops the measurement and begins the discharge process.

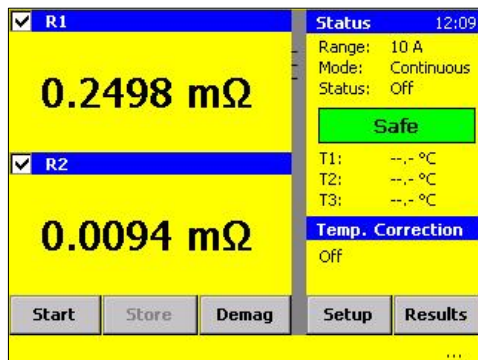
DO NOT disconnect the measuring cables until the green light is on and the indication Safe appears.



6.2.5 Demag

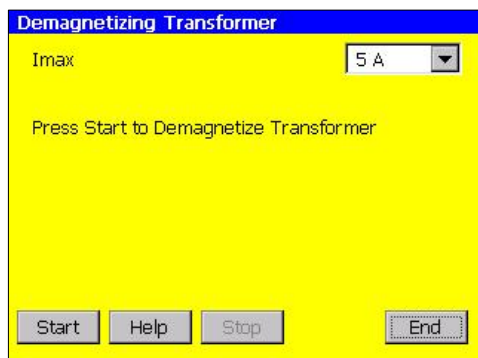
Demagnetisation procedure to demagnetize the test object (e.g. transformer core)

Demag button appears after measurement is finished.



Press Demag.

Connect the Current and the Sense (only Channel 1) cables to the high voltage side to the Transformer.



Select the demagnetizing current which is usually the same current as the test current and then press start.

Demagnetizing procedure runs automatically.

For a technical description of the demagnetizing feature: See Appendix: F Demagnetizing on Page 77.



6.2.6 Setup

By pressing the Setup button, the Setup screen will appear.

Press the appropriate text box (Caption) in the main menu screen and the Setup-Screen will automatically appear with the selected screen for Range, Temp. Correction or similar.

General

This screen allows the selection, modification and setting of the General Instrument parameters.

Mode

This screen allows the selection and setting of the measurement mode (single, continuous or interval).

Range

This screen allows the selection, modification and setting of the range for the Test Current.

Temp. Corr.

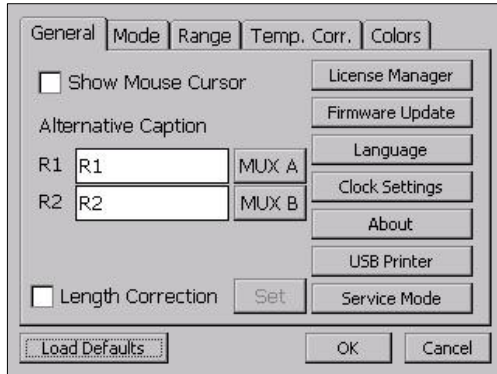
This screen activates the temperature correction feature.

Colors

This screen allows the modification and changes of the screen colors.



6.2.7 General



From the Main screen, press Setup.
Then enter the General Setup Menu.

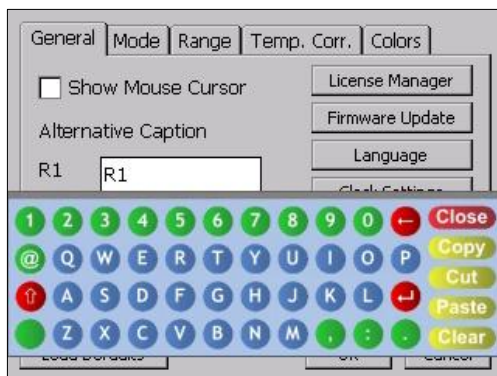
6.2.7.1 Mouse Cursor

Show or hide the Mouse Cursor. Useful if you operate with a USB Interface mouse.

The mouse cursor appears automatically after the USB mouse is connected.

You can control the instrument with a USB-mouse, track ball and/or keyboard.

6.2.7.2 Alternative Caption



R1...R2...R3¹ Measuring Channel, Name Caption

Change the name of the measurement channel displayed in the main screen.

Touch the text box (i.e. R1).

Press ↵ To store the settings

Press @ For special characters

Press "Close" To finish input

¹ The third channel is only available in the WR50-13



6.2.7.3 MUX A / MUX B

Use the buttons MUX A and MUX B if you have a Multiplexer connect to your instrument.
For a description see in the Appendix chapter G Multiplexer on page 79.

		-				
		H1	H2	H3	H0	H3-H1
+	H1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	H2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	H3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	H0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Set Labels

No Device - Caption only

OK

If you don't have a Multiplexer, you can use the buttons MUX A and MUX B to automatic label the caption.

See chapter 6.2.7.2 Alternative Caption.

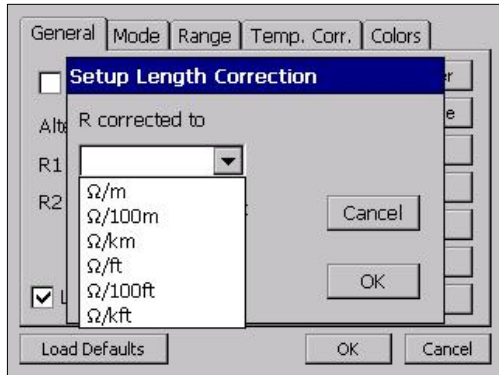
Set Labels		Set Default
1	<input type="text" value="H1"/>	H1; H2; H3; H0
2	<input type="text" value="H2"/>	H1; H2; H3; H0
3	<input type="text" value="H3"/>	X1; X2; X3; X0
N	<input type="text" value="H0"/>	Y1; Y2; Y3; Y0
		1U; 1V; 1W; 1N
		2U; 2V; 2W; 2N
		3U; 3V; 3W; 3N

Cancel OK

With "Set Labels" you can change the standard or you can set your own names by touching the text box.

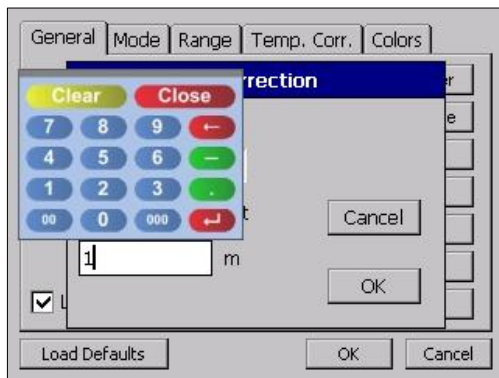


6.2.7.4 Length Correction



Length Correction

Change the measuring unit from Ohm to Ohm/Length. The test results are then corrected to the selected display method.



The length of the test object is pre-defined by the customer. Enter the length of the test specimen.

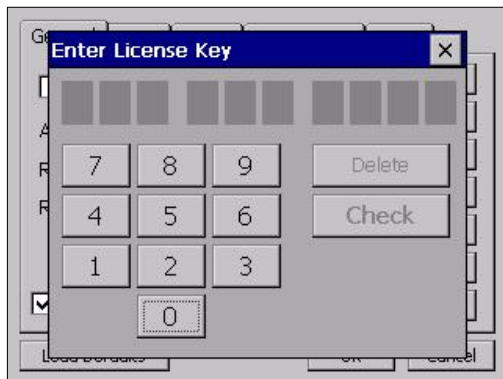


6.2.7.5 License



License Manager

The License Manager shows the validity of the license for the use of the instrument and the Heat Run Test Software. If there is no valid status for a license displayed, contact your local representative or Raytech GmbH.



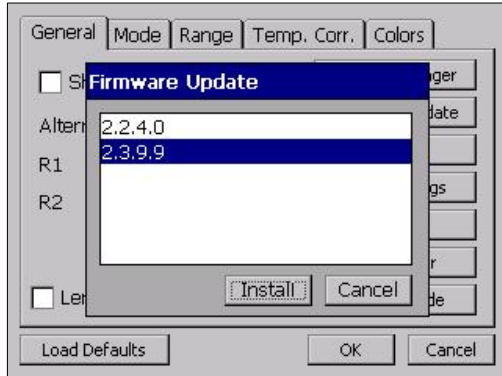
Extend the license

To modify or extend the license, enter a new license code.

The license code is generated by Raytech GmbH.



6.2.7.6 Firmware update

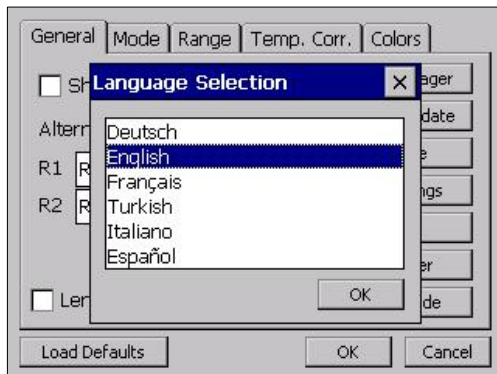


New Firmware versions are available free of charge at www.raytech.ch

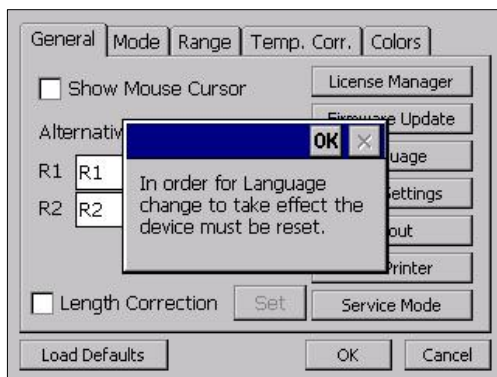
Download the new Firmware (.zip file) onto your USB key on the root directory (Not in a subdirectory, do not Unzip it).

Connect the USB-key to the instrument and press install. The system will detect and automatically install the new firmware and restart the system.

6.2.7.7 Language



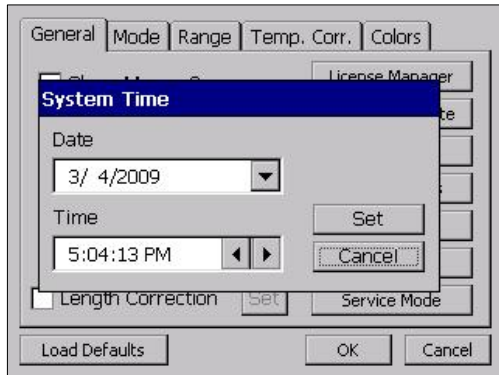
The selection of languages for the operating menu can be made.



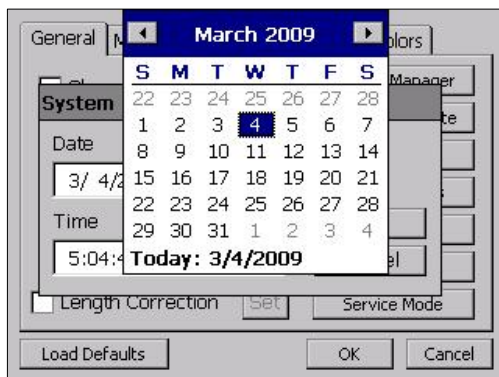
To activate the desired language, restart the instrument after the selection is made.



6.2.7.8 Clock Settings



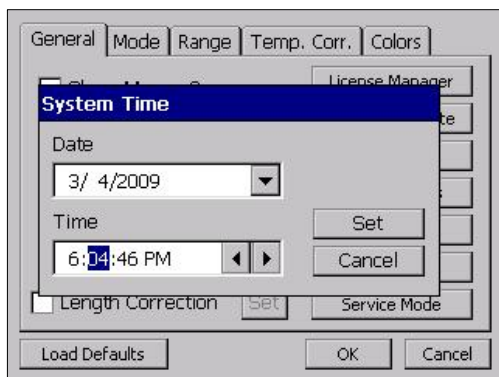
Adjustment of the internal clock can be made.



Date:

By pressing the arrow the calendar will be displayed. Select the date by pressing on the actual day.

The date format is: Month/Day/Year



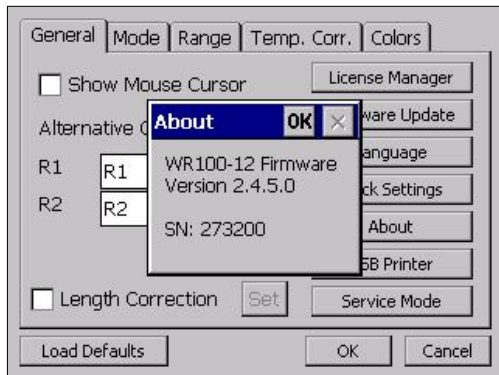
Time:

Select hour/minute/second by highlighting the numbers in the clock.

By pressing the arrows the time will increase or decrease.



6.2.7.9 About



Shows actual Firmware Version and the Serial Nr. of the instrument.

6.2.7.10 USB Printer

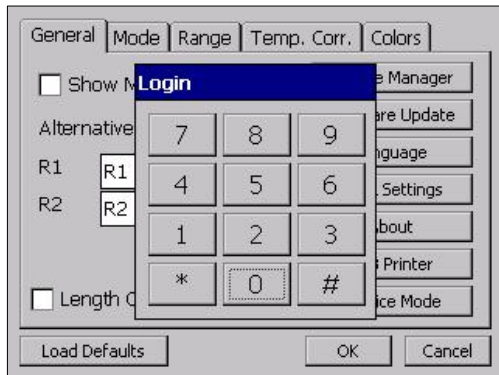


Certain external USB Printers can be connected. Select the desired printer to print results. Printers not listed are not supported.

For more Information see chapter D USB Printer Info on page 73.



6.2.7.11 Service Mode



The Service Mode has limited access.

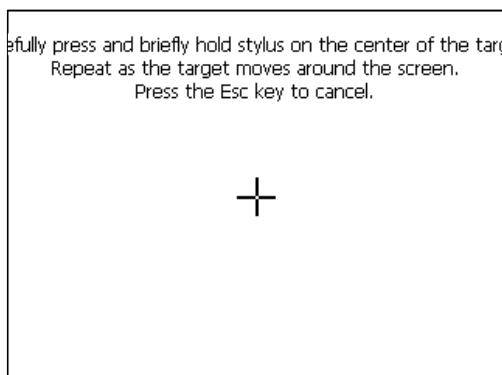
However, the touch screen parameters can be calibrated by the enduser.

To calibrate the touch screen parameters: Press 0000# and follow the on screen instructions as depicted below.

or exit directly by pressing #

6.2.7.11.1 Calibrate Touchscreen

After entering the code "0000"# in the Service Mode, you will see the following screen:



Press and hold stylus on the center of the target until the cross moves.

Repeat as the target moves around the screen.

Upon completion, press Enter to accept the new parameters or Esc to escape and not save the parameters if you have connected a keyboard to the instrument. If you don't have, press anywhere on the display to accept the new parameters.

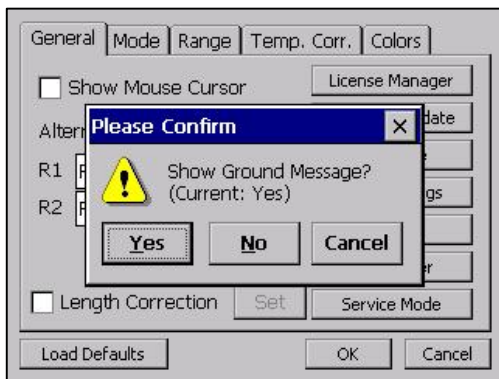


6.2.7.11.2 WR14 Ground Warning



Every time you switch the WR14 on, you get a Warning, that the Unit must be connected to Earth Ground for operator Safety.

It's possible to disable the Warning: After entering the code "0200"# in the Service Mode, you will see the following screen:



Now you can select whether you want the Warning enable (Yes) or disable (No).



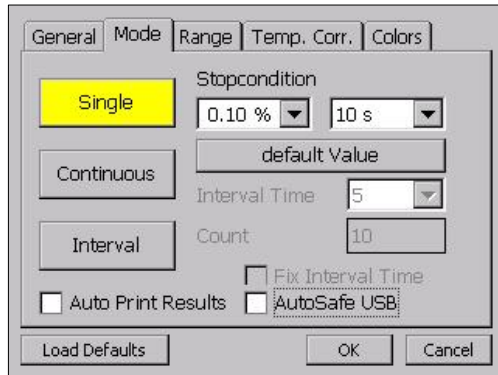
WARNING!

- ⇒ We highly recommend to enable the warning!
- ⇒ Unit must be connected to Earth Ground for operator Safety



6.2.8 Mode

6.2.8.1 Single



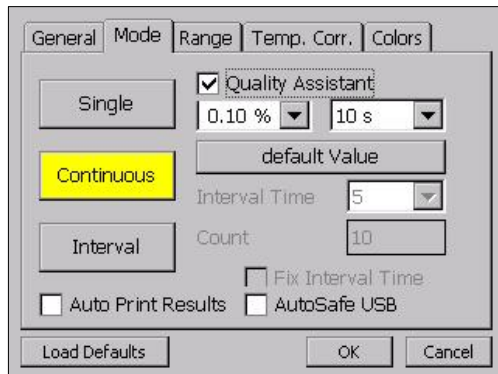
Performs 1 single measurement

Stopcondition:

Stops the measurement as soon as the result is within the selected conditions.

(Example: within $\pm 0.10\%$ during 10 Seconds of time)

6.2.8.2 Continuous



Performs continuous measurement until the measurement is stopped by the user.

Quality Assistant:

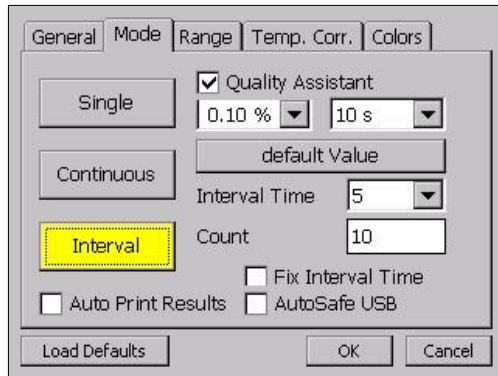
If the result is within the selected parameters, a green light in the main screen will illuminate and indicate this condition.

If the result is out of the selected parameters, a red light in the main screen will illuminate and indicate this condition.

If the selected conditions are almost met, a yellow light in the main screen will illuminate.



6.2.8.3 Interval



Performs a selected number of measurements (selected with “Count”)

Interval Time:

The time (in Seconds) selected between 2 measurements. It will automatically store the result.

Count:

The number of measurements to be taken.

When all measurements are taken, the System discharges the Transformer.

Fix Interval Time:

Selects the interval time from Start Time instead of from the 1st measurement point.

e.g. If the Interval Time is set to 10 seconds and the first measurement is taken at 27 seconds, the system stores results at 27, 37, 47...seconds if the checkbox is not checked. If the checkbox is checked, the results will be taken and stored at 27, 30, 40, 50...seconds.

Note:

The current remains ON for the duration of the test and automatically stops after “Count” number of measurements are taken.

Quality Assistant:

If the result is within the selected para-meters, a green light in the main screen will indicate this condition and automatically store the result.

The Interval measurement starts taking the results.

If the result is out of the selected para-meters, a red light in the main screen will indicate this condition. No results stored.

If the selected conditions are almost met, a yellow light in the main screen will illuminate and indicate this condition. No results stored.



Auto Print Results¹

If this feature is selected, the instrument additionally prints the results to a connected printer when a measurement will be stored.

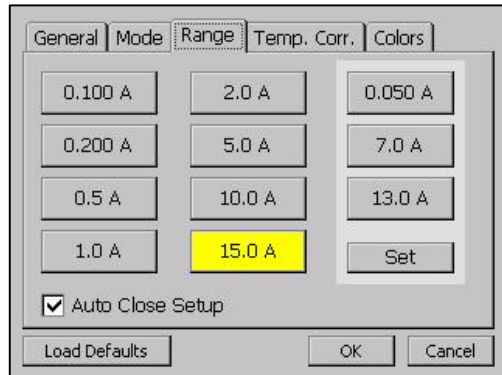
AutoSave USB:

The results will be additionally stored on a USB-Key during a measurement.

¹ Not available in WR14



6.2.9 Range

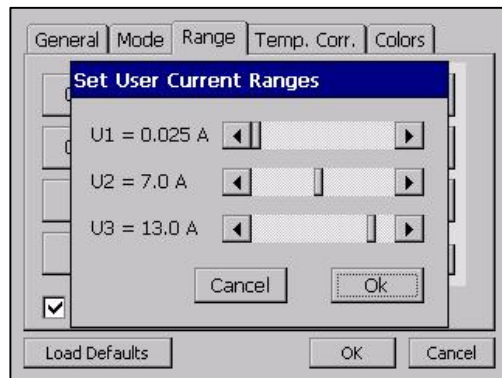


Selects the current range for the measurement.¹

Auto Close Setup:

Closes the Setup Window after the Current Range selection is made without pressing OK.

The 3 frames on the right side are reserved for the User specified settings.



For adjusting the User Settings:

Press "Set"

Adjust all 3 settings by moving the cursor left or right to the desired Current level. Press OK when finished.

¹ The maximum current of the WR50 is 50A
The maximum current of the WR14 is 15A



6.2.10 Temp. Corr.

General Mode Range Temp. Corr. Colors

Activated

Coefficient Reference Value

Cu (234.5 °C) 25 °C

Al (225 °C)

User defined 180 °C

Channels

T1 T2 T3

Ext 25 °C

Load Defaults OK Cancel

Activated:

Temperature correction is activated when the box is marked. The displayed test value then is a calculated result depending upon parameters selected.

Coefficient:

Choose the temperature coefficient of the material to be measured; Either CU (copper), AL (aluminium) or User defined. Temperature correction parameters are then displayed on the touch screen panel.

Reference value:

The base temperature the temperature correction factor is referred to.

Channels:

This allows the user to select which measurement channel (temperature probe or external temperature meter) that the temperature correction is applied to. If the required selection is more than one channel, then the average value of the selected measurement channels is calculated.

Ext.:

Manual input of an external measured temperature. For example, an external temperature meter.

Example for calculation:

In the example below, the measurement object is Copper and will be corrected to 25 degrees Celsius based on the temperature input of temperature channel 1.

If you do not have a Raytech temperature probe, activate the "Ext" box and fill in the temperature of the test object you measure with an external temperature meter.



The correction follows the formula:

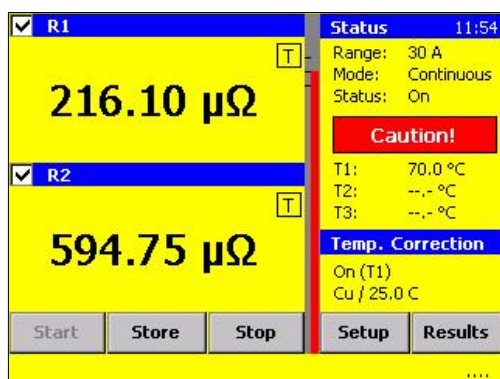
$$R_s = R_m * \frac{T_s + T_k}{T_m + T_k}$$

- Rs Resistance at desired temperature, Ts
- Rm Measured resistance
- Ts Desired reference temperature
- Tm The temperature at which resistance was/is measured
- Tk 234.5 for copper
225.0 for aluminium
(aluminium may be as high as 240)

If you are used to a correction with “alpha25” you can calculate the Tk by the formula:

$$T_k = \frac{1}{\alpha_{25}} - 25$$

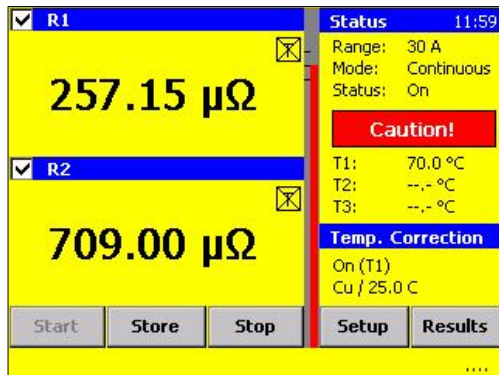
The Main Test screen appears as below if the Temperature correction is activated:



The “T” in the measuring channel box shows that the displayed resistance value is corrected. In this example it is corrected to 25 °C using Tk of Copper and referring to Temperature probe 1.

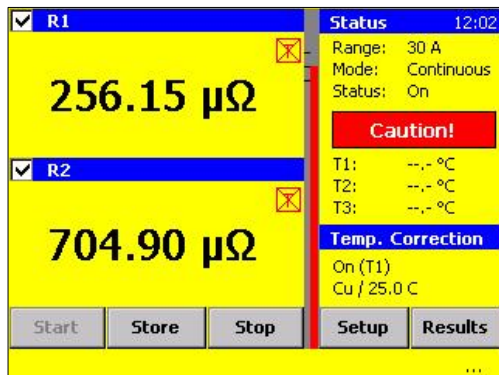


To view the actual result without the temperature correction, Press the “T” during the measurement:



The “crossed” “T” shows that the displayed resistance value is NOT corrected.

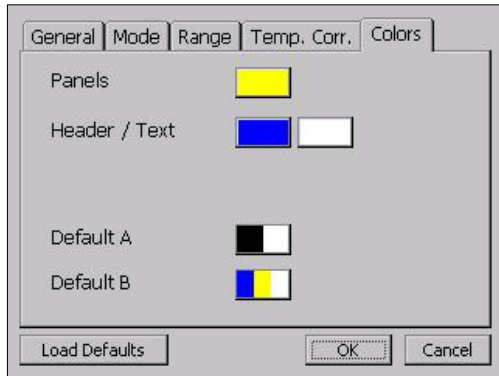
The corrected AND the uncorrected values are stored in memory whether or not the correction is activated in the display.



If the display shows a crossed Red T, the result is not corrected because a temperature probe is missing or not recognized by the system.



6.2.11 Colors

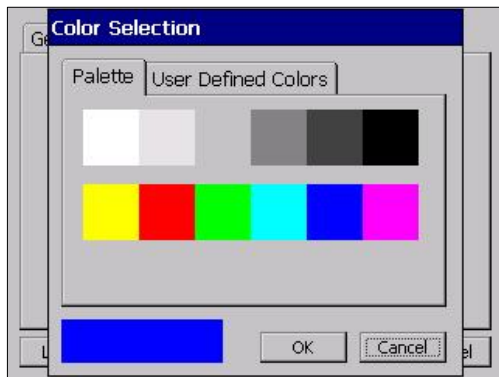


Shows the selected colors displayed on the screen.

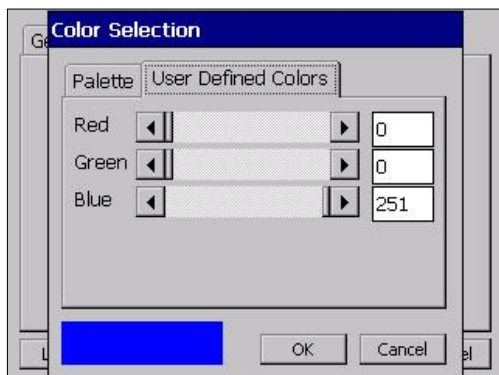
The User may change the colors on the touch screen display by selecting appropriate colors for each.

Default A: Black and white screen
Default B: Colored screen

Black and white may be selected on certain outdoor conditions. For example bright sun light.



Choose a color by selecting a predefined color available.



Choose a color by manually adjusting the color select bar.



6.3 Results

Print	Delete	Open	Export	HRT
Date	Time	Range	Mode	
2/17/2009	2:30 PM	10 A	Intervall	
2/17/2009	2:31 PM	10 A	Intervall	
2/17/2009	2:32 PM	10 A	Intervall	
2/17/2009	2:32 PM	10 A	Intervall	
2/24/2009	9:49 AM	10 A	Interval	
3/4/2009	3:19 PM	5 A	Continuous	
3/4/2009	3:20 PM	5 A	Interval	

Back

Shows the overview of the measurements which are sorted by Date/Time.

6.3.1 Print

Print	Delete	Open	Export	HRT
Print Selected	Print All	Time	Range	Mode
		10 PM	10 A	Intervall
2/17/2009		2:31 PM	10 A	Intervall
2/17/2009		2:32 PM	10 A	Intervall
2/17/2009		2:32 PM	10 A	Intervall
2/24/2009		9:49 AM	10 A	Interval
3/4/2009		3:19 PM	5 A	Continuous
3/4/2009		3:20 PM	5 A	Interval

Back

Print Selected:

Prints the details of the selected measurement.

Print All:

Prints the details of all stored measurements.

The default printer is the built-in printer. If an external USB Printer is selected, this will be recognized as the default printer.

6.3.2 Delete

Print	Delete	Open	Export	HRT
Date	Delete Selected ...	Delete All ...	Mode	
2/17/2009			A	Intervall
2/17/2009			10 A	Intervall
2/17/2009			10 A	Intervall
2/17/2009			10 A	Intervall
2/24/2009			10 A	Interval
3/4/2009			5 A	Continuous
3/4/2009			5 A	Interval

Back

Delete Selected:

Deletes the selected measurement.

Delete All:

Deletes all stored measurements.

After selecting delete, a warning window will appear to confirm this choice. Deleting selected files is permanent.



6.3.3 Open

Print Delete Open Export HRT				
Date	Header	Age	Mode	
2/17/2009	2:31 PM	10 A	Intervall	
2/17/2009	2:31 PM	10 A	Intervall	
2/17/2009	2:32 PM	10 A	Intervall	
2/17/2009	2:32 PM	10 A	Intervall	
2/24/2009	9:49 AM	10 A	Interval	
3/4/2009	3:19 PM	5 A	Continuous	
3/4/2009	3:20 PM	5 A	Interval	

Back

Header:

Opens the header for the selected measurement. The header cannot be modified.

Details:

Shows all of the details of each measurement stored under this data file.

You can although double tip on the measurement to open the details of the measurement.

Print Data HRT						
Time	R1	R2	T1	T2	T3	I
00:02:03	46.170 mΩ	0.9649 mΩ	73.8	73.6	0.0	15
00:02:08	46.134 mΩ	0.9642 mΩ	73.6	73.4	0.0	15
00:02:13	46.098 mΩ	0.9634 mΩ	73.3	73.2	0.0	15
00:02:18	46.062 mΩ	0.9627 mΩ	73.1	72.9	0.0	15
00:02:23	46.026 mΩ	0.9619 mΩ	72.8	72.7	0.0	15
00:02:28	45.990 mΩ	0.9612 mΩ	72.6	72.4	0.0	15
00:02:33	45.956 mΩ	0.9604 mΩ	72.4	72.2	0.0	15
00:02:38	45.920 mΩ	0.9597 mΩ	72.1	72.0	0.0	15
00:02:43	45.884 mΩ	0.9590 mΩ	71.9	71.7	0.0	15
00:02:48	45.850 mΩ	0.9582 mΩ	71.7	71.5	0.0	15

<- Header Close

Details:

Shows the details of the measurements.

A single measurement can be deleted by highlighting and selecting Data/Delete in the menu.

Print Data HRT						
Time	R1	R2	T1	T2	T3	I
00:02:03	46.170 mΩ	0.9649 mΩ	73.8	73.6	0.0	15
00:02:08	46.134 mΩ	0.9642 mΩ	73.6	73.4	0.0	15
00:02:13	46.098 mΩ	0.9634 mΩ	73.3	73.2	0.0	15
00:02:18	46.062 mΩ	0.9627 mΩ	73.1	72.9	0.0	15
00:02:23	46.026 mΩ	0.9619 mΩ	72.8	72.7	0.0	15
00:02:28	45.990 mΩ	0.9612 mΩ	72.6	72.4	0.0	15
00:02:33	45.956 mΩ	0.9604 mΩ	72.4	72.2	0.0	15
00:02:38	45.920 mΩ	0.9597 mΩ	72.1	72.0	0.0	15
00:02:43	45.884 mΩ	0.9590 mΩ	71.9	71.7	0.0	15
00:02:48	45.850 mΩ	0.9582 mΩ	71.7	71.5	0.0	15

Save Changes?

Yes No Cancel

<- Header Close

If you exit the Details after selecting delete, a warning window will appear to confirm this choice.

Deletion is permanent.



6.3.4 Export

Print		Delete		Open		Export		HRT	
Date		Export Selected to USB Drive [XML]							
11/12/2008		Export All to USB Drive [XML]							
4/12/2011		Export Selected to USB Drive [CSV]							
4/12/2011		Export All to USB Drive [CSV]							
4/12/2011	7:35 PM	5 A	Interval						
4/12/2011	7:37 PM	5 A	Interval						
4/12/2011	7:39 PM	5 A	Interval						
4/12/2011	7:43 PM	15 A	Single						
4/12/2011	7:43 PM	15 A	Single						
4/12/2011	7:45 PM	15 A	Interval						
4/12/2011	7:47 PM	15 A	Single						

Back

Export Selected to USB Drive [XML]:
Exports the selected measurement to the RaytechWRxx directory of a connected USB Key in XML-Format.

Export All to USB Drive [XML]:
Exports all measurements to the RaytechWRxx directory of a connected USB Key in XML-Format.

Export Selected to USB Drive [CSV]:
Exports the selected measurement to the RaytechWRxx directory of a connected USB Key in CSV-Format.

Export All to USB Drive [CSV]:
Exports all measurements to the RaytechWRxx directory of a connected USB Key in CSV-Format.

6.3.5 HRT

Print		Delete		Open		Export		HRT	
Date	Time	Range	N	Analyse					
2/17/2009	2:30 PM	10 A	Intervall						
2/17/2009	2:31 PM	10 A	Intervall						
2/17/2009	2:32 PM	10 A	Intervall						
2/17/2009	2:32 PM	10 A	Intervall						
2/24/2009	9:49 AM	10 A	Interval						
3/4/2009	3:19 PM	5 A	Continuous						
3/4/2009	3:20 PM	5 A	Interval						

Back

Heat Run Test Analysis

Only activated with the option HRT¹
(Heat Run Test)

For an explanation see chapter 7.2

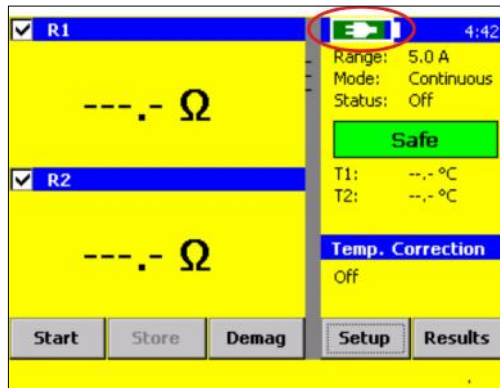
¹ The AHRT01 can also be ordered later from Raytech USA (Part Number 2042N-11001)



6.4 Battery Operation WR14

The WR14 is a Battery and Mains operated System.

The measurement doesn't stop if you have a mains power break down. It is very helpful if you are doing e.g. heat run tests.



There is a Battery Symbol on the top of the main screen of the WR14. It indicates the Battery status and the charging conditions.

With a full Battery you are able to measure 200 single measurements at 15 Amps.

Mains supply present

A connector-symbol is inside the Battery.

Battery charging

The filling inside the Battery moves from the left to the right.

The LED on the main switch is blinking if the battery is charging, although if the WR14 is switched off.

Charging condition

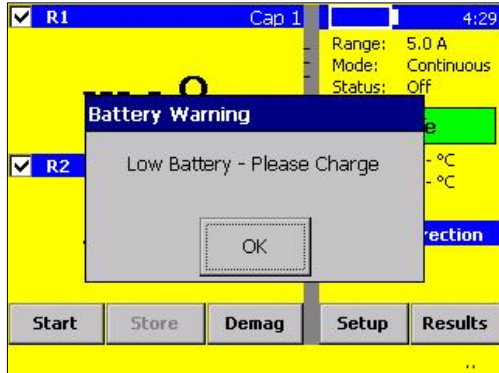
With the help of the filling inside the Battery you can see the charging condition:

If the Battery is filled totally green, the Battery is 100% charged.

The LED on the main switch is on (not blinking), If the instrument is switched on and the battery is fully charged.



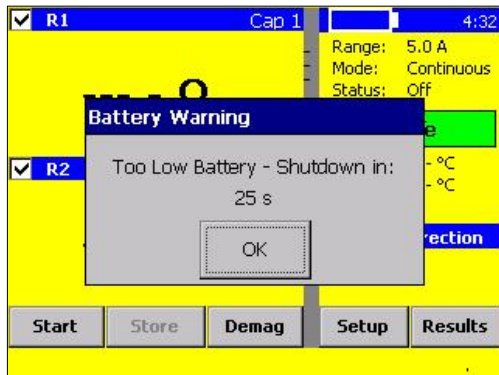
6.4.1 Low Battery



Low Battery

If the charging of the Battery is low, you see a Battery Warning.

The running measurement doesn't stop, but you are not able to start a new measurement before the mains supply is connected.



Very low Battery

If the charging of the Battery is very low, the WR14 displays a second Warning and shoots down the instruments if no mains supply will connect.



7 Options

7.1 Temperature Measurement



The Raytech WR-Instruments are very accurate and precise test systems. To take full advantage of this high accuracy, recording the temperature of the device under test is highly recommended. This is due to the characteristics of the increase in resistance of a metallic object as its temperature increases. Incorporated into the system are temperature compensation tables for Copper and Aluminium. These tables are used to automatically calculate the conversion factor to a known reference temperature.

Temperature Coefficient Settings: see chapter 6.2.10 on page 41.

The system allows up to three¹ (3) temperature probes to be used for the purpose of recording temperatures. Optional Part Number: TP01, can be purchased for this purpose.

TP01 temperature probe is mounted to a flexible cable that plugs into the front panel of the WR-instruments. This option enables the user to record the ambient temperature and/or the actual temperature of the device under test. A set of three (3) temperature probes (TP03) can be ordered to allow complete temperature measurements at three different reading points.

The Instrument will automatically detect when a TP 01 probe is connected. The temperature will be displayed on the instrument screen during a test and will appear on the printed report. The temperature, as well as the test results, can be saved into memory.

¹ The WR14 up to two (2) temperature probes



7.2 Heat run test Software

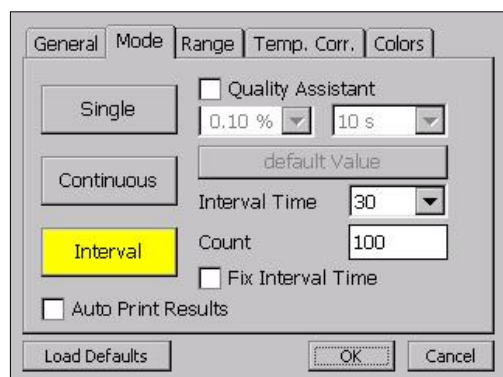
The Heat Run Test Software, option AHRT 01, is used to analyze the measurement results of the copper loss test of the windings of a transformer and to calculate the resistance values of the winding at the working temperature (time zero).

7.2.1 Introduction

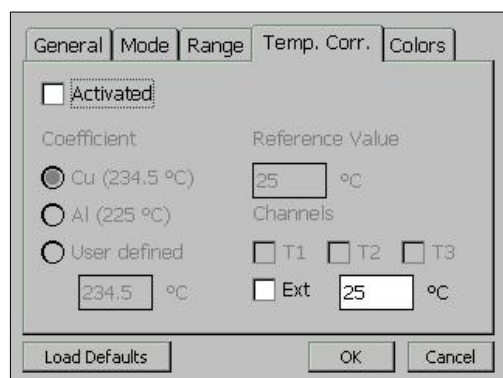
The Heat Run Test performs a measurement during the cooling curve of a transformer after the transformer has been heated.

The measurement is made in the interval mode without temperature correction.

In the Setup Menu the following settings must be made:



Activate "Interval Mode" and select the interval time. Select the time in seconds between measuring points and the number of data points.

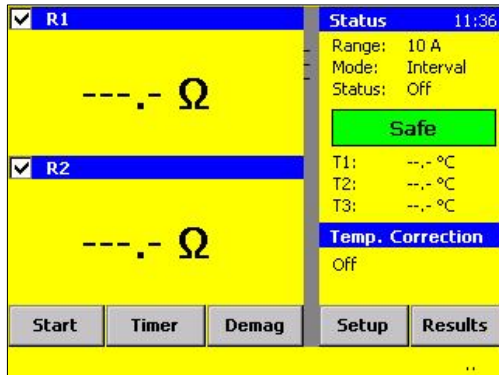


Temperature correction must be deactivated for Heat run testing.

Disable although the Quality Assistant.

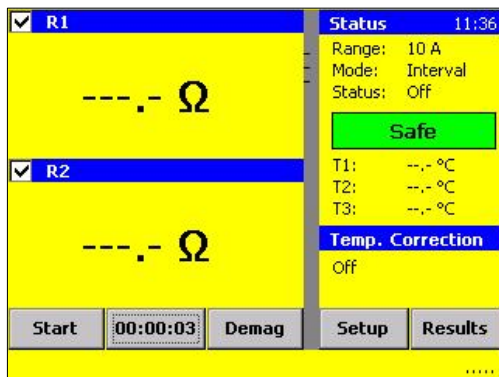


7.2.2 Measurement with interval mode for HRT



At the moment of switching off the heat source of the test object, the heat run timer must be started.

Press the “Timer” Button on the main screen to start the timer.

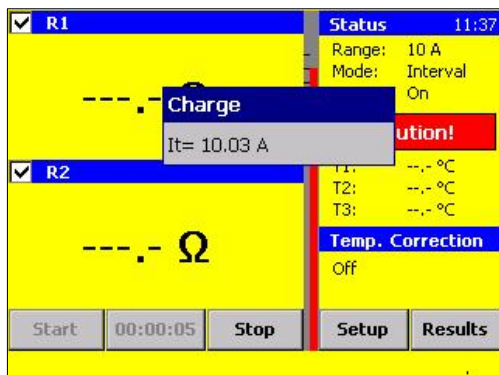


The timer starts running.

The timer can be halted at any time by pressing the button a second time.

Note: The current is NOT switched on at this time.

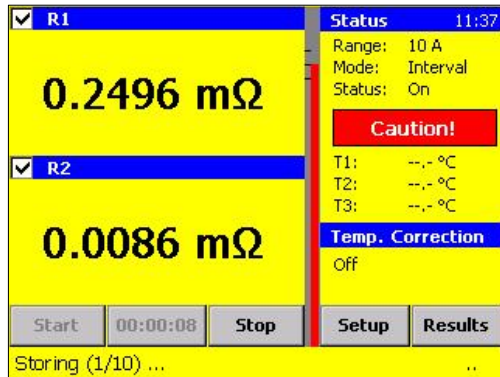
Disconnect the power cables or heat source of the test object and connect the measurement cables of the instrument.



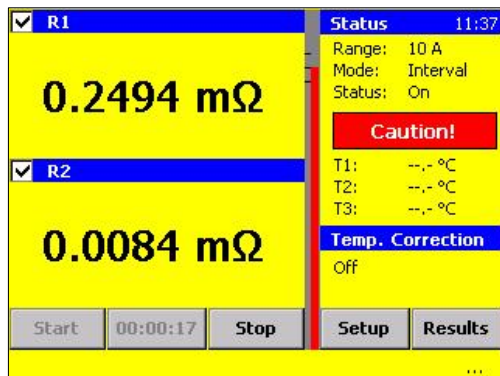
Measurement results should be obtained as quickly as possible.

To start the measurement press “START”.

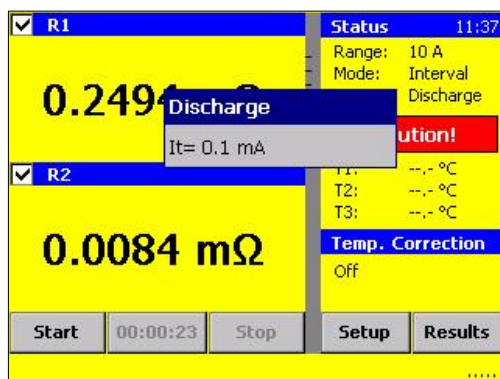
The current is applied and the system charges the transformer Winding(s) to be measured.



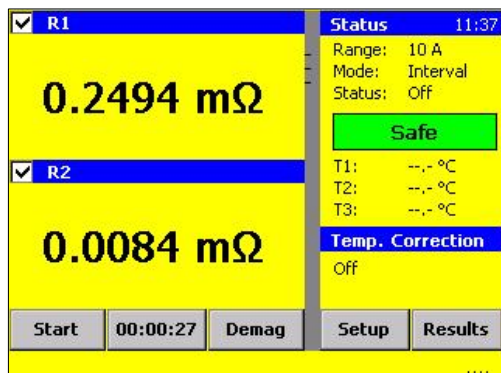
After charging the transformer, the instrument system monitors the measurements until the results are stable. The results are then stored automatically.



Press the “Stop” Button at any time to halt the measurement.



After storing the last measurement the instrument turns off the output Current, stops the measurement, starts automatically to discharge the transformer till the test object is safe.



Although the measurement is finished, the timer continues to operate. This allows further measurements on other windings of the same transformer.

The timer can be halted at any time by pressing the Timer button.

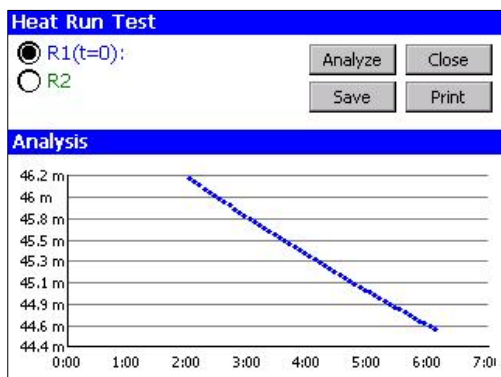
7.2.3 Analysing the HRT Results



Select the Data-set in the Result Screen.

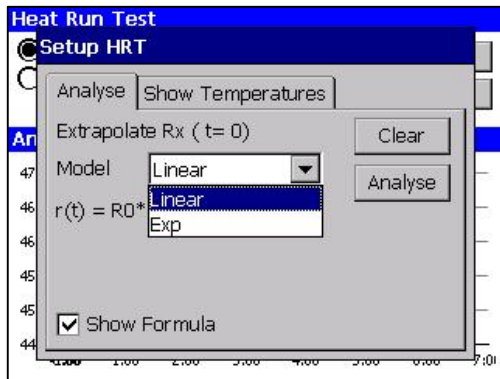
Select in the menu “HRT” “Analyse” to display the analysis curve.

Double tip the selected measurement. The detailed results are available for viewing without applied analysis.



The graph of the measured values is shown.

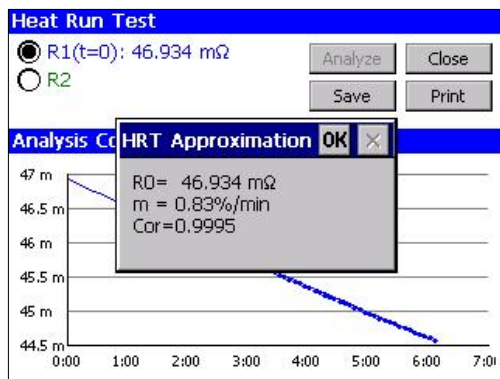
With “Save” you can store the graph as a gif-file to the internal memory.



Press “Analyse”

You’ll be asked for “Approximation Model” to calculate the Value of the Winding at time = zero

Select the Approximation Model:
(Exp)ponential or Linear



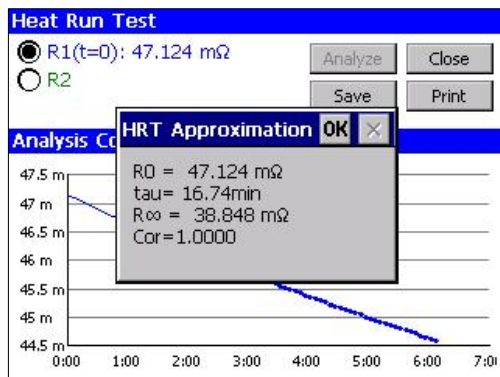
After selecting the Model press “Analyse”
The value of the approximation $R(t=0)$ is shown.

Linear Approximation:

R_0 : Winding Resistance at time $t = \text{zero}$

m : Slew rate dr/dt in %/ min

Cor : Correlation of the approximation



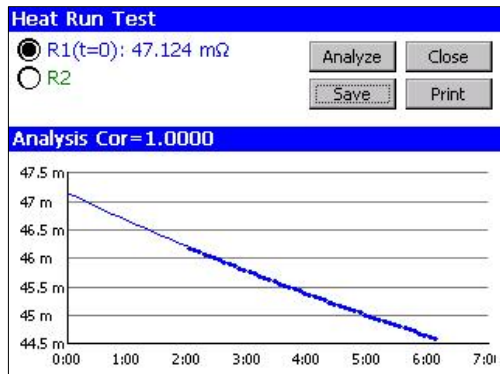
Exponential Approximation:

R_0 : Winding resistance at time $t = \text{zero}$

τ : Time constant

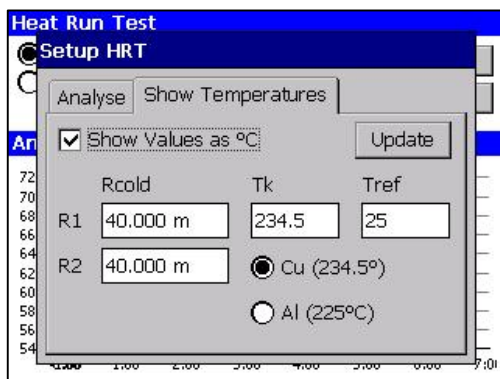
R : Winding resistance at time $t =$

Cor : Correlation of the approximation



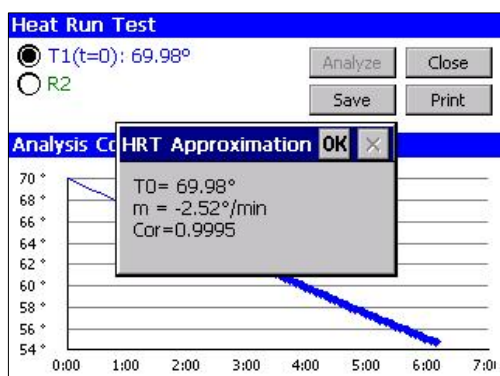
The approximation and the measured values.

7.2.3.1 Showing the graph in °C



When the resistance of the winding at any specific temperature and the material is known, all the values can be displayed as °C.

Enter the resistance value of the winding at a reference temperature and the temperature coefficient of the conductor.

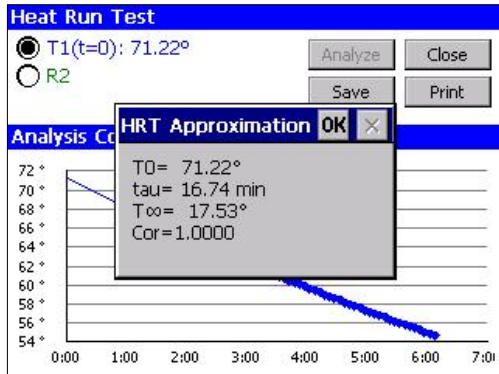


Linear Approximation:

T0: Temperature at time t = zero

m: Slew rate dt/dt in °/min

Cor: Correlation of the approximation



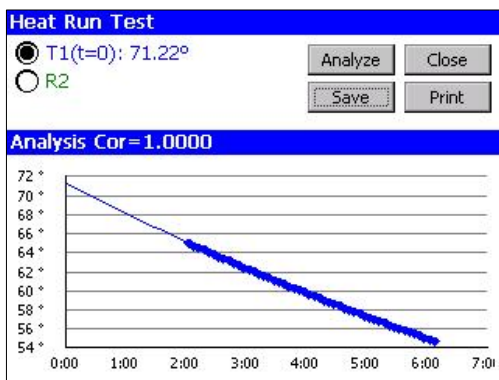
Exponential Approximation:

T0: Temperature at time t = zero

tau: Time constant

R : Temperature at time t =

Cor: Correlation of the approximation



The approximation and the values are shown as Temperature.



7.3 Cable extension

7.3.1 2040N-05003

The WR50-12 is available with the optional 10m cable extension sets for the Plug type cable sets (Note: Cable sets with the ring lug connectors do not have this option available). The Plug type connector locking system operates on the “push-pull” principle. It self locks when connected. To disconnection the Plug type connector, push in first then pull out.

Connectors that become dirty should be cleaned with industrial alcohol before connecting.

The 2040N-05003 consists of the following cables:



2x 10m Extensions for
the Current cables



2x 10m Extensions for
the Potential channel 1



2x 10m Extensions for
the Potential channel 2



7.3.2 2041N-05003

The WR50-13 is available with the optional 10m cable extension sets for the Plug type cable sets (Note: Cable sets with the ring lug connectors do not have this option available). The Plug type connector locking system operates on the “push-pull” principle. It self locks when connected. To disconnection the Plug type connector, push in first then pull out.

Connectors that become dirty should be cleaned with industrial alcohol before connecting.

The 2041N-05003 consists of the following cables:



2x 10m Extensions for the Current cables



2x 10m Extensions for the Potential channel 1



2x 10m Extensions for the Potential channel 2



2x 10m Extensions for the Potential channel 3



7.3.3 2043N-05000

The WR14 is available with an optional 10m cable set instead of the 5m cable set. System part number 2043N-05000 is the WR14, including 2043N-05001.

The 2043N-05001 consists of the following cables:



2x 10m Current cables



2x 10m Potential
cables channel 1



2x 10m Potential
cables channel 2

If you choose this option, the normal 5m cable set will not be delivered.

Extension cables for existing 5m cables are not available due to the screw type plugs.



8 Technical Specification

8.1 WR50

Type	WR50-12 / WR50-13
Size	L: 521 mm (20.5") W: 432 mm (17") H: 216 mm (8.5").
Weight:	16.6 kg (36.6 lbs.).
Input Power	90-264 VAC (1.5 kW max.) 47-63 Hz, automatic ranging
Output Voltage	0 to 50V DC
Test Current:	User Selectable: 0.025 50 Ampere.
Panel Display	Color LCD with back lighting and touch screen.
Front Panel	Sealed anodized.
Interface	2 x USB 1.1 (1 host / 1 device) and 9 Pin RS232 serial
Memory Storage	Stores up to 10000 complete test results.
Resistance Range:	0.00 $\mu\Omega$ to 100 k Ω
Operating Temperature	-10° C to 60° C
Storage Temperature	-20° C to 70° C

Current Range	Measuring Range	Accuracy	Resolution
30 - 50 A	0.00 $\mu\Omega$...1.3 Ω	$\pm 0.1\%$ Rdg $\pm 0.05 \mu\Omega$	5 Digits or 0.05 $\mu\Omega$
15 - 30 A	0.0 $\mu\Omega$...3.3 Ω	$\pm 0.1\%$ Rdg $\pm 0.1 \mu\Omega$	5 Digits or 0.1 $\mu\Omega$
8 - 15 A	0.0000 m Ω ...6.3 Ω	$\pm 0.1\%$ Rdg $\pm 0.2 \mu\Omega$	5 Digits or 0.2 $\mu\Omega$
3 - 8 A	0.0000 m Ω ...16.7 Ω	$\pm 0.1\%$ Rdg $\pm 0.5 \mu\Omega$	5 Digits or 0.5 $\mu\Omega$
1 - 3 A	0.000 m Ω ...47.2 Ω	$\pm 0.1\%$ Rdg $\pm 1 \mu\Omega$	5 Digits or 1 $\mu\Omega$
0.7 - 1 A	0.000 m Ω ...71.4 Ω	$\pm 0.1\%$ Rdg $\pm 2 \mu\Omega$	5 Digits or 2 $\mu\Omega$
0.3 - 0.7 A	0.000 m Ω ...167 Ω	$\pm 0.1\%$ Rdg $\pm 5 \mu\Omega$	5 Digits or 5 $\mu\Omega$
0.1 - 0.3 A	0.00 m Ω ...500 Ω	$\pm 0.1\%$ Rdg $\pm 10 \mu\Omega$	5 Digits or 10 $\mu\Omega$
25 - 100 mA	0.00 m Ω ...2 k Ω	$\pm 0.1\%$ Rdg $\pm 20 \mu\Omega$	5 Digits or 20 $\mu\Omega$
- 25 mA	2 k Ω ...10 k Ω	$\pm 0.2\%$ Rdg $\pm 200 \text{ m}\Omega$	5 Digits or 200 m Ω
- 25 mA	10 k Ω ...100 k Ω	$\pm 0.8\%$ Rdg $\pm 20 \Omega$	4 Digits or 20 Ω

Features

- Charges inductive loads up to 1500 Henry
- Heavy-duty protection circuitry
- Simple touch screen operation
- Data exchange with an USB-Key
- 3 Temperature channels
- High power DC Supply (50A/50V)
- DC Current adjustable for resistance values from 0.00 $\mu\Omega$ to 100 k Ω
- Fastest Discharge unit on market (more than 10 times faster)
- Discharge Indicator – visible and audible indicator for discharge status
- Demagnetizing Circuit (world unique)
- Warning device output to show “transformer under test”
- Emergency stop push button immediately turns off power and starts discharging
- Data transfer to internal or external Printer
- Data Storage of up to 10000 measurements
- Fastest discharge time in the market
- 5 Year standard warranty

Specifications are subject to change without notice.



8.2 WR14

Type	WR14
Size	L: 470 mm (18.5") W: 357 mm (14.1") H: 176 mm (6.9").
Weight:	9.4 kg (20.6 lbs.).
Input Power	90-264 VAC 47-63 Hz, or 12V DC (charging only)
Output Voltage	0 to 30V DC
Test Current:	User Selectable: 0.025 15 Ampere
Panel Display	Color LCD with back lighting and touch screen.
Front Panel	Sealed anodized.
Interface	2 x USB 1.1 (1 host / 1 device) and 9 Pin RS232 serial
Memory Storage	Stores up to 10000 complete test results.
Resistance Range:	0.00 $\mu\Omega$ to 100 k Ω
Operating Temperature	-10° C to 60° C
Storage Temperature	-20° C to 70° C

Current Range	Measuring Range	Accuracy	Resolution
10 - 15 A	0.00 $\mu\Omega$...1 Ω	$\pm 0.1\%$ Rdg $\pm 0.1 \mu\Omega$	5 Digits or 0.05 $\mu\Omega$
5 - 10 A	0.0 $\mu\Omega$...3 Ω	$\pm 0.1\%$ Rdg $\pm 0.2 \mu\Omega$	5 Digits or 0.1 $\mu\Omega$
1 - 5 A	0.0 $\mu\Omega$...15 Ω	$\pm 0.1\%$ Rdg $\pm 0.5 \mu\Omega$	5 Digits or 0.5 $\mu\Omega$
0.5 - 1 A	0.0 $\mu\Omega$...30 Ω	$\pm 0.1\%$ Rdg $\pm 2 \mu\Omega$	5 Digits or 1 $\mu\Omega$
0.1 - 0.5 A	0.0 $\mu\Omega$...300 Ω	$\pm 0.1\%$ Rdg $\pm 5 \mu\Omega$	5 Digits or 2 $\mu\Omega$
25 - 100 mA	0.0 $\mu\Omega$...1200 Ω	$\pm 0.1\%$ Rdg $\pm 20 \mu\Omega$	5 Digits or 10 $\mu\Omega$
- 25 mA	1.2 k Ω ...10 k Ω	$\pm 0.1\%$ Rdg $\pm 200 \text{ m}\Omega$	5 Digits or 200 m Ω
- 25 mA	10 k Ω ...100 k Ω	$\pm 0.5\%$ Rdg $\pm 10 \Omega$	4 Digits or 10 Ω

Features

- Charges inductive loads up to 1500 Henry
- Heavy-duty protection circuitry
- Simple touch screen operation
- Data exchange with an USB-Key
- 2 Temperature channels
- High power DC Supply (15A/30V)
- DC Current adjustable for resistance values from 0.00 $\mu\Omega$ to 100 k Ω
- Fastest Discharge unit on market (more than 10 times faster)
- Discharge Indicator – visible and audible indicator for discharge status
- Demagnetizing Circuit (world unique)
- Warning device output to show “transformer under test”
- Emergency stop push button immediately turns off power and starts discharging
- Data transfer to internal or external Printer
- Data Storage of up to 10000 measurements
- Fastest discharge time in the market
- 5 Year standard warranty
- Battery operated

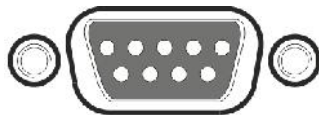
Specifications are subject to change without notice.



9 Interfaces

9.1 Hardware

9.1.1 RS 232



RS 232

1 x RS 232, 9 Pin

Pin 2	TxD (WR-> Host)
Pin 3	RxD (Host-> WR)
Pin 5	GND

Interface Parameters:
(fixed, not changeable)

Port	RS232
Baudrate	38400 Baud
Databit	8 Bit
Stopbits	1 Bit
Parity	No

9.1.3 USB



USB-Master

Standard 1.1



USB Slave

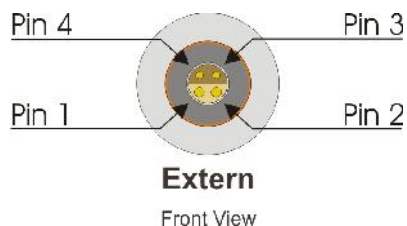
Standard 1.1



9.1.4 Extern

9.1.4.1 Standard type

The standard type has 4 pins. You can use pin 3 and 4 to connect an external Warning Light or Beeper to indicate a Dangerous condition.



There is an internal Relay whose contact is connected to the plug “Extern”.

An external power source and a Warning Light or Beeper may be connected to pins 3 & 4 to indicate a Dangerous condition. See: Example for connecting an external warning device below.

Use the working contact between Pin 3 and Pin 4, maximum Load 240VAC 2A.



The contact is open when the system is Safe.

The contact is closed when the system is Unsafe.

Pins 1 and 2 on the Extern connector: These pins are for Raytech Service use. Do not connect anything to these pins!

Standard type with 4 pins:

Connector in the instrument

Lemo: ERA.1E.304.CLL



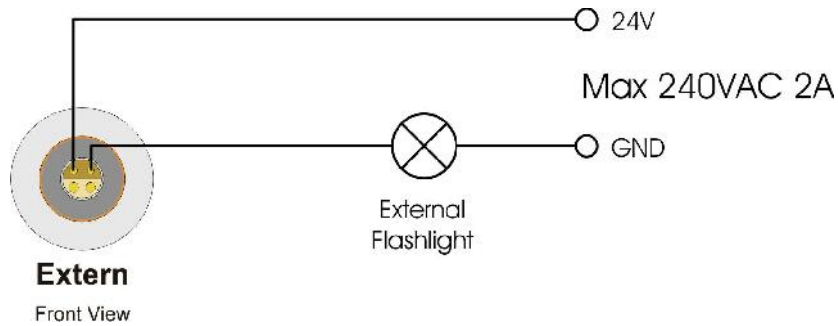
Extern

Lemo: FFA.1E.304.CLAC60



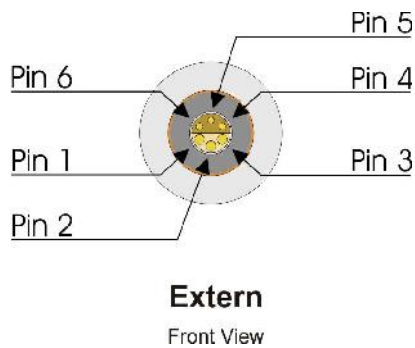


9.1.4.2 Example for connecting an external warning device



9.1.4.3 Extended Safety Circuit type

The Extended Safety Circuit type has 6 pins.



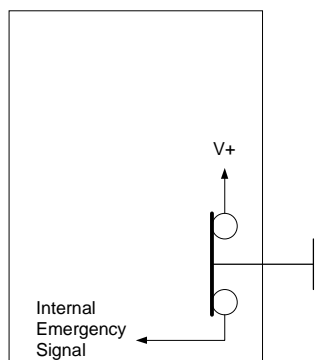
You can use pin 3 and 4 to connect an external Warning Light or Beeper to indicate a Dangerous condition. The function for this pins are the same as with the standard type, see chapter “9.1.4.1 Standard type” on page 64.

Pins 1 and 2 on the Extern connector: These pins are for Raytech Service use. Do not connect anything to these pins!

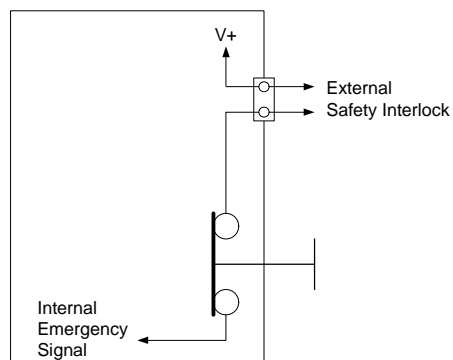


If the contact between Pin 5 and Pin 6 is open, the instrument acts as emergency stop is pressed.

without external safety circuit



with external safety circuit



If you would like to use the instrument without the extended safety circuit, you have to connect the plug below.

It has a bridge between Pin 5 and Pin 6



Extended Safety Circuit type with 6 pins:

Connector in the instrument

Lemo: ERA.1E.306.CLL

RAN: 40802

Extern

Lemo: FFA.1E.306.CLAC60

RAN: 40803



APPENDIX



WR14
Winding Resistance Meter 15A



WR50-12 / 13
Winding Resistance Meter 50A



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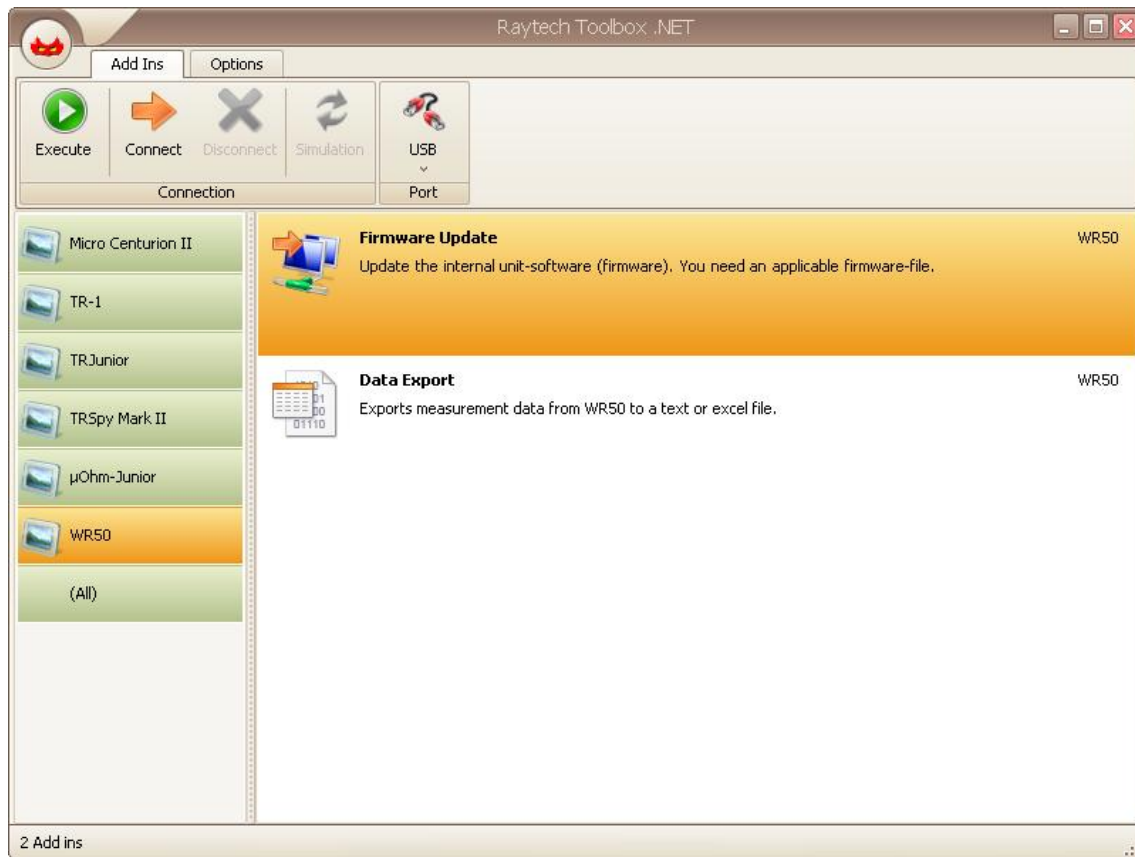
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	C.B.....USB Interface	
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A Raytech Toolbox

The Raytech Toolbox is another option for Data Exchange between the measuring instrument and an external computer.

The Raytech Toolbox can be downloaded free of charge. Contact Raytech USA.





B Software Development Kit SDK

The SDK is a device management software with various possible applications. It is essentially a software layer (or driver) that resides between the Operating System (OS) IO system, custom Windows Application and Raytech instruments. The SDK with native Raytech USB Driver for Windows provides the OS with full device functionality, appearing to OS as Raytech USB device. This software can also be used without native Raytech USB drivers to control the device over the standard RS 232 Serial port.

It is a powerful tool to write easy customised Software to control the Raytech Instruments.

For more information about the Software Development Kit, contact Raytech USA.



C Command Syntax

It is possible to control the instrument over the RS 232 or the USB port with an external computer. You can write your own test program for a full customized test procedure.

C.A Serial Interface

Related Firmware 2.6.0.0 and later.

Interface Parameters

Parameter	Value
Port	RS232
Baudrate	38400 Baud
Databit	8 Bit
Stopbits	1 Bit
Parity	No
TxD (WR-> Host)	Pin 2
RxD (Host-> WR)	Pin 3
Gnd	Pin 5

Command Syntax

Cmd [Para[,Para2..]] LF"

Separator for Cmd and Parameters ' ' (space 0x20)

Separator for Parameters: ','

Numeric Format of Numbers: float (C - Language), "." as decimal point

Format of Strings: all ASCII Characters from 0x20 to 0xff]

Standard Responds / Error Messages

"*1 Ok"	Command successful
"*2 Syntax error"	Command unknown
"*3 Out of range"	Parameter is out of allowed range
"*4 Fail"	Command is not allowed (at this time)
"*5 Missing parameter"	Too less Parameters
"*6 Too many parameter"	Too many Parameters
"*7 Out of Range Meas"	Range change not allowed while Measure
"*8 Internal"	Internal Error occurred

Compatibility all commands are valid for the WR series
examples must be adapted **to each system type:**
WR14, WR50, WR100

A description of all commands (90014 Command Set WRxx) is stored on the delivered USB-Key. The newest version is available from Raytech USA.



C.B USB Interface

Related Firmware 2.7.0.0 and later.

A description of all commands is available from Raytech USA.

There you find although the USB-driver and an installation guide. The USB-driver installation is not necessary in order to use the RS 232 serial port for communication with the device.



D USB Printer Info

Printer Requirements

Languages:

- HP PCL
- Epson ESC/P 2
- Epson Stylus COLOR
- Canon BJ (300 dpi)
- Canon BJ (360 dpi)
- Epson LX (9-pin)

Driver

The Printer has to act as Standard USB class 7.1 device. About every Printer acts as such device (except multifunction devices like All in One Printers).

Interface

USB 1.1 or 2.0

Suggested Printers

- Ink-Jet:

- Canon iP90
- Epson Stylus S20
- HP-Deskjet 6940
- HP-Deskjet H470B
- HP-Deskjet H470WBT
- Epson Stylus Office B40W

- Laser

- Brother HL-5240 (Tested)
- Brother HL-2140
- Brother HL-5240L
- HP-Laserjet P1505N
- HP-Laserjet P2055DN
- HP Color Laserjet CP2025N
- PocketJet 200
- PocketJet II

The information in this document is subject to change without notice.



E Measuring high- and low-voltage-side in series

It makes sense to measure the high voltage side in series to the low voltage side to magnetize the transformer faster. Take always the 2 windings on the same coil in the same current direction. In the following table you find examples on transformer connection schemes for injecting test current and measuring 2 windings simultaneously:

Transformer type			Current Connection			Sense Connection			
			Current +	Jumper	Current -	Channel 1		Channel 2	
P	S	V				+	-	+	-
D	d	0	H1	H3:X1	X3	H1	H3	X1	X3
			H2	H1:X2	X1	H2	H1	X2	X1
			H3	H2:X3	X2	H3	H2	X3	X2
		2	H1	H3:X1	X2	H1	H3	X1	X2
			H2	H1:X2	X3	H2	H1	X2	X3
			H3	H2:X3	X1	H3	H2	X3	X1
		4	H1	H3:X3	X2	H1	H3	X3	X2
			H2	H1:X1	X3	H2	H1	X1	X3
			H3	H2:X2	X1	H3	H2	X2	X1
		6	H1	H3:X3	X1	H1	H3	X3	X1
			H2	H1:X1	X2	H2	H1	X1	X2
			H3	H2:X2	X3	H3	H2	X2	X3
		8	H1	H3:X2	X1	H1	H3	X2	X1
			H2	H1:X3	X2	H2	H1	X3	X2
			H3	H2:X1	X3	H3	H2	X1	X3
		10	H1	H3:X2	X3	H1	H3	X2	X3
			H2	H1:X3	X1	H2	H1	X3	X1
			H3	H2:X1	X2	H3	H2	X1	X2
	yn	1	H1	H3:X1	X0	H1	H3	X1	X0
			H2	H1:X2	X0	H2	H1	X2	X0
			H3	H2:X3	X0	H3	H2	X3	X0
		5	H1	H3:X3	X0	H1	H3	X3	X0
			H2	H1:X1	X0	H2	H1	X1	X0
			H3	H2:X2	X0	H3	H2	X2	X0
7		H1	H3:X0	X1	H1	H3	X0	X1	
		H2	H1:X0	X2	H2	H1	X0	X2	
		H3	H2:X0	X3	H3	H2	X0	X3	
11		H1	H3:X0	X3	H1	H3	X0	X3	
		H2	H1:X0	X1	H2	H1	X0	X1	
		H3	H2:X0	X2	H3	H2	X0	X2	



Transformer type			Current Connection			Sense Connection			
			Current +	Jumper	Current -	Channel 1		Channel 2	
P	S	V				+	-	+	-
D	y	1	H1	H3:X1	X3	H1	H3	X1	X3
			H2	H1:X2	X1	H2	H1	X2	X1
			H3	H2:X3	X2	H3	H2	X3	X2
		5	H1	H3:X3	X1	H1	H3	X3	X1
			H2	H1:X1	X2	H2	H1	X1	X2
			H3	H2:X2	X3	H3	H2	X2	X3
		7	H1	H3:X3	X1	H1	H3	X3	X1
			H2	H1:X1	X2	H2	H1	X1	X2
			H3	H2:X2	X3	H3	H2	X2	X3
		11	H1	H3:X1	X3	H1	H3	X1	X3
			H2	H1:X2	X1	H2	H1	X2	X1
			H3	H2:X3	X2	H3	H2	X3	X2
Yn	d	1	H1	H0:X1	X2	H1	H0	X1	X2
			H2	H0:X2	X3	H2	H0	X2	X3
			H3	H0:X3	X1	H3	H0	X3	X1
		5	H1	H0:X3	X1	H1	H0	X3	X1
			H2	H0:X1	X2	H2	H0	X1	X2
			H3	H0:X2	X3	H3	H0	X2	X3
		7	H1	H0:X2	X1	H1	H0	X2	X1
			H2	H0:X3	X2	H2	H0	X3	X2
			H3	H0:X1	X3	H3	H0	X1	X3
		11	H1	H0:X1	X3	H1	H0	X1	X3
			H2	H0:X2	X1	H2	H0	X2	X1
			H3	H0:X3	X2	H3	H0	X3	X2
	yn	0	H1	H0:X1	X0	H1	H0	X1	X0
			H2	H0:X2	X0	H2	H0	X2	X0
			H3	H0:X3	X0	H3	H0	X3	X0
		6	H1	H0:X0	X1	H1	H0	X0	X1
			H2	H0:X0	X2	H2	H0	X0	X2
			H3	H0:X0	X3	H3	H0	X0	X3
	y	0	H1	H3:X1	X3	H1	H3	X1	X3
			H2	H1:X2	X1	H2	H1	X2	X1
			H3	H2:X3	X2	H3	H2	X3	X2
		6	H1	H3:X3	X1	H1	H3	X3	X1
			H2	H1:X1	X2	H2	H1	X1	X2
			H3	H2:X2	X3	H3	H2	X2	X3



Transformer type			Current Connection			Sense Connection			
			Current +	Jumper	Current -	Channel 1		Channel 2	
P	S	V				+	-	+	-
Y	d	1	H1	H3:X1	X3	H1	H3	X1	X3
			H2	H1:X2	X1	H2	H1	X2	X1
			H3	H2:X3	X2	H3	H2	X3	X2
		5	H1	H3:X3	X2	H1	H3	X3	X2
			H2	H1:X1	X3	H2	H1	X1	X3
			H3	H2:X2	X1	H3	H2	X2	X1
		7	H1	H3:X2	X1	H1	H3	X2	X1
			H2	H1:X3	X2	H2	H1	X3	X2
			H3	H2:X1	X3	H3	H2	X1	X3
		11	H1	H3:X1	X3	H1	H3	X1	X3
			H2	H1:X2	X1	H2	H1	X2	X1
			H3	H2:X3	X2	H3	H2	X3	X2
yn	0	H1	H3:X1	X0	H1	H3	X1	X0	
		H2	H1:X2	X0	H2	H1	X2	X0	
		H3	H2:X3	X0	H3	H2	X3	X0	
	6	H1	H3:X0	X1	H1	H3	X0	X1	
		H2	H1:X0	X2	H2	H1	X0	X2	
		H3	H2:X0	X3	H3	H2	X0	X3	
y	0	H1	H3:X1	X3	H1	H3	X1	X3	
		H2	H1:X2	X1	H2	H1	X2	X1	
		H3	H2:X3	X2	H3	H2	X3	X2	
	6	H1	H3:X3	X1	H1	H3	X3	X1	
		H2	H1:X1	X2	H2	H1	X1	X2	
		H3	H2:X2	X3	H3	H2	X2	X3	
S	s	0	H1	H0:X1	X0	H1	H0	X1	X0
		6	H1	H0:X0	X1	H1	H0	X0	X1

The table is in ANSI standard. You can change it e.g. to the ICE standard by substitute
H1 to 1U
H2 to 1V
H3 to 1W...



F Demagnetizing

Energizing magnetized transformers

Problems can be created when the core of a transformer becomes magnetized prior to being energized for use. Damage to the insulation and deformation of the windings are two of the most common side effects.

Generally, Transformer cores, during operation are magnetized, demagnetized and then magnetized and demagnetized in the opposite direction for each sine wave cycle.

It is not easy to determine the magnitude the core is magnetized at the moment the Alternating Current source is switched off. The larger the hysteresis of the iron in the core material, the greater the magnetization level. The magnitude of magnetization depends upon the moment the transformer is switched off and the applied voltage level during the power on state.

The highest magnetization in this scenario occurs when a transformer is switched off right at the moment the voltage source sine wave crosses the zero-line.

Transformer cores are also magnetized after having a Direct Current source flow in a winding. For example, the application of Direct Current when performing a winding resistance test. After measuring the Winding Resistance the core is magnetized to its' maximum Hysteresis.

Both of these scenarios can leave the core in an unpredictable state which can cause damage when energized. These problems can be eliminated if the transformer is demagnetized prior to being energized for use.

Conclusion

- A transformer is magnetized when power is switched off. Even if a transformer is completely de-energized, it can still be in a magnetized state!
- After performing DC tests on a transformer winding, the core is magnetized.

Consequences of energizing a magnetized transformer

When a magnetized transformer is switched back on line, it is quite possible, depending upon the position of the sine wave and other variables, that inrush current can exceed 8 times the nominal current flow. This hazardous situation may cause tripping of over-current relays, damage to the insulation medium and deformation of the transformer windings.



Procedure for eliminating the magnetized state of a transformer

One option that can be taken to safely switch a transformer back on line and avoid a dangerous and damaging situation is to apply a reduced AC voltage source and increase the voltage level to the operating voltage level. Under controlled conditions this may be possible. However, this undertaking may not be theoretically possible when energizing a transformer on site. Equipment required to fully demagnetize a transformer in this manner is large and expensive.

or

A better solution is the new Raytech Winding Resistance Meter, WR-Series.

These easy to use systems are recognized throughout the World for Precision Winding Resistance measurements. A unique and new feature built into the WR-series is the ability to Automatically Demagnetize a Transformer core on site.

Avoid unnecessary damage and unsafe conditions when energizing a transformer; use one of the Raytech WR-series instruments and be sure.

Parameters for demagnetizing

The Current of the WR series test system should be applied on the high inductive or High Voltage side of the transformer. Although the potential cables from Channel 1 must be connected.

The optimal demagnetizing current to be used is the same as the measuring current used during Winding Resistance Measurement or the maximum allowed for the nominal current level of the high voltage side.

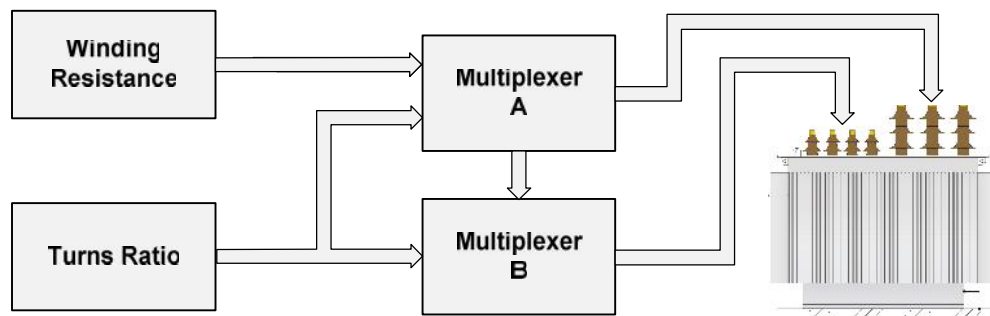


G Multiplexer

Description

Raytech Multiplexer is designed to drastically reduce cabling time and increase test performance. It is made to be used with Raytech Winding Resistance and Turns Ratio Meters. Any Multiplexer configuration can be easily controlled by a Winding Resistance Meters touch panel or by remote.

Example



Advantages & Features

- Minimizes cabling time.
- Does all measurements with one cabling per transformer, including Winding Resistance and Turns Ratio.
- Uses up to three Multiplexers and measure transformers with three winding systems with one cabling sequence.
- Get your own configuration containing from one to three Multiplexers, from one to three Winding Resistance Meters and one Turns Ratio Meter.
- Control your Tap Changer with a powerful tap changer interface.
- Operate all instruments on a touch screen or by remote control.
- Get a customized complete solution containing WR, TR and Multiplexers. Ask Raytech for a **ATOS** (Automatic Transformer Observing System)

Specifications:

Power supply: 100..240VAC
Case: 19" Rack 4U
Interface: Raytech Serial Intercom

Included in Delivery

- 10m standard cables set to test object
- Standard cables to WR and TR.
- Firmware Update for WR14/50/100

Options

- Cable set for 2 or 3 Multiplexer systems
- Integrated Safety Unit providing fused electrical power, central interlock system and central warning lamp interface



H Warranty Conditions

RAYTECH USA, Inc. warrants to the original purchaser that its products shall be free from defects in material and workmanship under normal use and service for a period of 60 months from the original date of shipment. An additional extended warranty period is provided, at cost to the end user, for the products covered under this warranty if the products are returned on each calendar year from the original date of shipment, prepaid, to Raytech USA, for system evaluation.

The obligation of RAYTECH USA, Inc. under this warranty is limited, in its exclusive option, to repair, replace, or issue credit for parts or materials which prove to be defective, and is subject to purchaser's compliance with the RAYTECH USA, Inc. warranty claim procedure as set forth within this manual. RAYTECH USA, Inc. shall at their option and expense, repair, replace any part or parts that prove to be defective within the warranty limitation period-irrespective of the operating time of the test equipment provided that the cause of the defect occurred prior to the time at which the risk was passed. The purchaser is obligated to immediately notify RAYTECH USA, Inc. in writing of any defects of the supplied test equipment. RAYTECH USA, Inc. must always be given the opportunity to rectify a defect within a reasonable amount of time. The purchaser shall grant adequate amount of time that the test equipment shall be repaired

This warranty covers only those parts and/or material deemed to be defective resulting from manufacturer's workmanship. The liability of RAYTECH USA, Inc. shall be limited to the repair, replacement, or issuance of credit for parts deemed defective within the meaning of this warranty. Costs for all transportation, labor or other expenses that may have occurred incidental to the inspection, repair, replacement, or issuance of credit for such parts and/or materials shall be the sole responsibility of purchaser. This warranty shall not apply to any accessories, parts, or materials not manufactured or supplied by RAYTECH USA, Inc. Equipment must be returned prepaid with a Return Material Authorization (RMA) to:

RAYTECH USA, Inc.

118 S. 2nd Street

Perkasie, PA 18944 USA

Tel. + 267 404 2676 Fax. + 267 404 2685

www.RaytechUSA.com

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper and unauthorized modifications or misuse and abuse of the product, negligence, alteration, modification, faulty installation by the customer, customer's agents or employees. Attempted or actual dismantling, disassembling, service or repair by any person, firm, or corporation not specifically authorized in writing by RAYTECH USA, Inc.

Defects caused by or due to handling by carrier, or incurred during shipment, trans-shipment, or other move. Inadequate maintenance by the customer, second source supplied software



or interfacing, operation outside the environmental limits, or improper site preparation. Exclusive remedies provided herein are the customer's sole and exclusive remedies. RAYTECH USA, Inc. shall not be liable for any damages resulting from the use of this equipment whether direct, indirect, special, incidental, or consequential damages, or whether based on contract, tort, or any other legal theory.

NO OTHER WARRANTY OR REMEDY IS EXPRESSED OR IMPLIED.

Arbitration

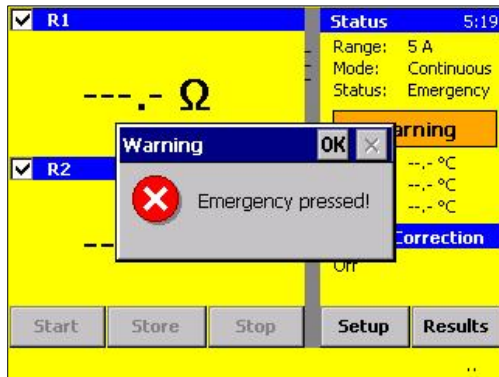
All disputes arising out of or in connection with the warranty agreement between the purchaser and Raytech USA, Inc. and including those regarding the legal validity of the warranty and this arbitration clause shall be settled out of court and may be referred to arbitration for final decision.

Any disputes between the purchaser and Raytech USA, Inc. shall be settled according to the rules of settlement and arbitration of the chamber of commerce in Pennsylvania by one or more arbitrators appointed also according to the rules of arbitration of the chamber of commerce in Pennsylvania.



I Error Messages

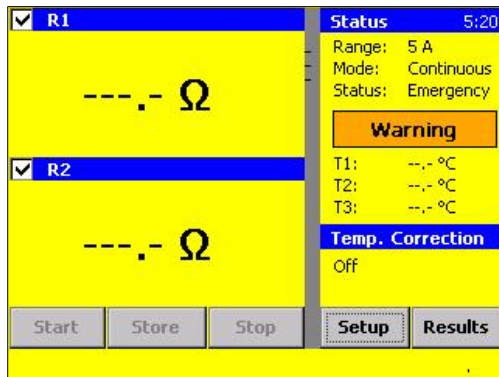
The Raytech instruments are designed to be trouble free, so you may not see many error messages.



The emergency switch is activated.¹

In this condition it is not possible to start a measurement.

Exit this message screen by touching “OK” without releasing the emergency switch.



The system will revert to a pretest or main screen similar to the following screen:

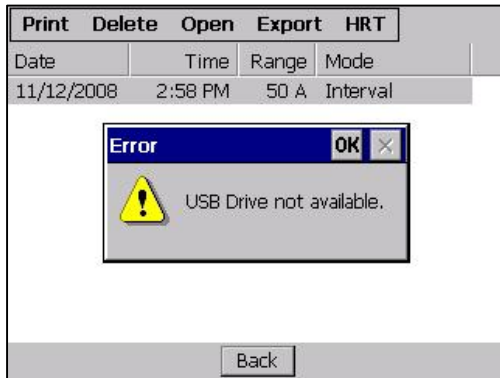
Because the emergency switch is still depressed, you are not able to start a new measurement.

All other features of the system such as storing, printing are still active.



Turn the Emergency Stop button clockwise to release.

¹ In case of Interlock-Modification for extend safety circuit the same message appears. For more information see chapter “9.1.4.3 Extended Safety Circuit type” on page 65.



Attempt to store results to the USB key without any device key plugged to the WR-instrument USB port.



Plug the USB key in and try again. The following will appear. The data can then be exported.





J Troubleshooting

When the WR-instruments are powered on an internal calibration and check sequence is performed.

Upon completion of the check sequence the test set will proceed to the “Main Screen”.

Should there be any problem with the test set an error message will appear.

Touch Panel does not work:

Please connect any USB mouse to the USB port and control the instrument with it. The instrument will automatically display a cursor and everything can be done by mouse. See chapter 6.2.7.1 Mouse Cursor.

You can recalibrate the touch Panel: see chapter “Calibrate Touchscreen” on page 35.

USB Memory Stick does not work:

There are a few unsupported memory sticks available on the market. Please use another model and try again.

Test Current cannot be turned on:

Is the Emergency stop switch pushed in? Turn it counter clockwise to release.

Erratic or erroneous readings

Possible causes

1. Test lead damaged or not connected.
2. Poor test lead connection.
3. Poor supply power source. Check extension cords, plugs and cables carefully.
4. Test set attached to a “Live” load or high interference load.



Can't switch off the WR14

Disconnect the power cable and press the main switch for 5 seconds.



NOTE

⇒ The WR-instruments are designed to be trouble free.
If problems or questions do arise please contact your nearest representative or our service support group in Pennsylvania.

K Contacts

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Your local Representative

