

WRM-10P S2

TRANSFORMER WINDING RESISTANCE METER

USER'S MANUAL



Vanguard Instruments
A DOBLE COMPANY



1520 S Hellman Avenue, Ontario, CA 91761

TEL: 909.923.9390 | FAX: 909.923.9391

www.vanguard-instruments.com

October, 2017
Revision 1.0

SAFETY SUMMARY

FOLLOW EXACT OPERATING PROCEDURES

Any deviation from the procedures described in this operator's manual may create one or more safety hazards, damage the WRM-10P S2, or cause errors in the test results. Vanguard Instruments assumes no liability for unsafe or improper use of the WRM-10P S2. The following safety precautions must be observed during all phases of test set up, test hookups, testing, and test-lead disconnects.

SAFETY WARNINGS AND CAUTIONS

This device must be used only by **trained operators**. All transformers under test must be **off line and fully isolated**.

SERVICE AND REPAIR

- Do not install substitute parts or perform any unauthorized modification to any WRM-10P S2 test unit.
- Repairs must be performed only by Vanguard Instruments factory personnel or by an authorized repair service provider. Unauthorized modifications can cause safety hazards and will void the manufacturer's warranty.

EQUIPMENT RATINGS

IP Rating: The enclosure for the WRM-10P S2 has an IP rating of 32.

Pollution Rating: The WRM-10P S2 has a pollution rating of 2.

Operating Voltage: The WRM-10P S2 is rated for use with an operating voltage of 120V or 240V, auto-ranging $\pm 10\%$ of selected voltage.

Power Cord: The WRM-10P S2 is supplied with a 16 AWG, 16A power cord with a NEMA 5-15P plug. Replacement cable must have the same or better rating and is available through the manufacturer.

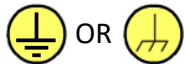
VENTILATION REQUIREMENTS

The WRM-10P S2 must be operated with the enclosure lid open.

SAFETY SYMBOLS



Indicates that caution should be exercised



OR

Indicates location of chassis ground terminal

CLEANING

To clean the WRM-10P S2:

- Disconnect all cables and turn the unit off.
- Use a soft, lint-free cloth to wipe all surfaces clean.
- Avoid getting moisture in openings and connectors.
- **DO NOT use any cleaning products or compressed air**

TABLE OF CONTENTS

CONVENTIONS USED IN THIS DOCUMENT	1
1.0 INTRODUCTION	2
1.1 General Description and Features	2
1.2 WRM-10P S2 Technical Specifications	4
1.3 WRM-10P S2 Controls and Indicators.....	5
2.0 PRE-TEST SETUP	6
2.1 Operating Voltages	6
2.2 LCD Screen Contrast Control.....	6
2.3 Printer Paper Control	6
2.4 Printer Paper	6
2.5 Replacing the Thermal Printer Paper.....	7
3.0 OPERATING PROCEDURES	8
3.1 WRM Cable Connections	8
3.2 General Procedures	10
3.3 Entering Test Record Header Information.....	11
3.4 Setting the Clock	14
3.5 Toggling the Calibration Notification Feature	15
3.6 Performing a Resistance Test.....	16
3.7 Performing a Load Tap Changer / Voltage Regulator Resistance Test	25
3.8 Performing a Special Resistance Test	32
3.9 Performing a Transient Test.....	39
3.10 Performing a Diagnostic Test.....	44
3.11 Working with Test Records.....	46
3.11.1. Restoring a Test Record from the Unit's Internal Flash EEPROM	46
3.11.2. Restoring a Test Record From a USB Flash Drive	50
3.11.3. Viewing a Test Record	52
3.11.4. Printing a Test Record	54
3.11.5. Saving a Test Record From the Working Memory	55
3.11.6. Copying Test Records to a USB Flash Drive.....	57
3.11.7. Printing a Directory of Test Records Stored in the WRM's Internal Memory.....	59
3.11.8. Printing a Directory of Test Records Stored in a USB Flash Drive.....	62
3.11.9. Erasing Test Records From the Unit's Internal Memory	64
3.11.10. Erasing Test Records From a Connected USB Flash Drive.....	67
4.0 WRM-10P S2 SPECIAL FEATURES.....	70
4.1 Bypassing the Resistance Reading Delay	70
4.2 Converting Resistance Measurements	71
5.0 Troubleshooting Guide	72

LIST OF FIGURES

Figure 1. WRM-10P S2 Controls and Indicators..... 5

Figure 2. Typical WRM Connections Diagram #1..... 8

Figure 3. Typical WRM Connections Diagram #2..... 8

Figure 4. Typical WRM Connections Diagram #3..... 9

Figure 5. Typical WRM Connections Diagram #4..... 9

Figure 6. Typical V1 Test Report Printout 22

Figure 7. Typical V1 and V2 Test Report Printout 23

Figure 8. Typical V1 and V2 Test Report Printout with Multiple Readings 24

Figure 9. Typical LTC/Voltage Regulator Test Report Printout..... 31

Figure 10. Typical Special Test Report Printout (1 minute @ 10 second intervals) 38

Figure 11. Typical Transient Test Report 43

Figure 12. Typical Internal Test Record Directory Printout 61

Figure 13. Typical USB Flash Drive Test Record Directory Printout..... 63

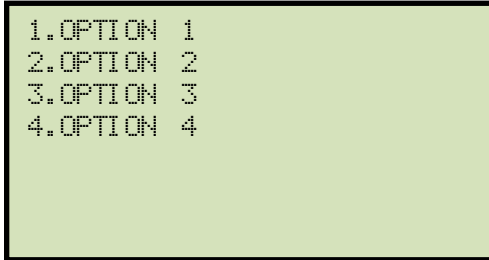
LIST OF TABLES

Table 1. WRM-10P S2 Technical Specifications 4

CONVENTIONS USED IN THIS DOCUMENT

This document uses the following conventions:

- The WRM-10P S2 is referred to as WRM for short.
- A key, switch, or knob on the WRM-10P S2 is indicated as **[KEY]**, **[SWITCH]**, **[KNOB]**.
- Menu names are referenced as "MENU NAME"
- WRM LCD screen output is shown as:



- Warning messages are indicated as:



- Important notes are indicated as:



1.0 INTRODUCTION

1.1 General Description and Features

The WRM-10P S2 is Vanguard's second generation lightweight winding resistance meter, designed to accurately measure the winding resistance of highly inductive power transformers. The unit's dual resistance-reading input channels can measure two winding resistances simultaneously, and four-wire (Kelvin) connections provide high accuracy and require no lead compensation. The WRM-10P S2 provides stable resistance readings of very large transformers by utilizing a 36Vdc power supply capable of outputting up to 10 Amperes. The resistance reading of a 100MVA transformer can be achieved in 5 minutes or less. The unit's power supply is cooled by heavy-duty fans designed for continuous operation. For greater flexibility in the field, the WRM-10P S2 comes with a built-in 2.5" wide thermal printer used for printing test reports.

The WRM-10P S2 can also be used to measure EHV circuit-breaker contact resistance, motor winding resistance, or any low resistance since it can accurately measure resistances ranging from 1 micro-ohm to 2,000 ohms. If the transformer winding temperature is entered, the WRM-10P S2 can calculate the equivalent resistance value of the winding material (aluminum or copper) at any standard reference temperature. Also, a special test mode can run a test for up to 60 minutes while saving resistance readings at 10, 15, 20, 30, or 60 second intervals. In addition to measuring the resistance value, the WRM-10P S2 also checks the "make-before-break" tap-switching sequences of voltage regulators and load tap changers.

The WRM-10P S2 is furnished with three 50-foot test cables. Each test cable lead is terminated with a quick-disconnect test clip.

Built-in Safety Features

The WRM-10P S2 automatically dissipates the stored energy in the transformer at the end of each test. This discharge circuit will continue to work even if the supply voltage is lost. For added safety, the unit's power supply is thermally protected from over-load damage.

User Interface

The WRM-10P S2 features a 5" back-lit LCD screen (240 x 128 pixels) that is viewable in bright sunlight and low-light levels. A rugged, "QWERTY"-style, membrane keyboard is used to control the unit.

Built-in Thermal Printer

The WRM-10P S2 features a built-in 2.5" wide thermal printer that can be used to print test reports in the field.

Internal Test Record Storage

The WRM-10P S2 can store 100 test records (up to 64 readings per test record) in Flash EEPROM. Test records can be retrieved and printed on the built-in thermal printer or can be transferred to a PC via the USB PC or USB Flash drive interfaces. Windows® -based software is provided with each WRM-10P S2 that can be used to retrieve test records from the unit and can also be used to export records in Microsoft® Excel format.

1.2 WRM-10P S2 Technical Specifications

Table 1. WRM-10P S2 Technical Specifications

TYPE	Portable transformer winding resistance meter
PHYSICAL SPECIFICATIONS	Dimensions: 17.5"W x 11.75"H x 12.5" D (44.5 cm x 29.8 cm x 31.8 cm) Weight: 27 lbs (12.2 kg)
INPUT POWER	100 – 120 Vac or 200 – 240 Vac (factory pre-set), 50/60 Hz
RESISTANCE READING RANGE	1 micro-ohm – 2,000 ohms
ACCURACY	1 – 19,999 micro-ohms: ±0.5% reading, ±1 count 20 – 999 milliohms: ±1% reading, ±1 count 1 – 2,000 ohms: ±1.5% reading, ±1 count
TEST VOLTAGE	36 Vdc max
TEST CURRENT RANGE	Auto range, 10 Amperes max
DISPLAY	5" back-lit LCD screen (240 x 128 pixels); viewable in bright sunlight and low-light levels
PRINTER	2.5-inch wide built-in thermal printer
KEYPAD	Rugged "QWERTY"-style membrane keypad
INTERNAL TEST RECORD STORAGE	Stores 100 test records of 64 readings each
COMPUTER INTERFACE	USB PC, USB Flash drive
PC SOFTWARE	Windows®-based software is included with purchase price
SAFETY	Designed to meet IEC61010 (1995), UL61010A-1, CSA-C22.2 standards
TEMPERATURE	Operating: -10°C to +50° C (+15°F to +122° F) Storage: -30° C to +70° C (-22°F to +158° F)
HUMIDITY	90% RH @ 40°C (104°F), non-condensing
ALTITUDE	2,000 m (6,562 ft) to full safety specifications
CABLES	Three 50-foot (15.24m) test cables, one ground cable, one power cord, one USB cable and cable carrying bag
OPTIONS	Shipping Case
WARRANTY	One year on parts and labor



NOTE

The above specifications are valid at nominal operating voltage and at a temperature of 25°C (77°F). Specifications may change without prior notice.

1.3 WRM-10P S2 Controls and Indicators

The WRM-10P S2's controls and indicators are shown in Figure 1. The purpose of the controls and indicators may seem obvious, but users should become familiar with them before using the WRM. Accidental misuse of the controls will usually cause no serious harm. Users should also be familiar with the safety summary found on the front page of this User's Manual.

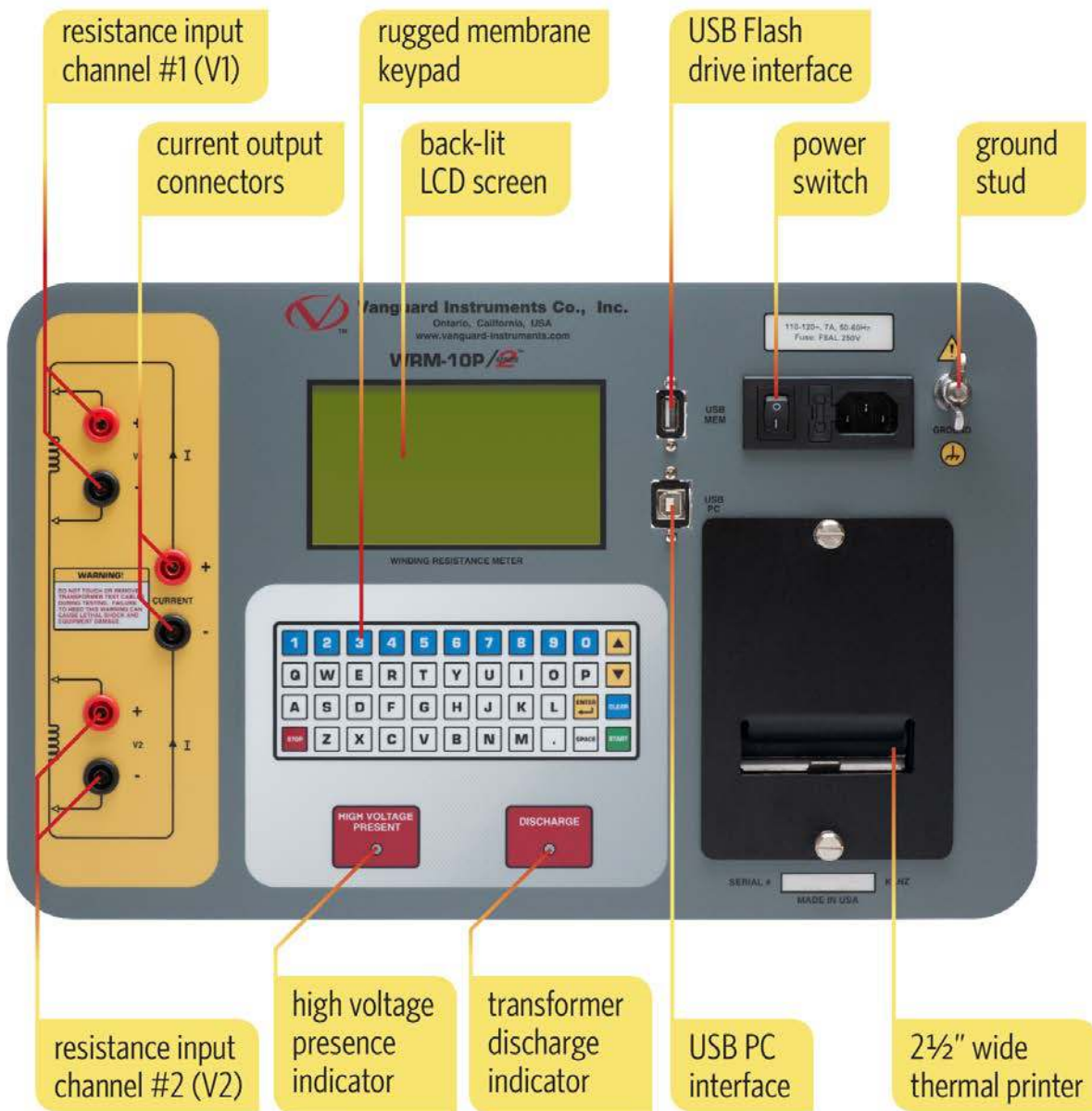


Figure 1. WRM-10P S2 Controls and Indicators

2.0 PRE-TEST SETUP

2.1 Operating Voltages

The WRM's operating voltage is preset at the factory and is selectable between 100-120 Vac, 50/60 Hz or 200-240 Vac, 50/60 Hz.

2.2 LCD Screen Contrast Control

To increase the LCD screen contrast, press and hold the [▲] key for two seconds.

To decrease the LCD screen contrast, press and hold the [▼] key for two seconds.

2.3 Printer Paper Control

To advance the WRM printer paper, press and release the [▲] key.

To retract the WRM printer paper, press and release the [▼] key.

2.4 Printer Paper

The WRM's built-in thermal printer uses 2.5" wide thermal paper for printing test results. To maintain the highest print quality and to avoid paper jams, the use of thermal paper supplied by Vanguard Instruments is highly recommended. Additional paper can be ordered from the following sources:

Vanguard Instruments

1520 S. Hellman Avenue

Ontario, CA 91761

Tel: 909-923-9390

Fax: 909-923-9391

Part Number: VIC TP-3 paper

BG Instrument Co.

13607 E. Trent Avenue

Spokane, WA 99216

Tel: 509-893-9881

Fax: 509-893-9803

Part Number: VIC TP-3 paper

2.5 Replacing the Thermal Printer Paper

The roll of thermal paper is housed inside a dispenser underneath the printer cover. To replace the paper, follow the steps below:

- Unscrew the two large printer cover screws and remove the printer cover.
- Remove the leftover thermal paper roll from the paper holder.
- Unroll the new thermal paper roll.
- Feed the thermal paper into the slot between the paper pocket and the rubber roller. The printer will automatically pull the paper under the thermal head.
- Place the paper roll into the paper holder.
- Lift the thermal head and align the thermal paper if necessary.
- Re-install the printer cover.

**NOTE**

Thermal paper has a chemical coating on one side of the paper. This side should be facing the thermal print head. Incorrect paper loading may result in blank output on the thermal paper.

The thermal paper will show a red stripe to indicate that the roll is about to run out of paper.

3.0 OPERATING PROCEDURES

3.1 WRM Cable Connections

Typical WRM connection diagrams are shown in Figure 2, Figure 3, Figure 4, and Figure 5.



WARNINGS

- Do not touch or disconnect any test lead that is connected to a transformer terminal while high current is being conducted during a test. **Failure to heed this warning can result in lethal electric shock to personnel and/or damage to the equipment.**
- Disconnect the test clips from the transformer bushing only after the WRM has completely discharged the transformer. Always disconnect the test clips slowly from the transformer bushing to prevent an accidental flash-over.

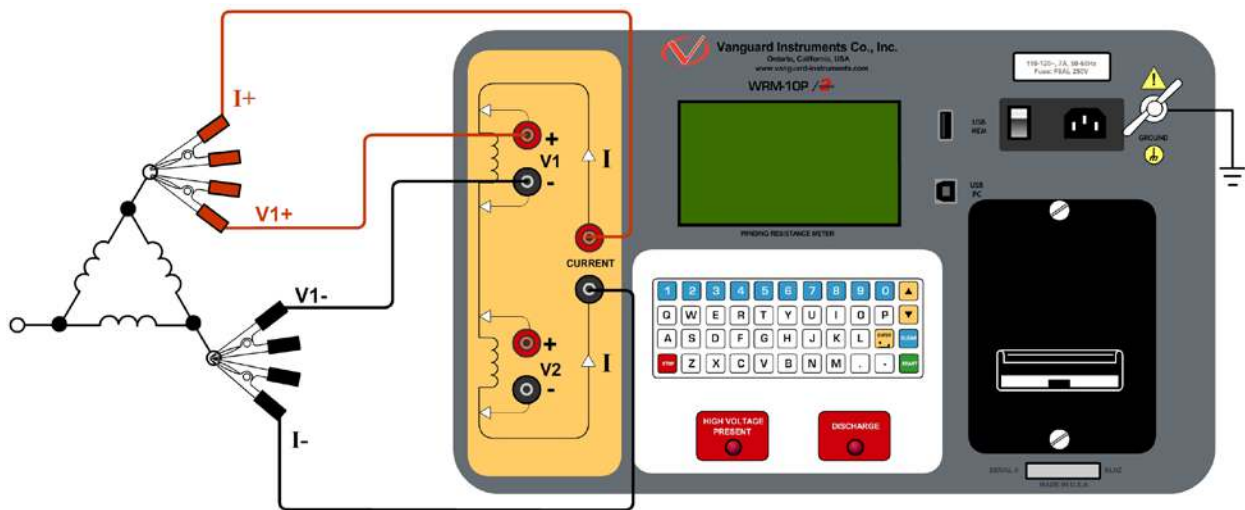


Figure 2. Typical WRM Connections Diagram #1

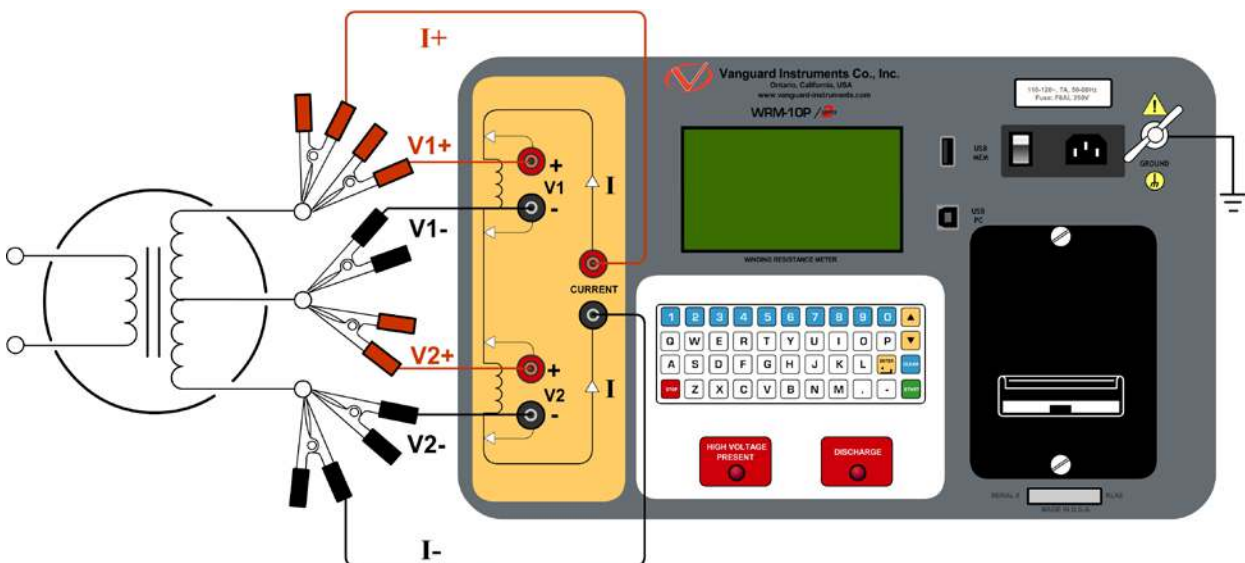


Figure 3. Typical WRM Connections Diagram #2

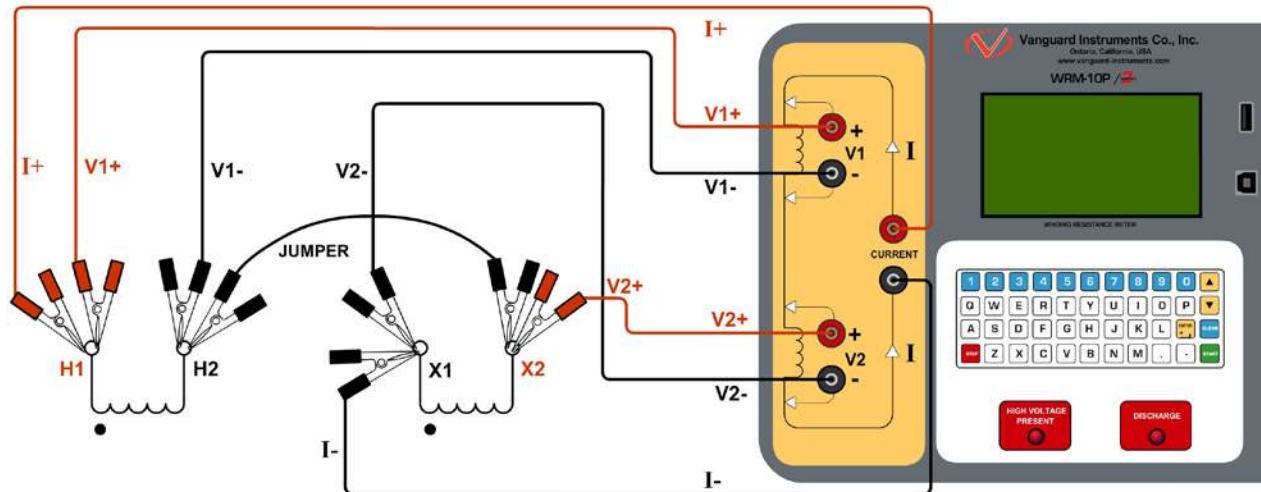


Figure 4. Typical WRM Connections Diagram #3

**NOTE**

The above figure illustrates the simultaneous testing of both the high and low windings on a single-phase transformer. When measuring two channels, the above cable connection is recommended since it will speed up the testing process.

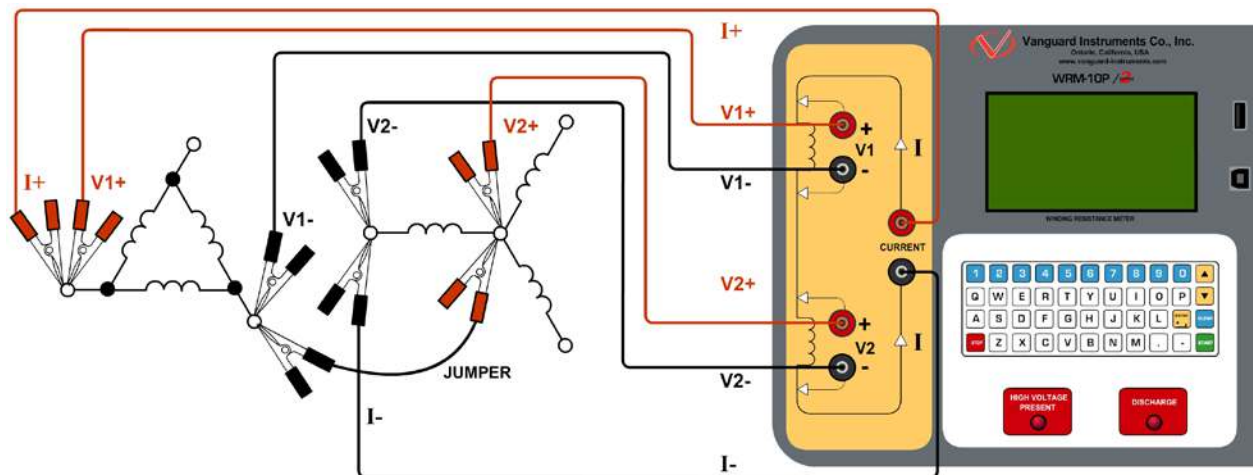


Figure 5. Typical WRM Connections Diagram #4

3.2 General Procedures

The main steps for using the WRM are outlined below:

- a. Ground the WRM to the substation ground.



WARNING

Always connect the WRM to the substation ground before connecting any test lead to any transformer bushing. Failure to follow this procedure may damage the WRM.

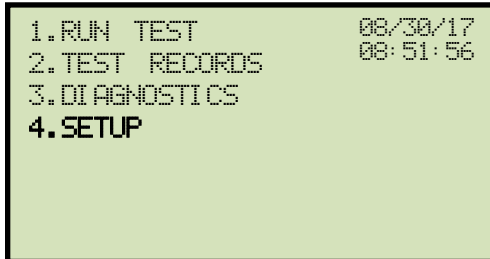
- b. Plug the WRM power cable into a power outlet.
- c. Insert current-cable plugs and voltage-sensing cable plugs into the corresponding control panel jacks.
- d. Attach the test cable clamps to the transformer terminal for the winding that is to be measured.
- e. Turn on the WRM by pressing **[I]** on the power rocker switch.
- f. The unit will self-calibrate, and then you will be presented with the "START-UP" menu as shown below:

```
1.RUN TEST      08/30/17
2.TEST RECORDS  08:51:56
3.DIAGNOSTICS
4.SETUP
```

3.3 Entering Test Record Header Information

You can enter the test record header information before performing tests. The record header includes identifying information such as the company, station, circuit, model number, etc. Once the header information has been entered, it will apply to all subsequent test records. To enter the header information:

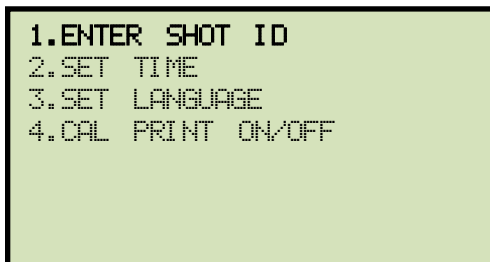
- a. Start from the "START-UP" menu:



```
1. RUN TEST          08/30/17
2. TEST RECORDS      08:51:56
3. DIAGNOSTICS
4. SETUP
```

Press the **[4]** key (*SETUP*).

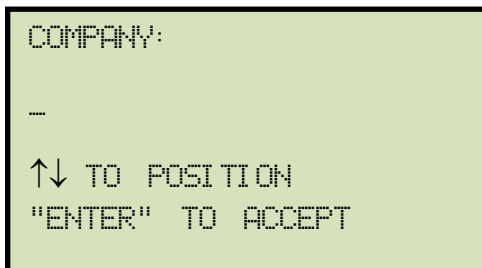
- b. The following screen will be displayed:



```
1. ENTER SHOT ID
2. SET TIME
3. SET LANGUAGE
4. CAL PRINT ON/OFF
```

Press the **[1]** key (*ENTER SHOT ID*).

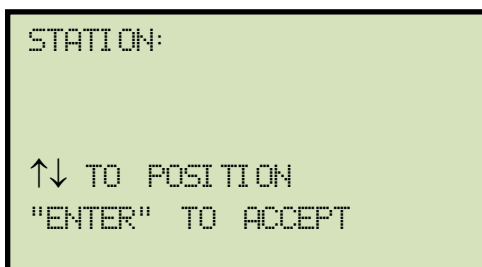
- c. The following screen will be displayed:



```
COMPANY:
-
↑↓ TO POSITION
"ENTER" TO ACCEPT
```

Type the company name using the keypad and press the **[ENTER]** key.

- d. The following screen will be displayed:

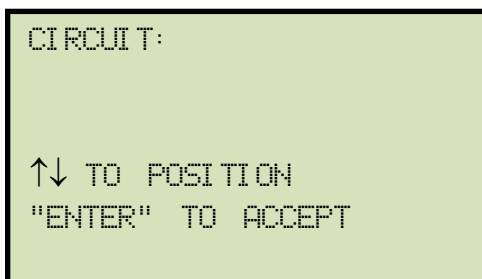
A green rectangular screen with a black border. The text is in a monospaced font. It displays 'STATION:' at the top, followed by a blank line. Below that is '↑↓ TO POSITION', followed by another blank line, and finally '"ENTER" TO ACCEPT' at the bottom.

```
STATION:

↑↓ TO POSITION
"ENTER" TO ACCEPT
```

Type the station name using the keypad and press the **[ENTER]** key.

- e. The following screen will be displayed:

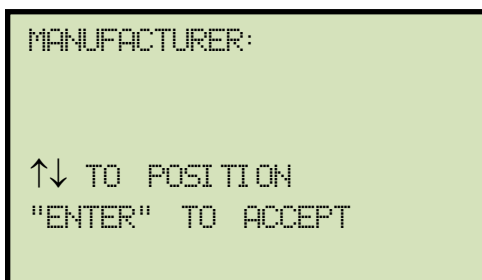
A green rectangular screen with a black border. The text is in a monospaced font. It displays 'CIRCUIT:' at the top, followed by a blank line. Below that is '↑↓ TO POSITION', followed by another blank line, and finally '"ENTER" TO ACCEPT' at the bottom.

```
CIRCUIT:

↑↓ TO POSITION
"ENTER" TO ACCEPT
```

Type the circuit information using the keypad and press the **[ENTER]** key.

- f. The following screen will be displayed:

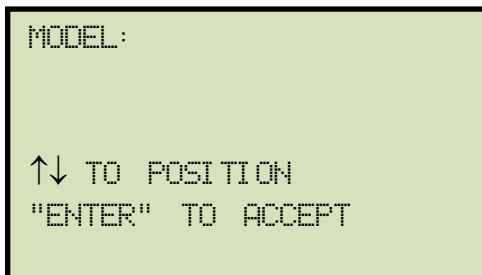
A green rectangular screen with a black border. The text is in a monospaced font. It displays 'MANUFACTURER:' at the top, followed by a blank line. Below that is '↑↓ TO POSITION', followed by another blank line, and finally '"ENTER" TO ACCEPT' at the bottom.

```
MANUFACTURER:

↑↓ TO POSITION
"ENTER" TO ACCEPT
```

Type the manufacturer name using the keypad and press the **[ENTER]** key.

- g. The following screen will be displayed:

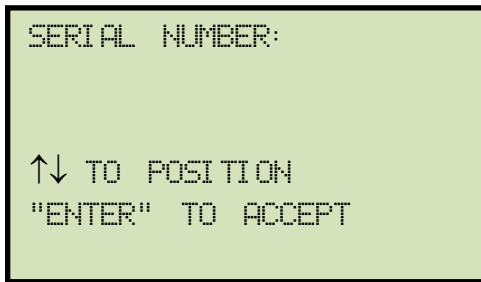
A green rectangular screen with a black border. The text is in a monospaced font. It displays 'MODEL:' at the top, followed by a blank line. Below that is '↑↓ TO POSITION', followed by another blank line, and finally '"ENTER" TO ACCEPT' at the bottom.

```
MODEL:

↑↓ TO POSITION
"ENTER" TO ACCEPT
```

Type the transformer model information using the keypad and press the **[ENTER]** key.

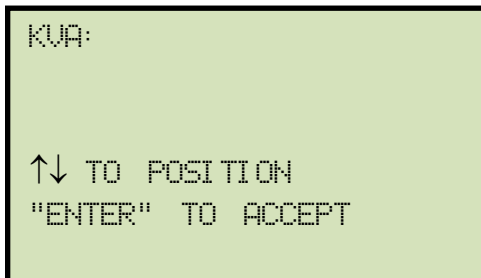
- h. The following screen will be displayed:

A screenshot of a green screen with black text. The text reads: "SERIAL NUMBER:" followed by a blank line, then "↑↓ TO POSITION" and "ENTER" TO ACCEPT".

```
SERIAL NUMBER:  
  
↑↓ TO POSITION  
"ENTER" TO ACCEPT
```

Type the transformer serial number using the keypad and press the **[ENTER]** key.

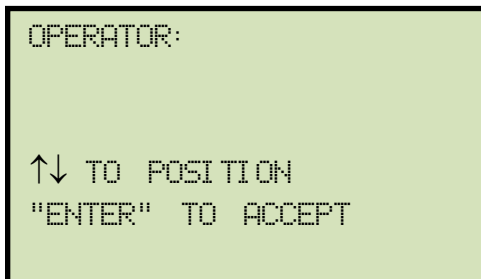
- i. The following screen will be displayed:

A screenshot of a green screen with black text. The text reads: "KVA:" followed by a blank line, then "↑↓ TO POSITION" and "ENTER" TO ACCEPT".

```
KVA:  
  
↑↓ TO POSITION  
"ENTER" TO ACCEPT
```

Type the transformer's KVA rating using the keypad and press the **[ENTER]** key.

- j. The following screen will be displayed:

A screenshot of a green screen with black text. The text reads: "OPERATOR:" followed by a blank line, then "↑↓ TO POSITION" and "ENTER" TO ACCEPT".

```
OPERATOR:  
  
↑↓ TO POSITION  
"ENTER" TO ACCEPT
```

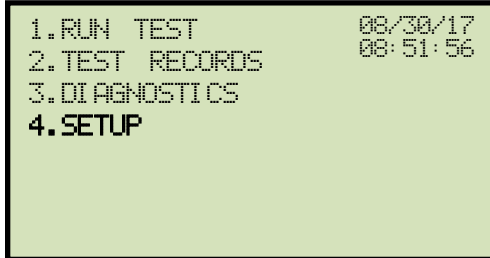
Type the operator's name using the keypad and press the **[ENTER]** key.

All header information will be saved, and you will be returned to the "START-UP" menu.

3.4 Setting the Clock

Follow the steps below to set the WRM-10P S2's internal clock:

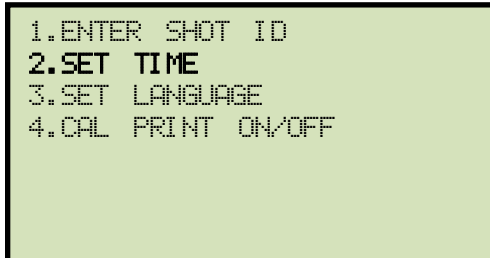
- a. Start from the "START-UP" menu:



```
1.RUN TEST      08/30/17
2.TEST RECORDS  08:51:56
3.DIAGNOSTICS
4.SETUP
```

Press the **[4]** key (*SETUP*).

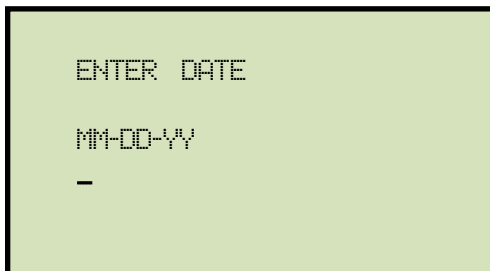
- b. The following screen will be displayed:



```
1. ENTER SHOT ID
2.SET TIME
3.SET LANGUAGE
4.CAL PRINT ON/OFF
```

Press the **[2]** key (*SET TIME*).

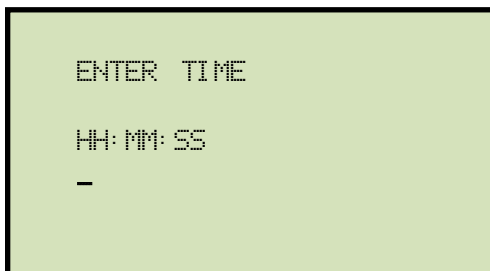
- c. The following screen will be displayed:



```
ENTER DATE

MM-DD-YY
-
```

Enter the month, date, and year using the keypad. When the last digit is entered, the following screen will be displayed:



```
ENTER TIME

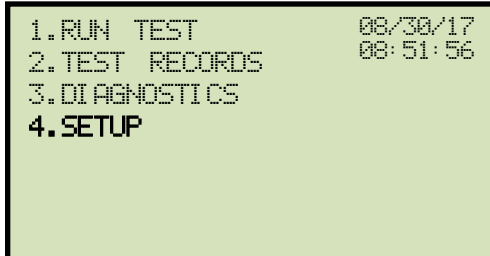
HH:MM:SS
-
```

Enter the hours (in 24-hour military format), minutes, and seconds using the keypad. When the last digit is entered, the clock will be set, and you will be returned to the "START-UP" menu.

3.5 Toggling the Calibration Notification Feature

The WRM-10P S2 offers a convenient feature that can print the unit's calibration due date at the bottom of the test reports printed on the unit's thermal printer. Follow the steps below to toggle this feature:

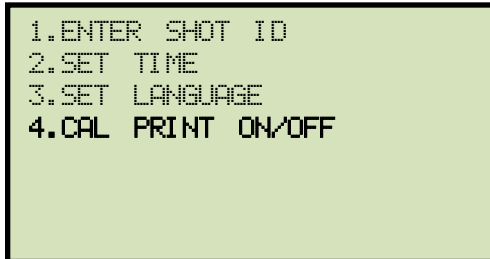
- a. Start from the "START-UP" menu:



```
1.RUN TEST      08/30/17
2.TEST RECORDS  08:51:56
3.DIAGNOSTICS
4.SETUP
```

Press the **[4]** key (*SETUP*).

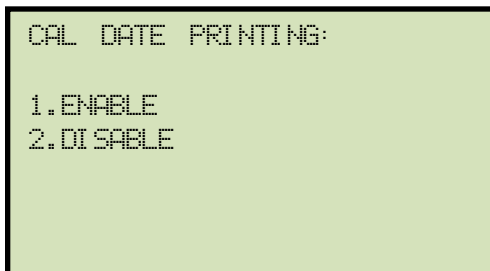
- b. The following screen will be displayed:



```
1. ENTER SHOT ID
2. SET TIME
3. SET LANGUAGE
4. CAL PRINT ON/OFF
```

Press the **[4]** key (*CAL PRINT ON/OFF*).

- c. The following screen will be displayed:

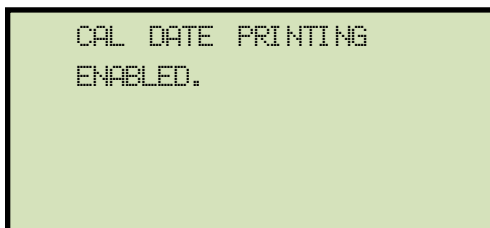


```
CAL DATE PRINTING:

1. ENABLE
2. DISABLE
```

Press the **[1]** key (*ENABLE*) to enable or the **[2]** key (*DISABLE*) to disable this feature.

- d. The following screen will be displayed (enabled option shown):



```
CAL DATE PRINTING
ENABLED.
```

Press any key to return to the "START-UP" menu.

3.6 Performing a Resistance Test

- a. Start from the "START-UP" menu:

```
1.RUN TEST      08/30/17
2.TEST RECORDS  08:51:56
3.DIAGNOSTICS
4.SETUP
```

Press the **[1]** key (*RUN TEST*).

- b. The following screen will be displayed:

```
1.V1 & V2 TEST
2.V1 ONLY TEST
3.SPECIAL TEST V1, V2
4.SPECIAL TEST V1
5.TRANSIENT TEST
```

Press the **[1]** key (*V1 & V2 TEST*) if you would like to perform a V1 & V2 test.

Press the **[2]** key (*V1 ONLY TEST*) if you would like to perform a V1 test only.

For this example, we will perform a V1 Only Test by pressing the **[2]** key.

Please see section 3.8 for information about performing special tests.



The WRM-10P S2's test current is 10 Amps.

NOTE

- c. The following menu will be displayed:

```
LTC or VTG REGULATOR?
1. YES
2. NO
```

Press the **[2]** key (*NO*).

d. The following screen will be displayed:

```
CONVERT READINGS TO
STANDARD TEMP?
1. YES
2. NO
```

1. YES

Press the **[1]** key (YES) if you wish to convert readings to standard temperature. The following screen will be displayed:

```
WINDING MATERIAL
1. COPPER, Tk=234.5
2. ALUMINUM, Tk=225
3. MANUALLY ENTER Tk
```

Press the **[1]** key (COPPER, $T_k=234.5$) to select copper as the winding material. **Continue to step e.**

Press the **[2]** key (ALUMINUM, $T_k=225$) to select aluminum as the winding material. **Continue to step e.**

Press the **[3]** key (MANUALLY ENTER T_k) to manually enter the T_k value. The following screen will be displayed:

```
Tk:
230.0 °C

↑↓ to Adjust Temp,
"ENTER" to Accept
```

You can increase the T_k value by 0.5°C increments by pressing the **[▲]** key.

You can decrease the T_k value by 0.5°C increments by pressing the **[▼]** key.

Press the **[ENTER]** key to confirm the temperature setting. **Continue to step e.**

2. NO

Press the **[2]** key (NO) if you do NOT wish to convert readings to standard temperature. **Continue to step g.**

- e. The following screen will be displayed:

```
D.U.T. TEMP:
25.0 °C    77.0 °F

↑↓ to Adjust Temp,
"ENTER" to Accept
```

Use the **▲** and **▼** keys to adjust the D.U.T. (Device Under Test) temperature by 0.5°C increments.

Press the **[ENTER]** key to confirm the D.U.T. temperature setting.

- f. The following screen will be displayed:

```
REFERENCE TEMP:
75.0 °C    167.0 °F

↑↓ to Adjust Temp,
"ENTER" to Accept
```

Use the **▲** and **▼** keys to adjust the reference temperature by 0.5°C increments.

Press the **[ENTER]** key to confirm the reference temperature setting.



NOTE

The WRM will calculate the equivalent resistance value at this new temperature. Please see section 4.2 for further information about how this value is calculated.

- g. The following warning screen will be displayed:

```
*****WARNING*****
DANGEROUS FLASH-OVER
WILL OCCUR IF CABLES
ARE DISCONNECTED!
*****
```

This warning is a reminder that the next sequence of test steps will run current through the test load. Press any key to continue.



NOTE

If necessary, you can press the **[STOP]** key to cancel the test.

- h. The following screen will be displayed:

```
-V1 ONLY TEST-

"START" TO RUN TEST
OR
"STOP" TO ABORT
```

Press the **[START]** key to run the test.

- i. The following screen will be displayed momentarily:

```
CALIBRATING
PLEASE WAIT...
```

After the WRM finishes its internal calibration, the following screen will be displayed:

```
*XFMR CHARGING*

PLEASE WAIT...

I   =   9.972 AMPS
```

This is only an informational screen to remind the operator that a test is in progress. The display duration of this message depends on the size of the winding's inductance.



NOTE

You can bypass this delay and observe the resistance value immediately. See section 4.1 for instructions on how to select this option.

- j. The WRM determines when the resistance reading is stable and displays the resistance value on the LCD screen as shown below:

```
TEST IN PROGRESS 06  
  
I    =    9.972 AMPS  
  
R1   =    1.000 mΩ
```

The WRM will continue the test and update the resistance values on the LCD screen. While the test is in progress, you can press the **[ENTER]** key to save the current readings from the LCD screen to the WRM's internal working memory. This process can be repeated as needed for a maximum of 48 times per test.

**NOTE**

Although this process can be used to store multiple readings when testing a Load Tap Changer (LTC) or Voltage Regulator, a more convenient method is also available. Please see section 3.7 for information about performing an LTC or Voltage Regulator test.

If the **[ENTER]** key is pressed, the data is saved and the following screen will be displayed on the LCD screen:

```
TEST IN PROGRESS 12  
==> TEST 1 SAVED <==  
I    =    9.975 AMPS  
  
R1   =    1.001 mΩ Δ=0%
```

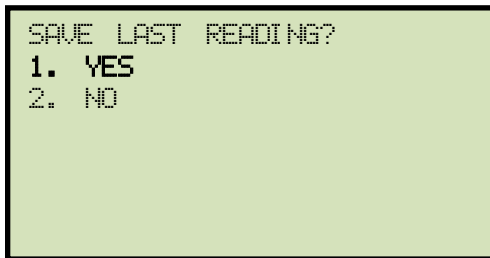
Once the test is saved, the WRM will continue testing and display the resistance value once it has stabilized. You can save the new test results by pressing the **[ENTER]** key.

Press the **[STOP]** key to stop running the test. The test results will be displayed as shown:

```
TEST RESULTS  
  
I    =    9.987 AMPS  
  
R1   =    1.001 mΩ
```

Press any key to continue.

- k. The following screen will be displayed:

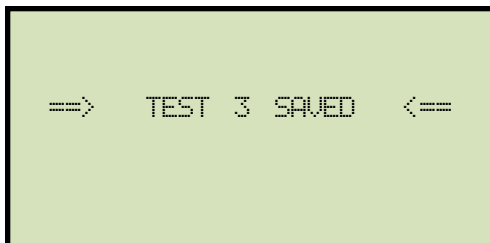


```
SAVE LAST READING?  
1. YES  
2. NO
```

Press the **[1]** key (YES) to save the last reading that was taken, or press the **[2]** key (NO) to discard the last reading.

For this example, we will press the **[1]** key for (YES).

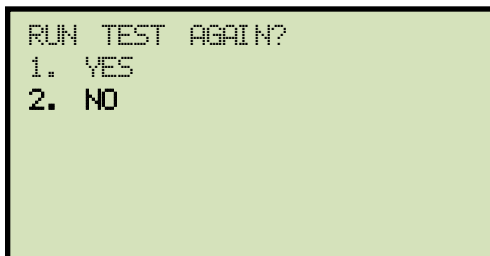
- l. The following screen will be displayed:



```
=> TEST 3 SAVED <=
```

Press any key to continue.

- m. The following screen will be displayed.



```
RUN TEST AGAIN?  
1. YES  
2. NO
```

Press the **[2]** key (NO).

- n. The following screen will be displayed:



```
PRINT RECORD?  
1. YES  
2. NO
```

Press the **[1]** key (YES) to print the test results on the built-in thermal printer.

A typical V1 test report printout is shown in Figure 6.

- o. The following screen will be displayed:

```
SAVE THIS RECORD?  
1. YES  
2. NO
```

Press the **[1]** key (YES) to save the test record.

- p. The following screen will be displayed:

```
SHOT NUMBER 002  
HAS BEEN SAVED!
```

Press any key to return to the "START-UP" menu.

TEST RESULTS	
DATE:09/06/17	TIME:09:19:08
COMPANY: STATION: CIRCUIT: MFR: MODEL: S/N: KVA RATING: OPERATOR:	
V1 ONLY TEST R1 = 1.842 MILLI-OHMS TAP/WINDING: _____	
DATE:09/06/17	TIME:09:19:08

Figure 6. Typical V1 Test Report Printout

REC NUMBER 1	
TEST RESULTS	
DATE:09/06/17	TIME:09:19:08
COMPANY: STATION: CIRCUIT: MFR: MODEL: S/N: KVA RATING: OPERATOR:	
EQUIVALENT RESISTANCE DATA MEAS TEMP $T_m = 25.0C$ $77.0F$ REF TEMP $T_s = 85.0C$ $185.0F$ COPPER WINDINGS, $T_K = 234.5C$ $R_s = R_{meas} \times [(T_s + T_K) / (T_m + T_K)]$ All temps for eqn are in deg C	
V1 & V2 TEST	
R1 = 2.145 MILLI-OHMS	Measured Resistance
R1s = 2.641 MILLI-OHMS	Equivalent Resistance at Reference Temperature
R2 = 2.071 MILLI-OHMS	
R2s = 2.550 MILLI-OHMS	
TAP/WINDING: _____	

Figure 7. Typical V1 and V2 Test Report Printout

REC NUMBER 3
TEST RESULTS
DATE:09/06/17 TIME:09:19:08
COMPANY: STATION: CIRCUIT: MFR: MODEL: S/N: KVA RATING: OPERATOR:
V1 & V2 TEST R1 = 1.841 MILLI-OHMS R2 = 17 MICRO-OHMS TAP/WINDING: _____
V1 & V2 TEST R1 = 1.841 MILLI-OHMS R2 = 16 MICRO-OHMS TAP/WINDING: _____
V1 & V2 TEST R1 = 1.842 MILLI-OHMS R2 = 16 MICRO-OHMS TAP/WINDING: _____
V1 & V2 TEST R1 = 1.841 MILLI-OHMS R2 = 16 MICRO-OHMS TAP/WINDING: _____

Figure 8. Typical V1 and V2 Test Report Printout with Multiple Readings

3.7 Performing a Load Tap Changer / Voltage Regulator Resistance Test

The Load Tap Changer/Voltage Regulator Resistance Test can be used to conveniently measure the resistance at each tap position. Once the number of taps has been entered, the WRM will request the user to set the tap position, starting with the lower taps, then to neutral, and then to the raise taps. At each tap position, the resistance is measured, displayed on the LCD screen, and stored. The WRM then instructs the user to change to the next tap position and repeat the testing process.

Follow steps below to perform an LTC/Voltage Regulator Test:

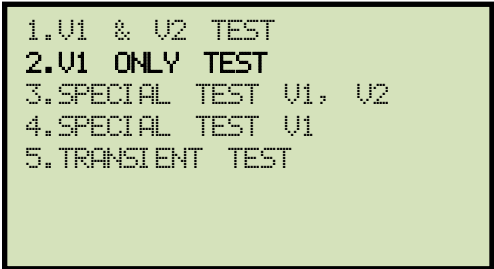
- a. Start from the "START-UP" menu:



```
1.RUN TEST          08/30/17
2.TEST RECORDS      08:51:56
3.DIAGNOSTICS
4.SETUP
```

Press the **[1]** key (*RUN TEST*).

- b. The following screen will be displayed:



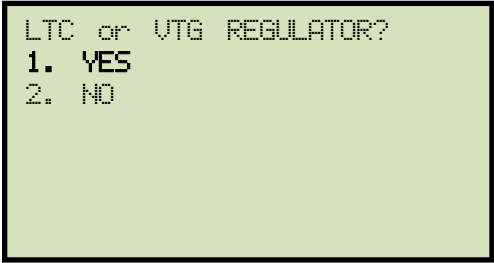
```
1.V1 & V2 TEST
2.V1 ONLY TEST
3.SPECIAL TEST V1, V2
4.SPECIAL TEST V1
5.TRANSIENT TEST
```

Press the **[1]** key (*V1 & V2 TEST*) if you would like to perform a V1 & V2 test.

Press the **[2]** key (*V1 ONLY TEST*) if you would like to perform a V1 test only.

For this example, press the **[2]** key (*V1 ONLY TEST*).

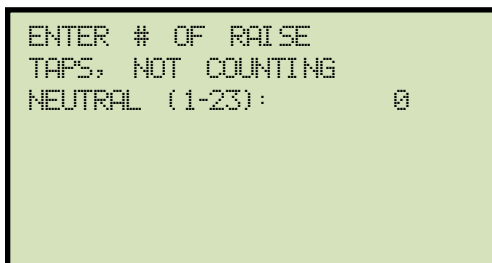
- c. The following screen will be displayed:



```
LTC or VTG REGULATOR?
1. YES
2. NO
```

Press the **[1]** key (*YES*).

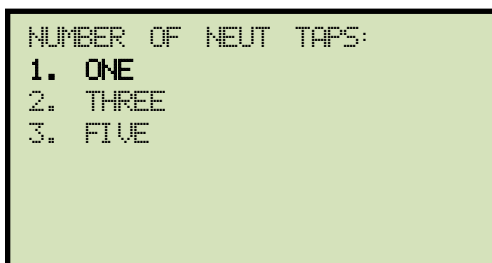
- d. The following screen will be displayed



```
ENTER # OF RAISE  
TAPS, NOT COUNTING  
NEUTRAL (1-23):      0
```

Type the number of "RAISE" taps (not counting neutral) the LTC or Voltage Regulator has using the keypad, and then press the **[ENTER]** key. We will enter "3" for our example.

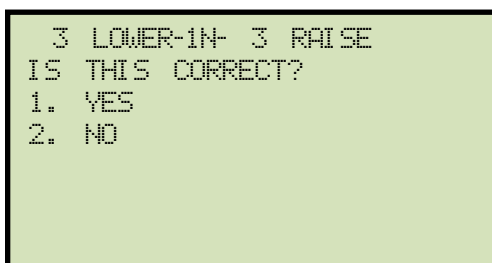
- e. The following screen will be displayed:



```
NUMBER OF NEUT TAPS:  
1. ONE  
2. THREE  
3. FIVE
```

Select the number of "NEUTRAL" taps by pressing the corresponding key. For this example we will select "ONE" by pressing the **[1]** key.

- f. The following screen will be displayed:



```
3 LOWER-1N- 3 RAISE  
IS THIS CORRECT?  
1. YES  
2. NO
```

If the tap information is correct, press the **[1]** key (YES) and **continue to step g.**

If the tap information is incorrect, press the **[2]** key (NO) and **return to step d.**

g. The following screen will be displayed:

```
CONVERT READINGS TO  
STANDARD TEMP?  
1. YES  
2. NO
```

1. YES

Press the **[1]** key (YES) if you wish to convert readings to standard temperature. The following screen will be displayed:

```
WINDING MATERIAL  
1. COPPER, Tk=234.5  
2. ALUMINUM, Tk=225  
3. MANUALLY ENTER Tk
```

Press the **[1]** key (COPPER, Tk=234.5) to select copper as the winding material. **Continue to step h.**

Press the **[2]** key (ALUMINUM, Tk=225) to select aluminum as the winding material. **Continue to step h.**

Press the **[3]** key (MANUALLY ENTER Tk) to manually enter the Tk value. The following screen will be displayed:

```
Tk:  
230.0 °C  
  
↑↓ to Adjust Temp,  
"ENTER" to Accept
```

You can increase the Tk value by 0.5°C increments by pressing the **[▲]** key.

You can decrease the Tk value by 0.5°C increments by pressing the **[▼]** key.

Press the **[ENTER]** key to confirm the temperature setting. **Continue to step h.**

2. NO

Press the **[2]** key (NO) if you do NOT wish to convert readings to standard temperature. **Continue to step j.**

- h. The following screen will be displayed:

```
D.U.T. TEMP:
25.0 °C    77.0 °F

↑↓ to Adjust Temp,
"ENTER" to Accept
```

Use the **▲** and **▼** keys to adjust the D.U.T. (Device Under Test) temperature.

Press the **[ENTER]** key to confirm the D.U.T. temperature setting.

- i. The following screen will be displayed:

```
REFERENCE TEMP:
75.0 °C    167.0 °F

↑↓ to Adjust Temp,
"ENTER" to Accept
```

Use the **▲** and **▼** keys to adjust the reference temperature.

Press the **[ENTER]** key to confirm the reference temperature setting.



NOTE

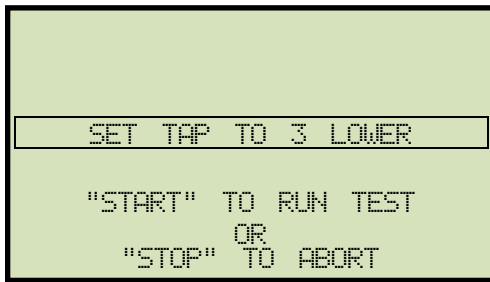
The WRM will calculate the equivalent resistance value at this new temperature. Please see section 4.2 for further information about how this value is calculated.

- j. The following screen will be displayed:

```
*****WARNING*****
DANGEROUS FLASH-OVER
WILL OCCUR IF CABLES
ARE DISCONNECTED!
*****
```

Press any key to continue.

- k. The following screen will be displayed:

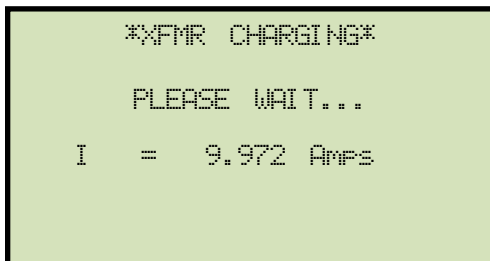


Set the LTC or Voltage Regulator tap position as indicated on the LTC screen and press the **[START]** key.

- l. The following screen will be displayed momentarily:



After the WRM finishes its internal calibration, the following screen will be displayed:

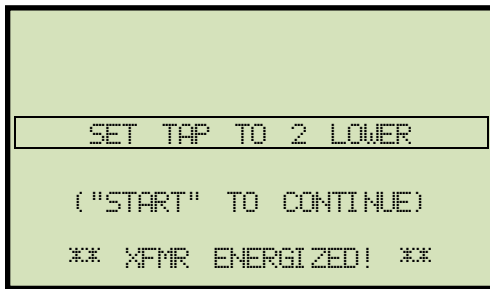


- m. The WRM determines when the resistance reading is stable and displays the resistance value on the LCD screen as shown below:



Press the **[ENTER]** key to accept and save the readings for the current tap.

- n. The following screen will be displayed:



Set the LTC or Voltage Regulator tap position to the position indicated on the LCD screen and press the **[START]** key.

The WRM will continue the test and display the results as in step m. **Repeat steps m through n** for all “Lower” positions and then through all “Raise” positions.

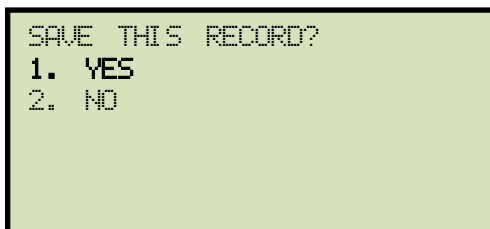
- o. The following screen will be displayed after the last “Raise” position’s resistance reading is stored:



Press the **[1]** key (YES) to print the test results on the unit's built-in thermal printer.

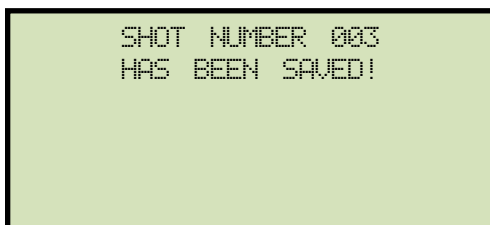
A typical LTC/voltage regulator test report printout is shown in Figure 9.

- p. The following screen will be displayed:



Press the **[1]** key (YES) to save the test record.

- q. The following screen will be displayed:



Press any key to return to the "START-UP" menu.

TEST RESULTS	
DATE:09/06/17	TIME:09:19:08
COMPANY: STATION: CIRCUIT: MFR: MODEL: S/N: KVA RATING: OPERATOR:	
V1 & V2 STATIC LTC TEST	
EQUIVALENT RESISTANCE DATA MEAS TEMP $T_m = 25.0C$ 77.0F REF TEMP $T_s = 85.0C$ 185.0F COPPER WINDINGS, $T_K = 234.5C$ $R_s = R_{meas} \times [(T_s+T_K)/(T_m+T_K)]$ All temps for eqn are in deg C	
TAP = 3 LOWER R1 = 996.2 OHMS R1s = 1226.5 OHMS R2 = 0 MICRO-OHMS R2s = 0 MICRO-OHMS	
TAP = 2 LOWER R1 = 996.9 OHMS R1s = 1227.3 OHMS R2 = 0 MICRO-OHMS R2s = 0 MICRO-OHMS	
TAP = 1 LOWER R1 = 996.5 OHMS R1s = 1226.9 OHMS R2 = 0 MICRO-OHMS R2s = 0 MICRO-OHMS	
TAP = NEUTRAL R1 = 996.9 OHMS R1s = 1227.4 OHMS R2 = 0 MICRO-OHMS R2s = 0 MICRO-OHMS	

Test Results Continued	
TAP = 1 RAISE R1 = 996.5 OHMS R1s = 1226.9 OHMS R2 = 0 MICRO-OHMS R2s = 0 MICRO-OHMS	
TAP = 2 RAISE R1 = 997.3 OHMS R1s = 1227.9 OHMS R2 = 0 MICRO-OHMS R2s = 0 MICRO-OHMS	
TAP = 3 RAISE R1 = 996.8 OHMS R1s = 1227.3 OHMS R2 = 0 MICRO-OHMS R2s = 0 MICRO-OHMS	

Figure 9. Typical LTC/Voltage Regulator Test Report Printout

3.8 Performing a Special Resistance Test

The Special Resistance Test is used to conduct a resistance test for a pre-defined period ranging from 1 to 45 minutes. The resistance data is recorded at pre-defined intervals (from 10 seconds to 1 minute). Follow the steps below to perform a Special Resistance Test:

- a. Start from the "START-UP" menu:

```
1.RUN TEST
2.TEST RECORDS
3.DIAGNOSTICS
4.SETUP
```

Press the **[1]** key (*RUN TEST*).

- b. The following screen will be displayed:

```
1.V1 & V2 TEST
2.V1 ONLY TEST
3.SPECIAL TEST V1, V2
4.SPECIAL TEST V1
5.TRANSIENT TEST
```

Press the **[3]** key (*SPECIAL TEST V1, V2*) if you would like to perform a V1 and V2 Special Test.

Press the **[4]** key (*SPECIAL TEST V1*) if you would like to perform a V1 only Special Test.

For this example, we will press the **[3]** key to perform a Special V1, V2 Test.

- c. The following screen will be displayed:

```
SPECIAL TEST INTERVAL

1. 10S (UP to 10 Min)
2. 15S (UP to 15 Min)
3. 20S (UP to 20 Min)
4. 30S (UP to 30 Min)
5. 60S (UP to 60 Min)
```

Select the special test interval by pressing the corresponding key on the keypad.

For this example, press the **[3]** key to select 20 seconds. Resistance data will be recorded at 20 second intervals.

- d. The following screen will be displayed:

```
ENTER SPECIAL TEST  
TIME IN MINUTES  
(1-20):      0
```

Enter the total special test time in minutes (from 1 to 20 minutes) using the keypad and press the **[ENTER]** key. For this example, we will press the **[1]** key (for 1 minute) and then press the **[ENTER]** key.

- e. The following screen will be displayed:

```
CONVERT READINGS TO  
STANDARD TEMP?  
1. YES  
2. NO
```

1. YES

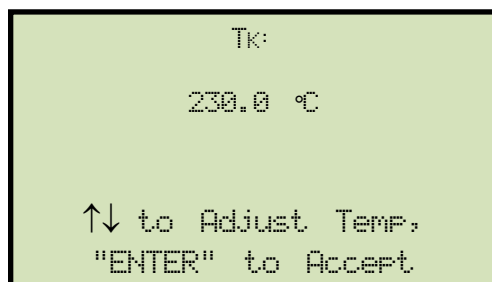
Press the **[1]** key (YES) if you wish to convert readings to standard temperature. The following screen will be displayed:

```
WINDING MATERIAL  
1. COPPER,   Tk=234.5  
2. ALUMINUM, Tk=225  
3. MANUALLY ENTER Tk
```

Press the **[1]** key (COPPER, $T_k=234.5$) to select copper as the winding material. **Continue to step f.**

Press the **[2]** key (ALUMINUM, $T_k=225$) to select aluminum as the winding material. **Continue to step f.**

Press the **[3]** key (MANUALLY ENTER T_k) to manually enter the T_k value. The following screen will be displayed:



You can increase the Tk value by 0.5°C increments by pressing the **▲** key.

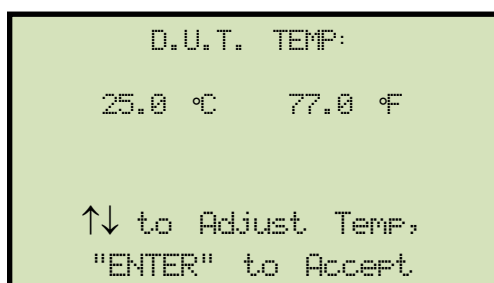
You can decrease the Tk value by 0.5°C increments by pressing the **▼** key.

Press the **ENTER** key to confirm the temperature setting. **Continue to step f.**

2. *NO*

Press the **2** key (NO) if you do NOT wish to convert readings to standard temperature. **Continue to step h.**

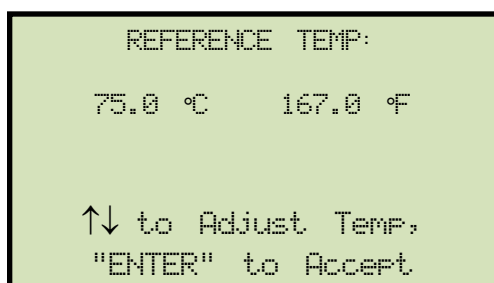
- f. The following screen will be displayed:



Use the **▲** and **▼** keys to adjust the D.U.T. (Device Under Test) temperature.

Press the **ENTER** key to confirm the D.U.T. temperature setting.

- g. The following screen will be displayed:



Use the **▲** and **▼** keys to adjust the reference temperature.

Press the **ENTER** key to confirm the reference temperature setting.

- h. The following warning screen will be displayed:

```
*****WARNING*****  
  DANGEROUS FLASH-OVER  
  WILL OCCUR IF CABLES  
  ARE DISCONNECTED!  
*****
```

This warning is a reminder that the next sequence of test steps will run current through the test load and that caution should be exercised.

Press any key to continue.

- i. The following screen will be displayed:

```
-U1 & U2 TEST-  
  
"START" TO RUN TEST  
  OR  
"STOP" TO ABORT
```

Press the **[START]** key to run the test.

- j. The following screen will be displayed momentarily:

```
CALIBRATING  
PLEASE WAIT...
```

After the WRM finishes its internal calibration, the following screen will be displayed:

```
*XFMR CHARGING*  
  
PLEASE WAIT...
```

This is only an informational screen to remind the operator that a test is in progress. The display duration of this message depends on the size of the winding's inductance.

- k. Next, the current will be ramped up, and the following screen will be displayed:

```

PRESS "ENTER"      00:02
To START LOGGING...

I   =   9.867 AMPS

**   XFMR ENERGIZED!   **

```

Press the **[ENTER]** key to start logging the test data.

- l. The WRM will start measuring the resistance, and the following screen will be displayed momentarily:

```

      MEASURING RES...

I   =   9.867 AMPS

**   XFMR ENERGIZED!   **

```

Once the resistance reading has stabilized, the following screen will be displayed:

```

      REMAINING TIME=00:58

I   =   9.867 AMPS

R1  =   1.001 mΩ
R2  =   1.001 mΩ

**   XFMR ENERGIZED!   **

```

The first line shows the remaining test time.

- m. The WRM will continue to measure the resistance, and when the selected time interval has passed, it will record the resistance value. The following screen will be displayed informing the user that a data point has been saved:

```

      REMAINING TIME=00:58
==> TEST 2 SAVED <==
I   =   9.867 AMPS

R1  =   1.001 mΩ Δ=0%
R2  =   1.001 mΩ Δ=0%

**   XFMR ENERGIZED!   **

```

The WRM will continue to measure the resistance and record the data points at each pre-defined interval until the total test time has elapsed.

- n. The following screen will be displayed when the total test time has elapsed:

```
TEST RESULTS  
I   =  9.906 AMPS  
R1  =  1.001 mΩ  
R2  =  1.001 mΩ  
  
**  XFMR ENERGIZED!  **
```

Press any key to continue.

- o. The following screen will be displayed:

```
PRINT RECORD?  
1. YES  
2. NO
```

Press the **[1]** key (YES) if you would like to print the test record.



If you had selected a long test time and a short data recording interval, the printout will be very long!

NOTE

Press the **[2]** key (NO) if you do not want to print the test record.

- p. The following screen will be displayed:

```
SAVE THIS RECORD?  
1. YES  
2. NO
```

Press the **[1]** key (YES) to save the test record.

- q. The following screen will be displayed:

```
SHOT NUMBER 005  
HAS BEEN SAVED!
```

Press any key to return to the "START-UP" menu.

TEST RESULTS	
DATE:09/11/17 TIME:08:43:34	
COMPANY:	
STATION:	
CIRCUIT:	
MFR:	
MODEL:	
S/N:	
KVA:	
OPERATOR:	
EQUIVALENT RESISTANCE DATA	
MEAS TEMP $T_m = 25.0C$ 77.0F	
REF TEMP $T_s = 75.0C$ 167.0F	
COPPER WINDINGS, $T_K = 234.5C$	
$R_s = R_{meas} \times [(T_s+T_K)/(T_m+T_K)]$	
All Temps for eqn are in deg C	
V1 & V2 SPECIAL TEST	
T = 00:00 (MM:SS)	T = 00:30 (MM:SS)
R1 = 1.001 MILLI-OHMS	R1 = 1.001 MILLI-OHMS
R1s = 1.194 MILLI-OHMS	R1s = 1.194 MILLI-OHMS
R2 = 1.001 MILLI-OHMS	R2 = 1.001 MILLI-OHMS
R2s = 1.194 MILLI-OHMS	R2s = 1.194 MILLI-OHMS
I = 9.885 AMPS	I = 9.900 AMPS
T = 00:10 (MM:SS)	T = 00:40 (MM:SS)
R1 = 1.001 MILLI-OHMS	R1 = 1.001 MILLI-OHMS
R1s = 1.194 MILLI-OHMS	R1s = 1.193 MILLI-OHMS
R2 = 1.001 MILLI-OHMS	R2 = 1.001 MILLI-OHMS
R2s = 1.194 MILLI-OHMS	R2s = 1.194 MILLI-OHMS
I = 9.894 AMPS	I = 9.903 AMPS
T = 00:20 (MM:SS)	T = 00:50 (MM:SS)
R1 = 1.001 MILLI-OHMS	R1 = 1.001 MILLI-OHMS
R1s = 1.194 MILLI-OHMS	R1s = 1.193 MILLI-OHMS
R2 = 1.001 MILLI-OHMS	R2 = 1.001 MILLI-OHMS
R2s = 1.194 MILLI-OHMS	R2s = 1.194 MILLI-OHMS
I = 9.897 AMPS	I = 9.906 AMPS
T = 00:30 (MM:SS)	T = 01:00 (MM:SS)
R1 = 1.001 MILLI-OHMS	R1 = 1.001 MILLI-OHMS
R1s = 1.194 MILLI-OHMS	R1s = 1.194 MILLI-OHMS
R2 = 1.001 MILLI-OHMS	R2 = 1.001 MILLI-OHMS
R2s = 1.194 MILLI-OHMS	R2s = 1.194 MILLI-OHMS
I = 9.897 AMPS	I = 9.906 AMPS

Figure 10. Typical Special Test Report Printout (1 minute @ 10 second intervals)

3.9 Performing a Transient Test

The transient test verifies that a regulating switch in a Voltage Regulator or Load Tap Changer changes contacts through its selection range without a break in the circuit. This is an important test because in actual use, any break in current in a regulating tap switch generates large reactive voltage spikes that are hazardous and exceeds the switch's voltage ratings, thus causing irreparable damage.

By connecting the WRM continuity test input across the switching input and running the regulator switch through all the contacts in its range, any breaks in continuity caused by faulty tap switching can be detected. Please note that the transient test is applicable for the V1 channel only.

Follow the steps below to perform a Transient Test:

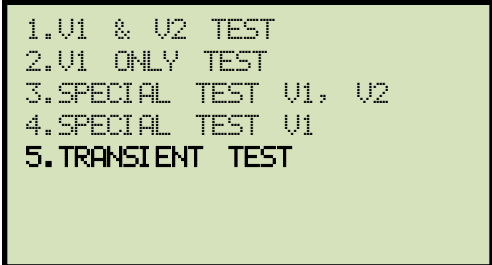
- a. Start from the "START-UP" menu:



```
1.RUN TEST
2.TEST RECORDS
3.DIAGNOSTICS
4.SETUP
```

Press the **[1]** key (*RUN TEST*).

- b. The following screen will be displayed:



```
1.U1 & U2 TEST
2.U1 ONLY TEST
3.SPECIAL TEST U1, U2
4.SPECIAL TEST U1
5.TRANSIENT TEST
```

Press the **[5]** key (*TRANSIENT TEST*).

c. The following screen will be displayed:

```
TRANSIENT FILTER
INTERVAL:    5 mSecs
THRESHOLD:   2

1. CONTINUE
2. EDIT SETTINGS
```

**NOTE**

- The interval value is the interval at which the WRM-10P S2 takes current measurements (1 - 20 mSecs).
- The threshold value determines the tolerance threshold for changes in the voltage measurements (1 - 5). This value is multiplied by 0.36V to determine the threshold value for voltage spikes.

1. *CONTINUE*

Press the **[1]** key (*CONTINUE*) if you do not want to make any changes to the test parameters. **Continue to step d.**

2. *EDIT SETTINGS*

Press the **[2]** key (*EDIT SETTINGS*) if you would like to change the test parameters.

The following screen will be displayed:

```
TIME INTERVAL
( 1-20): 5 mSec

↑↓ to Adjust
"ENTER" to Accept
```

Press the **[▲]** or **[▼]** key to increase or decrease the time interval by 1 mSec increments, respectively. Press the **[ENTER]** key.

The following screen will be displayed:

```
THRESHOLD LEVEL
( 1-5): 2

↑↓ to Adjust
"ENTER" to Accept
```

Press the **[▲]** or **[▼]** key to increment or decrement the threshold level, respectively. Press the **[ENTER]** key and **continue to step d.**

- d. The following warning screen will be displayed:

```
*****WARNING*****  
  DANGEROUS FLASH-OVER  
  WILL OCCUR IF CABLES  
  ARE DISCONNECTED!  
*****
```

Press any key to continue.

- e. The following screen will be displayed:

```
TRANSIENT TEST  
  
"START" TO RUN TEST  
  OR  
"STOP" TO ABORT
```

Press the **[START]** key.

- f. The following screen will be displayed:

```
*XFMR CHARGING*  
  
PLEASE WAIT...
```

This is only an informational screen to remind the operator that a test is in progress. The display duration of this message depends on the size of the winding's inductance.

- g. The test begins as the magnetic field in the transformer ramps up to a stable plateau. The following screen will be displayed when the transformer current stabilizes:

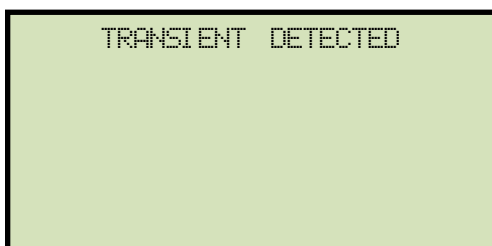
```
TRANSIENT TEST  
(Interval = 5 mSecs  
Threshold = 2 )  
  
RUN TAPS NOW...  
  
** XFMR ENERGIZED! **
```

Manually run the regulator switch through all the contacts in its range. Press the **[STOP]** key to end the test.

The following screen will be displayed if no transient is detected:

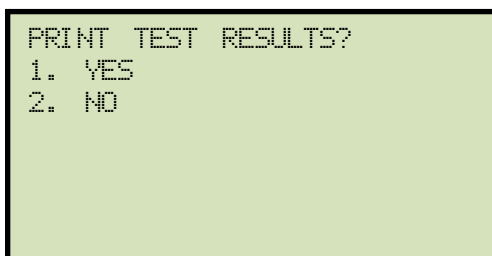


The following screen will be displayed if a switch break is detected:



Press any key to continue.

h. The following screen will be displayed:



Press the **[1]** key (*YES*) to print the test results. The test results will be printed, and you will be returned to the "START-UP" menu. A typical voltage regulator test report is shown in Figure 11.

Press the **[2]** key (*NO*) if you do not want to print the test results. You will be returned to the "START-UP" menu.

TEST RESULTS	
DATE:09/20/17	TIME:14:33:59
COMPANY:	
STATION: LAB	
CIRCUIT:	
MFR:	
MODEL:	
S/N:	
KVA:	
OPERATOR:	
TRANSIENT TEST RESULTS	
NO TRANSIENT DETECTED.	
FROM TAP ____ TO TAP ____	
FILTER SETTINGS:	
Interval= 5 mSecs, Threshold= 2	

Figure 11. Typical Transient Test Report

3.10 Performing a Diagnostic Test

In diagnostic mode, the WRM can run a resistance test and then display the sense voltages and test current on the screen. This feature can be used to verify the WRM's voltage and current readings against an external meter. Follow the steps below to perform a diagnostic test:

- a. Start from the "START-UP" menu:

```
1.RUN TEST
2.TEST RECORDS
3.DIAGNOSTICS
4.SETUP
```

Press the **[3]** key (*DIAGNOSTICS*).

- b. The following warning screen will be displayed:

```
*****WARNING*****
  DANGEROUS FLASH-OVER
  WILL OCCUR IF CABLES
  ARE DISCONNECTED!
*****
```

Press any key to continue.

- c. The following screen will be displayed:

```
- USER DIAG TEST -

"START" TO RUN TEST
      OR
"STOP" TO ABORT
```

Press the **[START]** key.

- d. The following screen will be displayed:

```
- USER DIAG TEST -

I      =  --
U1     =  --
U2     =  --

** XFMR ENERGIZED! **
```


Once the readings have stabilized, they will be displayed on the screen as shown below:

```
- USER DIAG TEST -  
  
I      = 10.068 Amps  
U1     = 10.1 mV  
U2     = 10.1 mV  
  
** XFMR ENERGIZED! **
```

Press the **[STOP]** key to end the test and return to the "START-UP" menu.

3.11 Working with Test Records

3.11.1. Restoring a Test Record from the Unit's Internal Flash EEPROM

Follow the steps below to restore a test record from the WRM's internal Flash EEPROM to the unit's working memory so that it can be reviewed or printed:

- a. Start from the "START-UP" menu:



```
1.RUN TEST
2.TEST RECORDS
3.DIAGNOSTICS
4.SETUP
```

Press the **[2]** key (*TEST RECORDS*).

- b. The following screen will be displayed:



```
1.PRINT RECORD
2.DISPLAY RECORD
3.SAVE RECORD
4.RESTORE RECORD
5.RECORD DIRECTORY
6.ERASE RECORD
7.COPY TO THUMB DRIVE
```

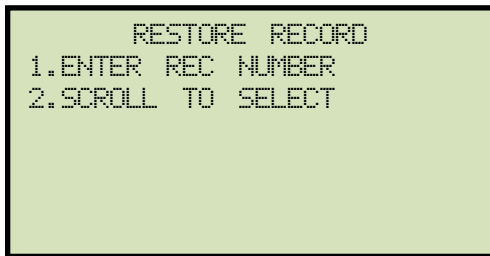


Option 7 (*COPY TO THUMB DRIVE*) will be displayed only if a USB Flash drive is inserted in the WRM-10P S2's USB Flash drive port.

NOTE

Press the **[4]** key (*RESTORE RECORD*).

- c. The following screen will be displayed:



```
RESTORE RECORD
1. ENTER REC NUMBER
2. SCROLL TO SELECT
```



If you have a USB Flash drive inserted in the WRM's "USB MEM" port, the following screen will be displayed instead of the above screen:

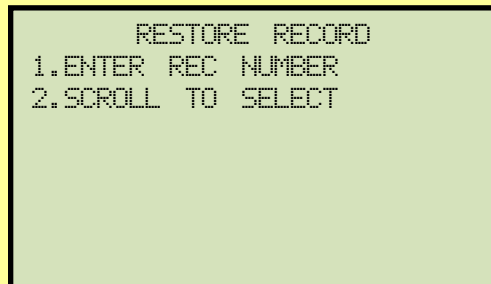
NOTE



```
1. INTERNAL STORAGE
2. THUMB DRIVE
```

Press the **[1]** key (*INTERNAL STORAGE*).

The following screen will be displayed:



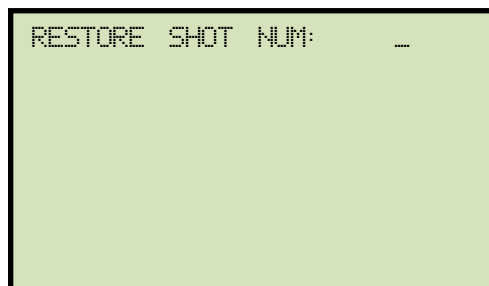
```
RESTORE RECORD
1. ENTER REC NUMBER
2. SCROLL TO SELECT
```

Continue with the steps below.

1. ENTER REC NUMBER

If you know the record number that you would like to restore, press the **[1]** key.

The following screen will be displayed:



```
RESTORE SHOT NUM:  _
```

Type the record number using the keypad and then press the **[ENTER]** key.

Continue to step d.

2. SCROLL TO SELECT

Press the **[2]** key (*SCROLL TO SELECT*) if you would like to scroll through a directory of the stored test records. The following screen will be displayed:

```
SHOT DIRECTORY

"UP" TO SCROLL FWD
"DOWN" TO SCROLL RVS
"ENTER" TO SELECT
```

Press the **[▲]** or **[▼]** key to display the next or previous test record, respectively. The test record's header information will be displayed as shown:

```
09/20/17 15:18
NUMBER OF TESTS: 3
U1 & U2 TEST
CMP:
STA:
CKT:
MFR:
```

Continue to press the **[▲]** or **[▼]** key until you have located the test record you would like to restore, and then press then **[ENTER]** key. **Continue to step d.**

d. The following screen will be displayed:

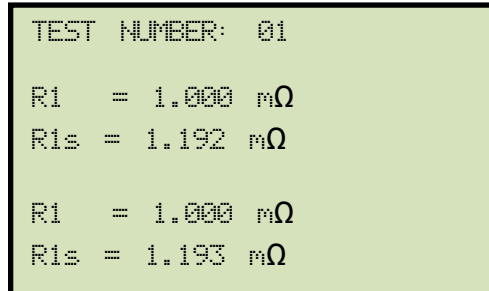
```
RECORD 001 RESTORED!
1.DISPLAY TEST DATA
2.PRINT TEST DATA
```

1. DISPLAY TEST DATA

Press the **[1]** key (*DISPLAY TEST DATA*) to view the restored test record's data on the unit's LCD screen. The following screen will be displayed, showing the test record's header data:

```
09/20/17 15:18
NUMBER OF TESTS: 3
U1 & U2 TEST
CMP:
STA:
CKT:
MFR:
```

Press the **[▲]** or **[▼]** key to view the first or last reading in the test record, respectively. The results will be displayed as shown below:



```
TEST NUMBER: 01

R1  = 1.000 mΩ
R1s = 1.192 mΩ

R1  = 1.000 mΩ
R1s = 1.193 mΩ
```

If the test record contains additional readings, you can continue to press the **[▲]** or **[▼]** key to view the next reading.

Press the **[STOP]** key when done, and you will be returned to the "START-UP" menu.

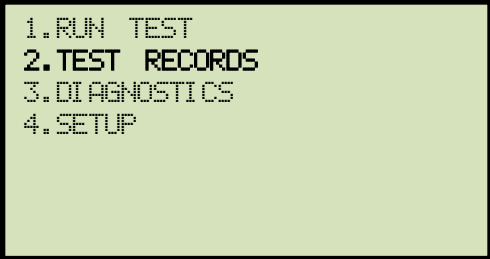
2. *PRINT TEST DATA*

Press the **[2]** key (*PRINT TEST DATA*) to print the restored test record's data on the unit's built-in thermal printer. The test record will be printed and you will be returned to the "START-UP" menu.

3.11.2. Restoring a Test Record From a USB Flash Drive

Follow the steps below to restore a test record from a USB Flash drive to the WRM's working memory:

- a. Make sure the USB Flash drive containing the test records is inserted in the WRM's "USB MEM" port, and then start from the "START-UP" menu:



```
1.RUN TEST
2.TEST RECORDS
3.DIAGNOSTICS
4.SETUP
```

Press the **[2]** key (*TEST RECORDS*).

- b. The following screen will be displayed:



```
1.PRINT RECORD
2.DISPLAY RECORD
3.SAVE RECORD
4.RESTORE RECORD
5.RECORD DIRECTORY
6.ERASE RECORD
7.COPY TO THUMB DRIVE
```

Press the **[4]** key (*RESTORE RECORD*).


- c. The following screen will be displayed:



```
1.INTERNAL STORAGE
2.THUMB DRIVE
```

Press the **[2]** key (*THUMB DRIVE*).

- d. The following screen will be displayed:



```
RESTORE THUMB DRIVE

REC_   _
```

Type the record number using the keypad, and then press the **[ENTER]** key.

**NOTE**

If you do not know the record number, you can first print a test record directory following the instructions in section 3.11.8.

- e. The following screen will be displayed:

```
REC_001  RESTORED!  
          PRINT RECORD?  
1.YES  
2.NO
```

1. *YES*

Press the **[1]** key (*YES*) to print the restored test record's data on the unit's built-in thermal printer. The data will be printed, and you will be returned to the "START-UP" menu.

2. *NO*

Press the **[2]** key (*NO*) if you do not want to print the restored test record's data. You will be returned to the "START-UP" menu. To view or print the restored test record's data, please see section 3.11.3 and 3.11.4, respectively.

3.11.3. Viewing a Test Record

The WRM-10P S2's temporary working memory always contains the test results from either the last test that was performed or the last test that was restored from either the unit's internal memory or from a USB Flash drive. You can view the data from the unit's working memory by following the steps below:

- a. Start from the "START-UP" menu:

```
1.RUN TEST
2.TEST RECORDS
3.DIAGNOSTICS
4.SETUP
```

Press the **[2]** key (*TEST RECORDS*).

- b. The following screen will be displayed:

```
1.PRINT RECORD
2.DISPLAY RECORD
3.SAVE RECORD
4.RESTORE RECORD
5.RECORD DIRECTORY
6.ERASE RECORD
7.COPY TO THUMB DRIVE
```



Option 7 (*COPY TO THUMB DRIVE*) will be displayed only if a USB Flash drive is inserted in the WRM-10P S2's USB Flash drive port.

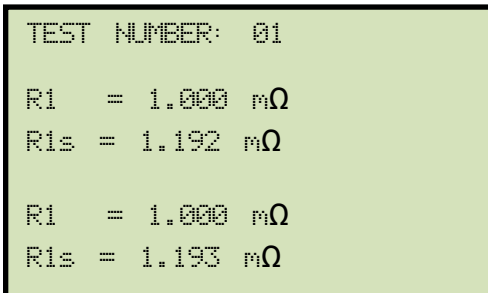
NOTE

Press the **[2]** key (*DISPLAY RECORD*).

- c. The following screen will be displayed, showing the test record's header data:

```
09/20/17 15:18
NUMBER OF TESTS: 3
V1 & V2 TEST
CMP:
STA:
CKT:
MFR:
```


Press the **[▲]** or **[▼]** key to view the first or last reading in the test record, respectively. The results will be displayed as shown below:



```
TEST NUMBER: 01

R1  = 1.000 mΩ
R1s = 1.192 mΩ

R1  = 1.000 mΩ
R1s = 1.193 mΩ
```

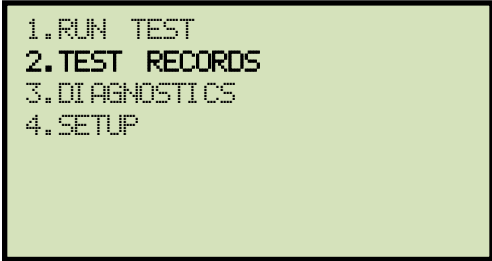
If the test record contains additional readings, you can continue to press the **[▲]** or **[▼]** key to view the next reading.

Press the **[STOP]** key when done, and you will be returned to the "START-UP" menu.

3.11.4. Printing a Test Record

Once you perform a test or restore a test record from the unit's internal memory or USB Flash drive, you will be presented the option to print the test record. If you do not print the test record immediately after performing a test or restoring a test record, you can do so later by following the steps below:

- a. Start from the "START-UP" menu:



```
1. RUN TEST
2. TEST RECORDS
3. DIAGNOSTICS
4. SETUP
```

Press the **[2]** key (*TEST RECORDS*).

- b. The following screen will be displayed:



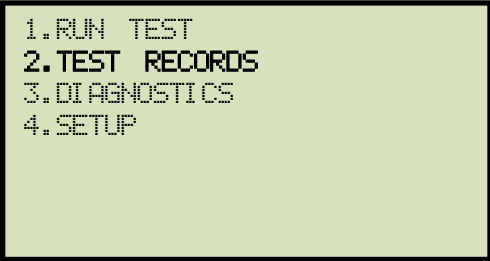
```
1. PRINT RECORD
2. DISPLAY RECORD
3. SAVE RECORD
4. RESTORE RECORD
5. RECORD DIRECTORY
6. ERASE RECORD
7. COPY TO THUMB DRIVE
```

Press the **[1]** key (*PRINT RECORD*). The test record in the working memory will be printed on the unit's built-in thermal printer, and you will be returned to the "START-UP" menu.

3.11.5. Saving a Test Record From the Working Memory

Whenever a test is performed or a test record is restored from the unit's internal memory or from a USB Flash drive, the test data is stored in the unit's working memory. The test record in the WRM's working memory can be saved to the unit's internal memory or to a USB Flash drive by following the steps below:

- a. Start from the "START-UP" menu:



```
1.RUN TEST
2.TEST RECORDS
3.DIAGNOSTICS
4.SETUP
```




If you would like to save the test record to a USB Flash drive, please insert the USB Flash drive in the unit's "USB MEM" port.

NOTE

Press the **[2]** key (*TEST RECORDS*).

- b. The following screen will be displayed:

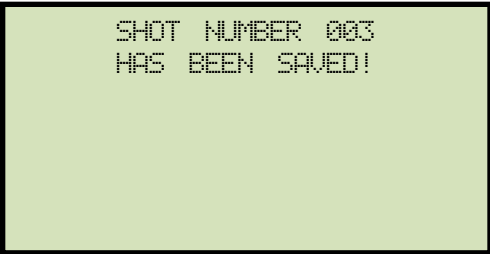


```
1.PRINT RECORD
2.DISPLAY RECORD
3.SAVE RECORD
4.RESTORE RECORD
5.RECORD DIRECTORY
6.ERASE RECORD
7.COPY TO THUMB DRIVE
```

Press the **[3]** key (*SAVE RECORD*).

If a USB Flash drive is inserted in the "USB MEM" port, **continue to step c.**

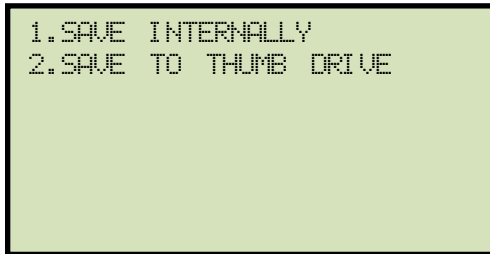
If a USB Flash drive is NOT inserted in the "USB MEM" port, the following screen will be displayed:



```
SHOT NUMBER 003
HAS BEEN SAVED!
```

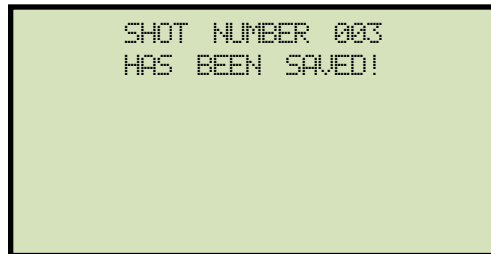
Press any key to return to the "START-UP" menu.

- c. The following screen will be displayed:



1. *SAVE INTERNALLY*

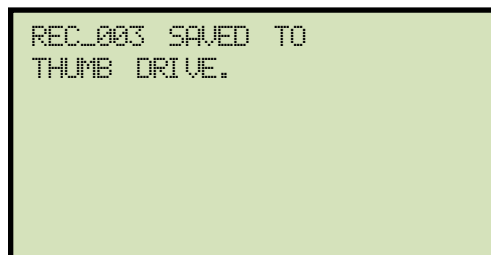
Press the **[1]** key (*SAVE INTERNALLY*) to save the test record from the unit's working memory to the unit's internal memory. The following screen will be displayed:



Press any key to return to the "START-UP" menu.

2. *SAVE TO THUMB DRIVE*

Press the **[2]** key (*SAVE TO THUMB DRIVE*) to save the test record from the unit's working memory to the connected USB Flash Drive. The following screen will be displayed:

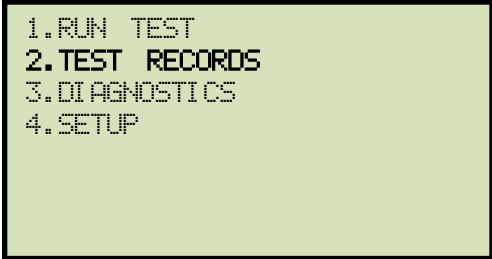


Press any key to return to the "START-UP" menu.

3.11.6. Copying Test Records to a USB Flash Drive

Follow the steps below to copy one or all test records from the unit's internal memory to a connected USB Flash drive:

- a. Make sure a USB Flash drive is connected to the unit's "USB MEM" port, and then start from the "START-UP" menu:



```
1.RUN TEST
2.TEST RECORDS
3.DIAGNOSTICS
4.SETUP
```

Press the **[2]** key (*TEST RECORDS*).

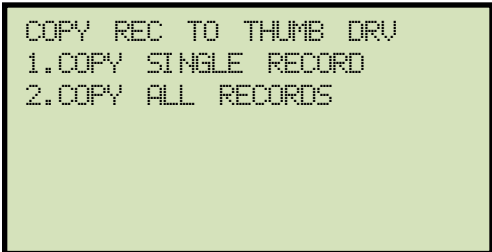
- b. The following screen will be displayed:



```
1.PRINT RECORD
2.DISPLAY RECORD
3.SAVE RECORD
4.RESTORE RECORD
5.RECORD DIRECTORY
6.ERASE RECORD
7.COPY TO THUMB DRIVE
```

Press the **[7]** key (*COPY TO THUMB DRIVE*).

- c. The following screen will be displayed:



```
COPY REC TO THUMB DRV
1.COPY SINGLE RECORD
2.COPY ALL RECORDS
```

1. *COPY SINGLE RECORD*

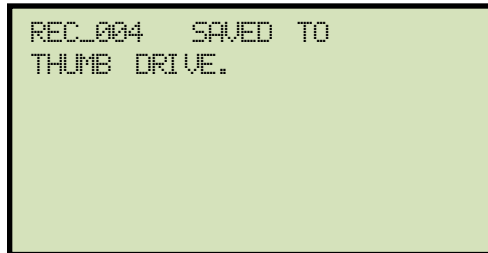
Press the **[1]** key (*COPY SINGLE RECORD*) if you would like to copy a single test record to the USB Flash drive. The following screen will be displayed:



```
ENTER RECORD NUMBER
TO COPY TO THUMB DRV
```

NUMBER: _

Type the record number that you would like to copy to the USB Flash drive and then press the **[ENTER]** key. The test record will be copied to the USB Flash drive, and the following confirmation screen will be displayed:

A screenshot of a monochrome LCD screen with a light green background. The screen displays the text 'REC_004 SAVED TO' on the first line and 'THUMB DRIVE.' on the second line, both in a pixelated font.

Press any key to return to the "START-UP" menu.

2. *COPY ALL RECORDS*

Press the **[2]** key (*COPY ALL RECORDS*) if you would like to copy all test records to the USB Flash drive. All test records from the unit's internal memory will be copied to the USB Flash drive, and you will be returned to the "START-UP" menu when the process is finished.

3.11.7. Printing a Directory of Test Records Stored in the WRM's Internal Memory

Follow the steps below to print a directory of all the test records stored in the WRM's internal memory:

- a. Start from the "START-UP" menu:

```
1.RUN TEST
2.TEST RECORDS
3.DIAGNOSTICS
4.SETUP
```

Press the **[2]** key (*TEST RECORDS*).

- b. The following screen will be displayed:

```
1.PRINT RECORD
2.DISPLAY RECORD
3.SAVE RECORD
4.RESTORE RECORD
5.RECORD DIRECTORY
6.ERASE RECORD
7.COPY TO THUMB DRIVE
```

Press the **[5]** key (*RECORD DIRECTORY*).

- c. The following screen will be displayed:

```
PRINT DIRECTORY

1. FULL DIRECTORY
2. SHORT DIRECTORY
```

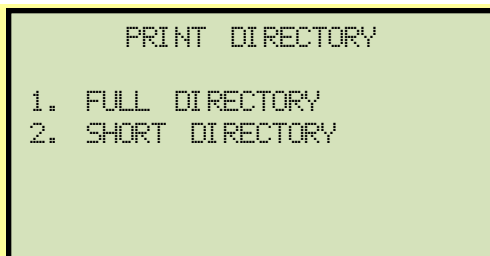


NOTE

The above screen will be displayed only if a USB Flash drive is NOT connected to the WRM's USB Flash drive port. If a USB Flash drive is connected, the following screen will be displayed:

```
1.INTERNAL DIRECTORY
2.THUMB DRIVE DIR
```

Press the **[1]** key (*INTERNAL DIRECTORY*). The following screen will be displayed:



Continue with the steps below:

1. *FULL DIRECTORY*

Press the **[1]** key (*FULL DIRECTORY*) to print a full directory of all the test records stored in the WRM's internal memory. The directory listing will be printed on the thermal printer, and you will be returned to the "START-UP" menu. A sample directory listing printout is shown in Figure 12.

2. *SHORT DIRECTORY*

Press the **[2]** key (*SHORT DIRECTORY*) to print a directory of the last 10 records stored in the WRM's internal memory. The short directory listing will be printed on the thermal printer, and you will be returned to the "START-UP" menu.

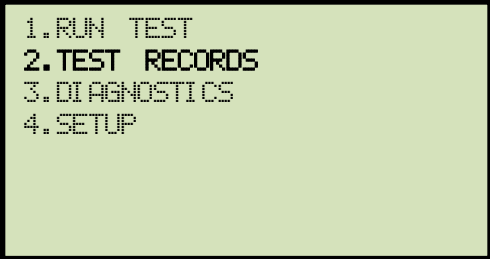
TEST DIRECTORY
RECORD NUMBER: 2 DATE/TIME: 09/20/17 15:18:25 V1 & V2 TEST NUMBER OF TESTS: 3 STATION: LAB CIRCUIT: MFR: MODEL: WRM 10P S2 S/N: 350004
RECORD NUMBER: 4 DATE/TIME: 09/20/17 15:17:15 V1 & V2 TEST NUMBER OF TESTS: 2 STATION: LAB CIRCUIT: MFR: MODEL: WRM 10P S2 S/N: 350004
RECORD NUMBER: 1 DATE/TIME: 09/20/17 15:17:15 V1 & V2 TEST NUMBER OF TESTS: 2 STATION: LAB CIRCUIT: MFR: MODEL: WRM 10P S2 S/N: 350004
RECORD NUMBER: 0 DATE/TIME: 09/20/17 15:16:27 V1 ONLY TEST NUMBER OF TESTS: 3 STATION: LAB CIRCUIT: MFR: MODEL: WRM 10P S2 S/N: 350004

Figure 12. Typical Internal Test Record Directory Printout

3.11.8. Printing a Directory of Test Records Stored in a USB Flash Drive

Follow the steps below to print a directory of all the test records stored in a connected USB Flash drive:

- a. Insert the USB Flash drive containing the test records in the WRM's "USB MEM" port, and then start from the "START-UP" menu:



```
1.RUN TEST
2.TEST RECORDS
3.DIAGNOSTICS
4.SETUP
```

Press the **[2]** key (*TEST RECORDS*).

- b. The following screen will be displayed:



```
1.PRINT RECORD
2.DISPLAY RECORD
3.SAVE RECORD
4.RESTORE RECORD
5.RECORD DIRECTORY
6.ERASE RECORD
7.COPY TO THUMB DRIVE
```

Press the **[5]** key (*RECORD DIRECTORY*).

- c. The following screen will be displayed:



```
1.INTERNAL DIRECTORY
2.THUMB DRIVE DIR
```

Press the **[2]** key (*THUMB DRIVE DIR*). The directory listing will be printed on the thermal printer, and you will be returned to the "START-UP" menu. A sample directory listing printout is shown in Figure 13.

THUMB DRV DIR
THUMB DRV FILENAME: REC_004 DATE/TIME: 09/20/17 15:18:25 V1 & V2 TEST NUMBER OF TESTS: 3 STATION: LAB CIRCUIT: MFR: MODEL: WRM 10P S2 SER NO: 350004 KVA:
THUMB DRV FILENAME: REC_003 DATE/TIME: 09/20/17 15:17:15 V1 & V2 TEST NUMBER OF TESTS: 2 STATION: LAB CIRCUIT: MFR: MODEL: WRM 10P S2 SER NO: 350004 KVA:
THUMB DRV FILENAME: REC_002 DATE/TIME: 09/20/17 15:17:15 V1 & V2 TEST NUMBER OF TESTS: 2 STATION: LAB CIRCUIT: MFR: MODEL: WRM 10P S2 SER NO: 350004 KVA:
THUMB DRV FILENAME: REC_001 DATE/TIME: 09/20/17 15:17:15 V1 & V2 TEST NUMBER OF TESTS: 2 STATION: LAB CIRCUIT: MFR: MODEL: WRM 10P S2 SER NO: 350004 KVA:
THUMB DRV FILENAME: REC_000 DATE/TIME: 09/20/17 15:16:27 V1 ONLY TEST NUMBER OF TESTS: 3 STATION: LAB CIRCUIT: MFR: MODEL: WRM 10P S2 SER NO: 350004 KVA:

Figure 13. Typical USB Flash Drive Test Record Directory Printout

3.11.9. Erasing Test Records From the Unit's Internal Memory

Follow the steps below to erase an individual test record or all test records from the WRM's internal memory:

- a. Start from the "START-UP" menu:

```
1.RUN TEST
2.TEST RECORDS
3.DIAGNOSTICS
4.SETUP
```

Press the **[2]** key (*TEST RECORDS*).

- b. The following screen will be displayed:

```
1.PRINT RECORD
2.DISPLAY RECORD
3.SAVE RECORD
4.RESTORE RECORD
5.RECORD DIRECTORY
6.ERASE RECORD
7.COPY TO THUMB DRIVE
```

Press the **[6]** key (*ERASE RECORD*).

- c. The following screen will be displayed:

```
ERASE RECORD
1.ERASE SINGLE RECORD
2.ERASE ALL RECORDS
```



NOTE

The above screen will be displayed only if a USB Flash drive is NOT connected to the WRM's USB Flash drive port. If a USB Flash drive is connected, the following screen will be displayed:

```
1.ERASE INTERNAL REC
2.ERASE THUMB DRV REC
```

Press the **[1]** key (*ERASE INTERNAL REC*). The following screen will be displayed:

```
ERASE RECORD
1.ERASE SINGLE RECORD
2.ERASE ALL RECORDS
```

Continue with the steps below:

1. *ERASE SINGLE RECORD*

Press the **[1]** key (*ERASE SINGLE RECORD*) if you would like to erase a single test record. The following screen will be displayed:

```
ERASE RECORD
NUMBER:  _
```

Type the record number to be erased and press the **[ENTER]** key.



NOTES

- You can press the **[STOP]** key to cancel the process.
- If you do not know the record number, you can first print a test record directory using the instructions in section 3.11.7.

The test record will be erased, and the following confirmation screen will be displayed:

```
RECORD 003 ERASED!
```

Press any key to return to the "START-UP" menu.

2. *ERASE ALL RECORDS*

Press the **[2]** key (*ERASE ALL RECORDS*) if you would like to erase all the test records from the unit's internal memory. The following screen will be displayed:




ERASE ALL RECORDS?
Are you SURE?

"ENTER" TO CONTINUE

**NOTE**

You can press the **[STOP]** key to cancel the process. Any test records that are erased **CANNOT** be recovered!

Press the **[ENTER]** key to continue with the erasure process. All test records will be deleted from the unit's internal memory, and the following screen will be displayed:



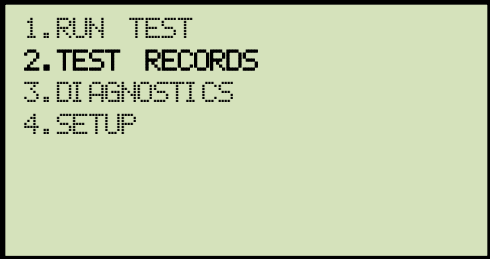
RECORDS ERASED!

Press any key to return to the "START-UP" menu.

3.11.10. Erasing Test Records From a Connected USB Flash Drive

Follow the steps below to erase an individual test record or all test records from a connected USB Flash drive:

- a. Insert the USB Flash drive containing the test records in the WRM's "USB MEM" port, and then start from the "START-UP" menu:



```
1.RUN TEST
2.TEST RECORDS
3.DIAGNOSTICS
4.SETUP
```

Press the **[2]** key (*TEST RECORDS*).

- b. The following screen will be displayed:



```
1.PRINT RECORD
2.DISPLAY RECORD
3.SAVE RECORD
4.RESTORE RECORD
5.RECORD DIRECTORY
6.ERASE RECORD
7.COPY TO THUMB DRIVE
```

Press the **[6]** key (*ERASE RECORD*).

- c. The following screen will be displayed:



```
1.ERASE INTERNAL REC
2.ERASE THUMB DRV REC
```

Press the **[2]** key (*ERASE THUMB DRV REC*).

d. The following screen will be displayed:

```
      ERASE RECORD
1.ERASE SINGLE RECORD
2.ERASE ALL RECORDS
```

1. ERASE SINGLE RECORD

Press the **[1]** key (*ERASE SINGLE RECORD*) if you would like to erase a single test record from the USB Flash drive. The following screen will be displayed:

```
      ERASE THUMB DRIVE
      REC_    _
```

Type the test record number to be erased and press the **[ENTER]** key.



NOTES

- You can press the **[STOP]** key to cancel the process.
- If you do not know the record number, you can first print a test record directory using the instructions in section 3.11.8.

The test record will be erased, and the following confirmation screen will be displayed:

```
THUMB DRIVE REC_001
ERASED!
```

Press any key to return to the "START-UP" menu.

2. ERASE ALL RECORDS

Press the **[2]** key (*ERASE ALL RECORDS*) if you would like to erase all of the test records from the USB Flash drive. The following screen will be displayed:



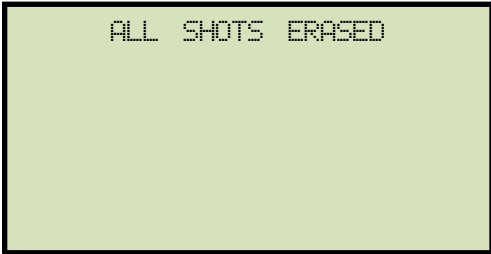
ERASE ALL RECORDS?
Are you SURE?

"ENTER" TO CONTINUE

**NOTE**

You can press the **[STOP]** key to cancel the process. Any test records that are erased **CANNOT** be recovered!

Press the [ENTER] key to continue with the erasure process. All test records will be deleted from the connected USB Flash drive, and the following screen will be displayed:



ALL SHOTS ERASED

Press any key to return to the "START-UP" menu.

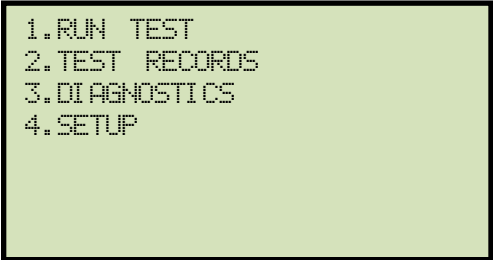
4.0 WRM-10P S2 SPECIAL FEATURES

4.1 Bypassing the Resistance Reading Delay

When the WRM first applies the test voltage to the transformers winding, the current is increased slowly until the transformer's winding reaches saturation. During this period, the resistance value varies substantially and the readings may appear unstable to the operator. The WRM has a built-in 3 minute delay between the start of the test and when the resistance value is displayed on the LCD. This feature eliminates the possibility of early erroneous readings. Depending on the transformer size, the delay may be shorter or longer than 3 minutes.

The operator can bypass this delay and observe the test results immediately. To bypass this delay:

Start at the "START-UP" menu:



```
1.RUN TEST
2.TEST RECORDS
3.DIAGNOSTICS
4.SETUP
```

Press the numbers **[9]**, **[8]**, and **[7]** in sequence. The following screen will be displayed momentarily:



```
QUICK DISPLAY MODE
SET!
```

You will then be returned to the "START-UP" menu.

Once the Quick Display Mode has been set, the WRM will display resistance values as soon as measurements are made. This bypass setting will remain active until the unit is turned off. When the unit is turned on again, it will use the default 3 minute delay before displaying resistance values.

4.2 Converting Resistance Measurements

The WRM can convert the resistance reading of the device under test at its present temperature to the equivalent resistance value at a different temperature. The conversion is accomplished by the following formula:

$$Rs = \frac{Rm (Ts + Tk)}{(Tm + Tk)}$$

Where:

Rs is the resistance at desired temperature

Rm is the measured resistance

Ts is the desired reference temperature

Tm is the temperature at which the resistance was measured

Tk is the winding material constant

Tk = 234.5 for copper

Tk = 240.0 for aluminum

5.0 Troubleshooting Guide

PROBLEM DESCRIPTION	Probable Cause	Suggested Solution
No current displayed on the LCD screen when performing a test.	<ul style="list-style-type: none">• Opened current cable connection.• Opened transformer windings.	<ul style="list-style-type: none">• Check current cable connection.• Perform a quick test using a shunt or a piece of aluminum bar.
Resistance reading is zero or invalid while current value is displayed on the LCD screen.	<ul style="list-style-type: none">• Opened sense leads connection.• Sense leads problem.	<ul style="list-style-type: none">• Check sense leads connection to D.U.T.• Check sense leads using an ohmmeter.• Perform a diagnostic test. See section 3.10.



1520 S. Hellman Ave • Ontario, CA 91761 • USA

Phone: 909-923-9390 • Fax: 909-923-9391

www.vanguard-instruments.com

Copyright © 2017 by Vanguard Instruments, a Doble Company

WRM-10P S2 User's Manual • Revision 1.0 • October 5, 2017 • TA