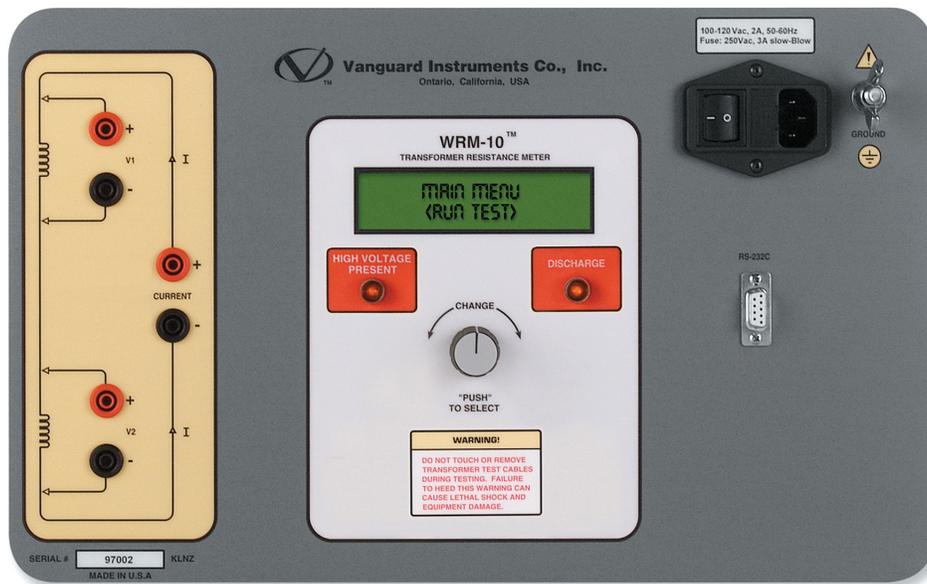


WRM-10TM

TRANSFORMER WINDING RESISTANCE METER

USER'S MANUAL



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SAFETY SUMMARY

FOLLOW EXACT OPERATING PROCEDURES

Any deviation from the procedures described in this User's Manual may create one or more safety hazards, may damage the WRM-10, damage the test transformer, or cause errors in the test results. Vanguard Instruments Company, Inc. assumes no liability for unsafe or improper use of the WRM-10.

All safety precautions provided in this manual must be observed during all phases of testing including test preparation, test lead connection, actual testing, and test lead disconnection.

SAFETY WARNING AND CAUTIONS

The WRM-10 shall be used only by **trained operators**. All transformers under test shall be **off-line** and **fully isolated**.

DO NOT MODIFY TEST EQUIPMENT

To avoid the risk of introducing additional or unknown hazards, do not install substitute parts or perform any unauthorized modification to any WRM-10 test unit. To ensure that all designed safety features are maintained, it is highly recommended that repairs be performed only by Vanguard Instruments Company factory personnel or by an authorized repair service provider. Unauthorized modifications can cause safety hazards and will void the manufacturer's warranty.

WARNING

Do not remove test leads during a test. Failure to heed this warning can result in lethal electrical shock to personnel and damage to the equipment.

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CONVENTIONS USED IN THIS DOCUMENT

This document uses the following conventions:

- The WRM-10's control knob is referenced as **[CONTROL KNOB]**
- Menu names are referenced as "MENU NAME"
- WRM-10 LCD screen output is shown as:

```
MAIN MENU
<RUN TEST>
```

- Warning messages are indicated as:



Warning message

WARNING

- Important notes are indicated as:



Note details

NOTE

1.0 INTRODUCTION

1.1 General Description and Features

The WRM-10 is 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. Four-wire (Kelvin) connections provide high accuracy voltage reading and require no lead compensation. The WRM-10 provides stable resistance readings of very large transformers by utilizing a 36 Vdc 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.

Since the WRM-10 can accurately measure resistances ranging from 1 micro-ohm to 2,000 ohms, it can also be used to measure EHV circuit-breaker contact resistance, motor winding resistance, or any low resistance. In addition to measuring the resistance value, the WRM-10 also checks the "make-before-break" tap-switching sequences of voltage regulators and load tap changers.

The WRM-10 is furnished with three 50-foot test cables, a ground cable, a power cord, and a cable carrying bag. Each test cable lead is terminated with a quick-disconnect test clip.

1.2 Functional Description

The WRM-10's operation is based on the electrical relationship described by Ohm's law: $R=V/I$, where I is a known current and V is the DC voltage measured across the unknown resistance. The value of the unknown resistance is calculated by dividing the measured voltage by the current which is calculated by the microprocessor. Calculated resistance readings are then displayed on the unit's back-lit LCD screen.

A special current source allows the WRM-10 to output up to 10 Amperes of test current. The test current is automatically adjusted depending on the load resistance. For added safety, the current source circuit is thermally protected. Also, a built-in discharge circuit automatically discharges the stored energy in the transformer at the end of each test.

1.3 Technical Specifications

Table 1. WRM-10 Technical Specifications

TYPE	Portable transformer winding resistance meter
PHYSICAL SPECIFICATIONS	16.8"W x 12.6"H x 10.6"D (42.6 cm x 32.0 cm x 27 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: $\pm 0.5\%$ reading, ± 1 count 20 – 999 milli-ohms: $\pm 1\%$ reading, ± 1 count; 1 – 2,000 ohms: $\pm 1.5\%$ reading, ± 1 count
TEST VOLTAGE	36 Vdc max
TEST CURRENT RANGE	Auto range, 10 Amperes max
DISPLAY	Back-lit LCD Screen (16 characters by 2 lines); viewable in bright sunlight and low-light levels
CONTROL	Single "turn-and-push" knob
COMPUTER INTERFACE	RS-232C port (19,200 baud) used for factory calibration and diagnostics
SAFETY	Designed to meet IEC61010 (1995), UL61010A-1, CSA-C22.2 standards
ENVIRONMENT	Operating: -10°C to 50°C (15°F to $+122^{\circ}\text{F}$); Storage: -30°C to 70°C (-22°F to $+158^{\circ}\text{F}$)
CABLES	Three 50-foot test cables, ground cable, power cord and cable bag
OPTIONS	Transportation 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.

1.4 WRM-10 Controls and Indicators

The WRM-10's controls and indicators are shown in Figure 1 below. A leader line with an index number points to each control and indicator, which is cross-referenced to a functional description in Table 2. The table describes the function of each item on the control panel. The purpose of the controls and indicators may seem obvious, but users should become familiar with them before using the WRM-10. 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.

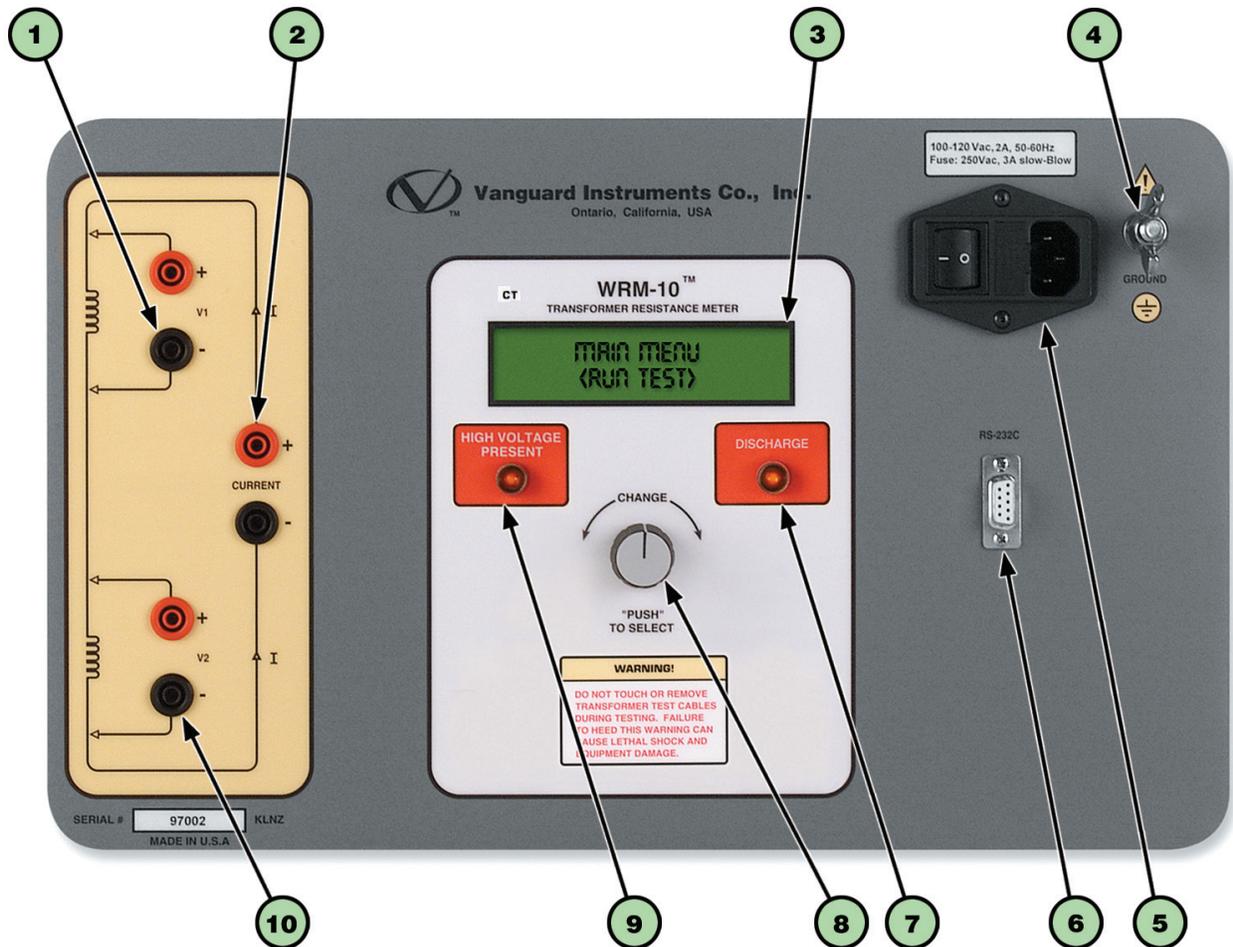


Figure 1. WRM-10 Controls and Indicators

Table 2. Functional Descriptions of WRM-10 Controls and Indicators

Item Number	Panel Markings	Functional Description								
1	V1	Voltage sensing input channel #1. Female connector jacks used for connecting voltage-sensing test leads.								
2	I	Current output. Female connector jacks used for connecting current test leads.								
3	None	Back-lit LCD screen (16 characters by 2 lines); viewable in bright sunlight and low-light levels.								
4	GROUND	Safety ground terminal. 5/16-18 threaded stud with hand-turned wing nut. This must be connected to the station ground before connecting any WRM-10 test leads to the transformer.								
5	100-120 Vac, 2A, 50-60 Hz Fuse: 250 Vac, 3A Slow-Blow	Input power connector with third-wire safety ground. On/Off rocker toggle switch with built-in fuse protection.								
6	RS-232C	9-pin RS-232C interface port; female DB type. Data rate is set to 19,200 baud, 1 start bit, 2 stop bits, 8 data bits and no parity bit. <table border="1" data-bbox="565 764 922 909"> <thead> <tr> <th>Pin</th> <th>Signal</th> </tr> </thead> <tbody> <tr> <td>2</td> <td>RX</td> </tr> <tr> <td>3</td> <td>TX</td> </tr> <tr> <td>5</td> <td>Signal Ground</td> </tr> </tbody> </table>	Pin	Signal	2	RX	3	TX	5	Signal Ground
Pin	Signal									
2	RX									
3	TX									
5	Signal Ground									
7	DISCHARGE	Red LED indicator light. This warning indicator is lit when the WRM-10 is discharging the stored energy in the transformer. Do NOT disconnect the test leads when this light is on. Failure to heed this warning can result in shock and/or fatal injury to personnel.								
8	CHANGE "PUSH" TO SELECT	Single turn-and-press control knob used to operate the WRM-10. You can scroll through different menu options by turning this knob, and you can select a function by pressing the knob.								
9	HIGH VOLTAGE PRESENT	Red LED indicator light. This warning light is illuminated when there is a possibility of high voltage across the test leads. Do NOT disconnect the test leads when this light is on. Failure to heed this warning can result in shock and/or fatal injury to personnel.								
10	V2	Voltage input sensing channel #2. Female connector jacks used for connecting voltage-sensing test leads.								

2.0 PRE-TEST SETUP

2.1 Operating Voltages

The WRM-10'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. The voltage is set by placing jumper(s) on the power terminal block as listed in Table 3 and illustrated in Figure 2 and Figure 3. The relay must also be changed if the voltage settings are changed. Please see Figure 4 for the location of the relay.

Table 3. Voltage Selection Jumper Settings

Voltage Selection	Terminal Block Jumpers	Relay Part Number
100 – 120 Vac	Brown to Blue and Yellow to Green	HE2aN-Q-AC120V
200 – 240 Vac	Blue to Yellow	HE2aN-Q-AC-240V

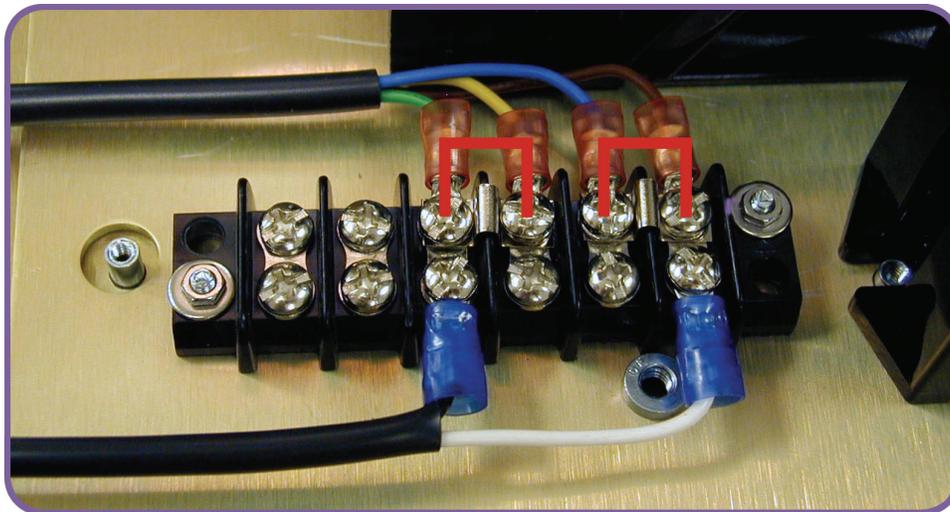


Figure 2. 100 – 120 Vac Jumper Settings

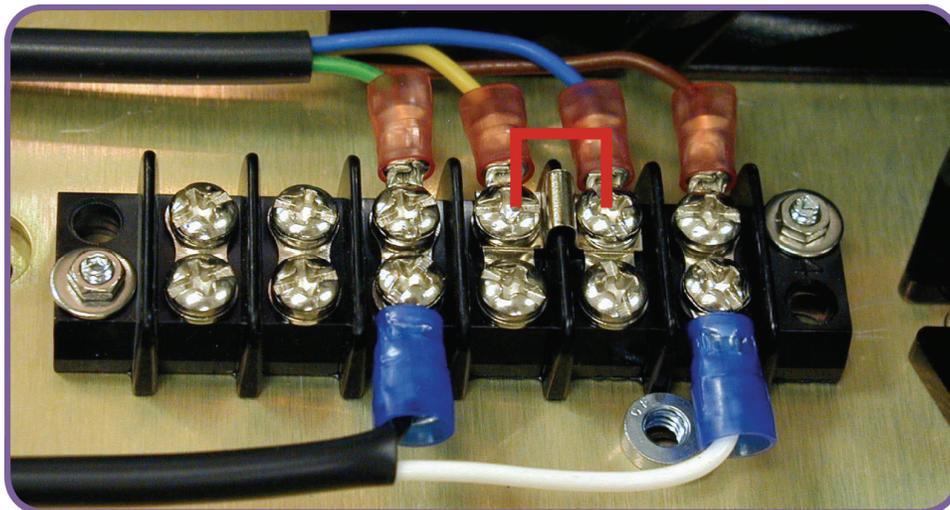


Figure 3. 200 – 240 Vac Jumper Settings



Figure 4. Relay Location

2.2 LCD Screen Contrast Control

To adjust the LCD screen's contrast:

- a. Start from the "MAIN MENU":

```
MAIN MENU
<RUN TEST>
```

Turn the **[CONTROL KNOB]** till the following screen is displayed:

```
MAIN MENU
<ADJ CONTRAST>
```

Press the **[CONTROL KNOB]**.

- b. The following screen will be displayed:

```
ADJ CONTRAST
"PUSH" = DONE
```

Turn the **[CONTROL KNOB]** clockwise to increase the contrast (darken the screen).

Turn the **[CONTROL KNOB]** counter-clockwise to decrease the contrast (lighten the screen).

Press the **[CONTROL KNOB]** when you are done adjusting the contrast level. You will be returned to the "MAIN MENU".

3.0 OPERATING PROCEDURES

3.1 WRM-10 Cable Connections

Typical WRM-10 connections diagrams are shown in Figure 5 and Figure 6. A typical dual winding connections diagram is shown in Figure 7.



WARNING

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.

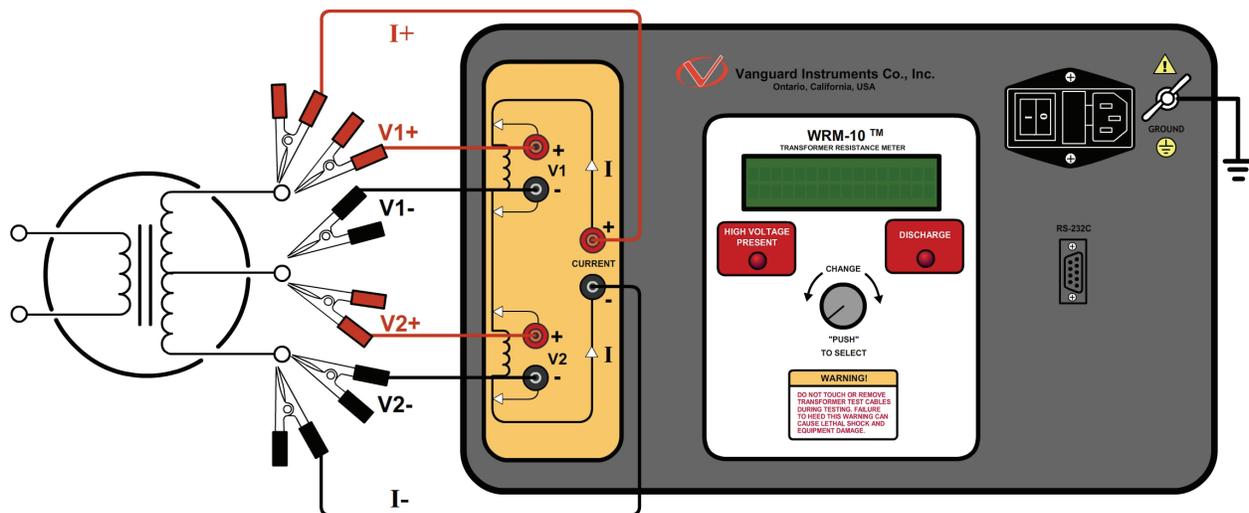


Figure 5. Typical WRM-10 Connections Diagram #1



WARNING

Disconnect the test clips from the transformer bushing only after the WRM-10 has completely discharged the transformer. Always disconnect the test clips slowly from the transformer bushing to prevent an accidental flash-over.

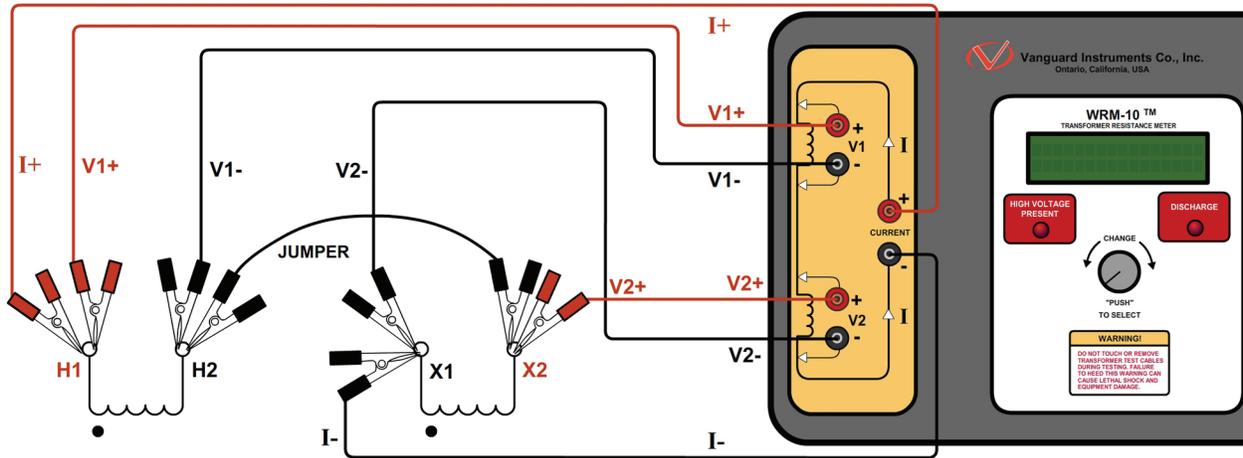


Figure 6. Typical WRM-10 Connections Diagram #2



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.

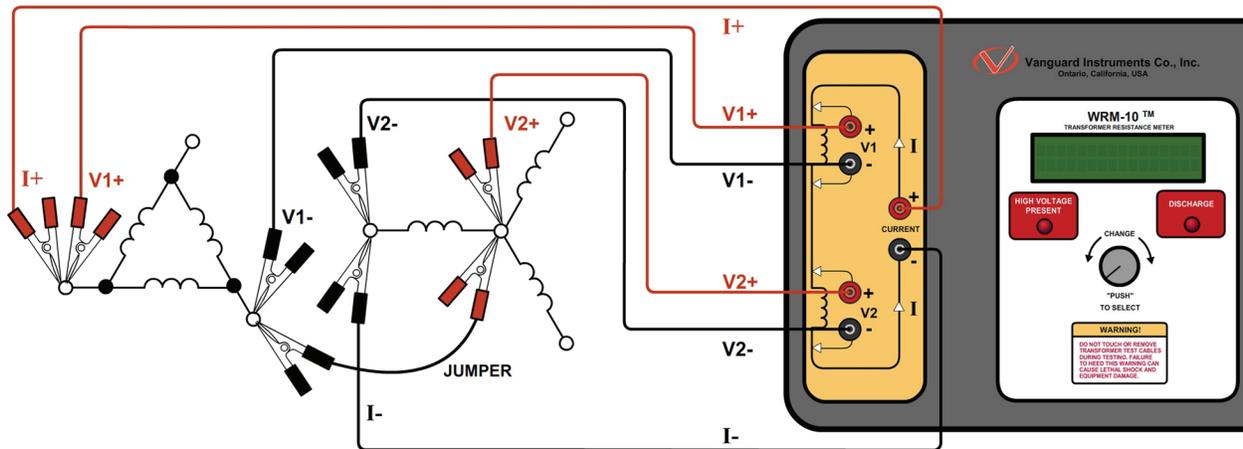


Figure 7. Typical Dual Winding Connections Diagram

3.2 General Procedures

The main steps for using the WRM-10 are outlined below:

- a. Ground the WRM-10 to the substation ground.



WARNING

Always connect the WRM-10 to the substation ground before connecting any test lead to any transformer bushing. Failure to follow this procedure may damage the WRM-10.

- b. Plug the WRM-10 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-10 by pressing **[I]** on the power rocker switch.
- f. The unit will self-calibrate, and then you will be presented with the "MAIN MENU" as shown below:

```
MAIN MENU
<RUN TEST>
```

3.3 Performing Transformer Tests

3.3.1. Performing a Single Resistance Test

- a. Start from the "MAIN MENU":

```
MAIN MENU
<RUN TEST>
```

Press the **[CONTROL KNOB]**.

- b. The following screen will be displayed:

```
RUN TEST
<V1 & V2>
```

Turn the **[CONTROL KNOB]** till the following screen is displayed:

```
RUN TEST
<V1 ONLY>
```

Press the **[CONTROL KNOB]**.

- c. The following screen will be displayed:

```
FLASH-OVER IF
CABLES REMOVED!
```

Press the **[CONTROL KNOB]**.

- d. The following screen will be displayed:

```
"PRESS" TO START
"TURN" TO ABORT
```

Press the **[CONTROL KNOB]** to start the test. You can abort the test by turning the **[CONTROL KNOB]**.

- e. The following screen will be displayed:

```
⚡ *XFMR CHARGING ⚡
```

The above screen will continue to display while the WRM-10 is performing the test (the lightning bolts will be flashing). When the WRM-10 has determined that the resistance readings are stable, the test results will be displayed as shown:

```
R1 = 10.0 mΩ
R2 = 10.5 mΩ
```

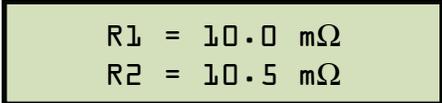
The WRM-10 will continue to apply the test voltage on the transformer's windings and update the resistance values on the LCD screen. Press the **[CONTROL KNOB]** to stop the test.

- f. The WRM-10 will automatically discharge the transformer and display the following screen during the discharging process:



DISCHARGE XFMR!
PLEASE WAIT...

After the transformer is discharged, the test results will be displayed on the screen as shown:



R1 = 10.0 mΩ
R2 = 10.5 mΩ

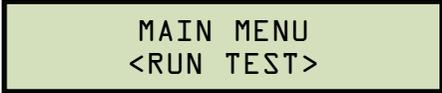
Press the **[CONTROL KNOB]**. You will be returned to the "MAIN MENU".

3.3.2. Performing a Voltage Regulator Test

The Voltage Regulator Test verifies that a regulating switch in a primary voltage tap regulator changes contacts through its selection range without a break in the circuit. This test is important because in actual use, any break in the current in a regulating tap switch generates large reactive voltage spikes that are hazardous and may exceed the switch's voltage ratings, thus causing irreparable damage. By connecting the WRM-10's continuity test input across the switching input and running the regulator switch through all the contacts in its range, any break in continuity caused by faulty tap switching can be detected.

To perform a voltage regulator test:

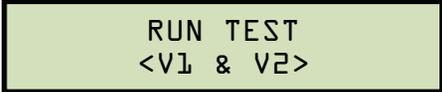
- a. Start from the "MAIN MENU":



```
MAIN MENU
<RUN TEST>
```

Press the **[CONTROL KNOB]**.

- b. The following screen will be displayed:



```
RUN TEST
<V1 & V2>
```

Turn the **[CONTROL KNOB]** till the following screen is displayed:



```
RUN TEST
<VTG REG>
```

Press the **[CONTROL KNOB]**.

- c. The following screen will be displayed:



```
FLASH-OVER IF
CABLES REMOVED!
```

Press the **[CONTROL KNOB]**.

- d. The following screen will be displayed:



```
VTG REG TEST
"PUSH" TO START
```

Press the **[CONTROL KNOB]** to start the test.

- e. The following screen will be displayed while the test is being performed:



After the transformer has been charged, the following screen will be displayed:



Run the voltage regulator tap switch.

- f. If no transient is detected as the taps are switching:
1. The screen display will not change
 2. Turn or press the **[CONTROL KNOB]** to end the test. The following screen will be displayed:



If a switch break is detected:

1. The following message will be displayed:



2. Turn or press the **[CONTROL KNOB]** to end the test.

3.4 User Diagnostic Mode

The user diagnostic mode can be used to monitor the V1 and V2 voltages and the test current on the WRM-10's LCD screen. To use the WRM-10 in user diagnostic mode:

- a. Connect the WRM-10 to the test transformer, and then start from the "MAIN MENU":

```
MAIN MENU
<RUN TEST>
```

Turn the **[CONTROL KNOB]** till the following screen is displayed:

```
MAIN MENU
<USER DIAG>
```

Press the **[CONTROL KNOB]**.

- b. The following screen will be displayed:

```
RUN TEST
<V1 & V2>
```

Turn the **[CONTROL KNOB]** till the following screen is displayed:

```
FLASH-OVER IF
CABLES REMOVED!
```

Press the **[CONTROL KNOB]**.

- c. The following screen will be displayed:

```
"PRESS" TO START
"TURN" TO ABORT
```

Press the **[CONTROL KNOB]** to start the test.

- d. The following screen will be displayed momentarily:

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

The WRM-10 will then alternate between displaying the following screens:

```
V1 = 1.03V
I = 00.005A
```

```
V2 = 1.03V
I = 00.005A
```

- e. Press or turn the **[CONTROL KNOB]** to end the test. You will be returned to the "MAIN MENU".



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