TRM-20 and TRM-40
TRANSFORMER RESISTANCE METERS

USER'S MANUAL

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SAFETY SUMMARY

NOTICE

This manual applies to both the TRM-20 and TRM-40 transformer resistance meters. The operating procedures are virtually the same for both models, and any differences are clearly described where applicable.

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 TRM-20/40, 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 TRM-20/40.

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 TRM-20/40 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 TRM-20/40 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 electrical shock to personnel and damage to the equipment.

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CONVENTIONS USED IN THIS DOCUMENT

This document uses the following conventions:

- Both the TRM-20 and TRM-40 are simply referred to as "TRM" in this manual. The exact model number is used only in cases where differences between the units are discussed.

- A key, switch, or knob on the TRM is indicated as **[KEY]**, **[SWITCH]**, **[KNOB]**.

- Menu names are referenced as "MENU NAME"

- TRM LCD screen output is shown as:

```
1. OPTION 1
2. OPTION 2
3. OPTION 3
4. OPTION 4
5. OPTION 5
```

- When instructions are provided, the menu item that should be selected is printed in bold as shown below (option 3 should be selected in this example):

```
1. OPTION 1
2. OPTION 2
3. OPTION 3
4. OPTION 4
5. OPTION 5
```

- 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 TRM-20 and TRM-40 are Vanguard Instruments' third generation transformer winding resistance meters. The TRM line is designed specifically to measure DC resistance values of transformer windings, rotating machine windings, or any dc resistance of an inductive device. The TRM line features dual resistance-reading input channels that can measure two winding resistances simultaneously (primary and secondary windings of a transformer).

Both the TRM-20 and TRM-40 can provide a fast and stable reading of very large transformers by utilizing a 60Vdc power supply. The TRM-20 is capable of outputting a selectable test current from 1A to 20A while the TRM-40's test current is selectable from 1A to 40A.

Since the TRM-20 and TRM-40 can accurately measure resistance values from 1 micro-ohm to 2,000 Ohms, they can be used as micro-ohm meters to measure EHV circuit breaker contact resistance, or for any low resistance measuring application.

If the transformer winding resistance temperature is available at the time of testing, the TRM can calculate the equivalent resistance value at any temperature value. This useful feature allows the user to compare the field readings against the factory test resistance values.

A special test mode allows the TRM to collect data automatically for up to 90minutes (at 60-second sampling interval) or 45 minutes (at 30 second sampling interval). Test data is recorded with a time stamp.

All test results can be printed on a 2.5" wide thermal printer. Test record header information including the company, substation name, transformer information can also be entered using the 16-key key pad.

The TRM-20 and TRM-40 can also demagnetize the inductive device under test, eliminating the manual task of demagnetizing the transformer core after a resistance test.

The TRM also has a "make-before-break" test mode that can be used to test the load tap changer (LTC) or voltage regulator test sequence. The TRM produces a "Dynamic-Resistance" graph of the LTC or voltage regulator contact under operation. An opened contact can be detected visually from this resistance chart.

The TRM's built-in LTC/Voltage regulator can be used to change the LTC/Voltage regulator tap position from the TRM front panel.

Safety Features

The TRM automatically dissipates the energy stored in the transformer at the end of each test. The discharge circuit will continue to work even if the TRM power supply is lost.

Test Record Storage

The TRM can store up to 100 test records internally. For external test record storage, the TRM features a USB Flash drive interface port. Up to 999 test records can be stored on a connected USB Flash drive.

User Interface

The TRM features a back-lit graphic LCD screen (124x64) that is clearly viewable in both bright sunlight and low-light levels. An alpha-numeric keypad is used to enter test information and to operate the unit.

Computer Interfaces

The TRM can be connected to a PC via the unit's RS-232C, USB, or Bluetooth interface. A PC can be used to retrieve test records (stored in the TRM or USB Flash drive) or to run tests using the provided software. Test records are automatically exported to PDF, Excel, and XML formats.

1.2   Technical Specifications

Table 1. TRM-20/40 Technical Specifications

TYPE	Portable transformer winding resistance meter
PHYSICAL SPECIFICATIONS	21" W x 17" H x 9" D (53 cm x 43 cm x 24 cm); Weight: 33 lbs (15.4Kg)
OPERATING VOLTAGE	100-240 Vac, 50/60 Hz
RESISTANCE READING RANGE	1 micro-ohm – 2000 Ohms (TRM-20); 1 micro-ohm to 500 Ohms (TRM-40)
ACCURACY	1 – 19,999 micro-ohms: ±0.5% reading, ±1 count; 20 – 999 milliohms: ±1% reading, ±1 count; 1 -2000 Ohms: ±1.5% reading, ±1 count
TEST CURRENT	1-20A in 1A increments (TRM-20); 1-40A in 1A increments (TRM40)
TEST VOLTAGE	60Vdc charging, 18V DC max during measurement
RESISTANCE CHANNELS	Two static resistance reading channels
DISPLAY	Back-lit LCD (64 x 128 dot graphic), viewable in direct sunlight and low light levels
PRINTER	Built-in 2.5" wide thermal printer
INTERNAL TEST RECORD STORAGE	100 test records. Each record can contain up to 99 readings.
EXTERNAL TEST RECORD STORAGE	Up to 999 test records on external USB Flash drive.
COMPUTER INTERFACES	RS-232C, USB, and Bluetooth
SAFETY	Designed to meet UL 61010A-1 and Can/CSA C22.2 No 1010.1092 standards
ENVIRONMENT	Operating: -10˚C to 50˚ C (15˚F to +122˚ F); Storage: -30˚ C to 70˚ C (-22˚F to +158˚ F)
HUMIDITY (MAX)	90% RH @ 40° C (104° F) non-condensing
ALTITUDE (MAX)	2000m (6562 ft) to full safety specifications
CABLES	One 50-foot current cable set, two 50-foot resistance sense cable set, one LTC control cable, one ground cable, one power cord, One RS-232C cable, one USB cable
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.

1.3   TRM Controls and Indicators

The TRM-20/40'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 TRM. 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.
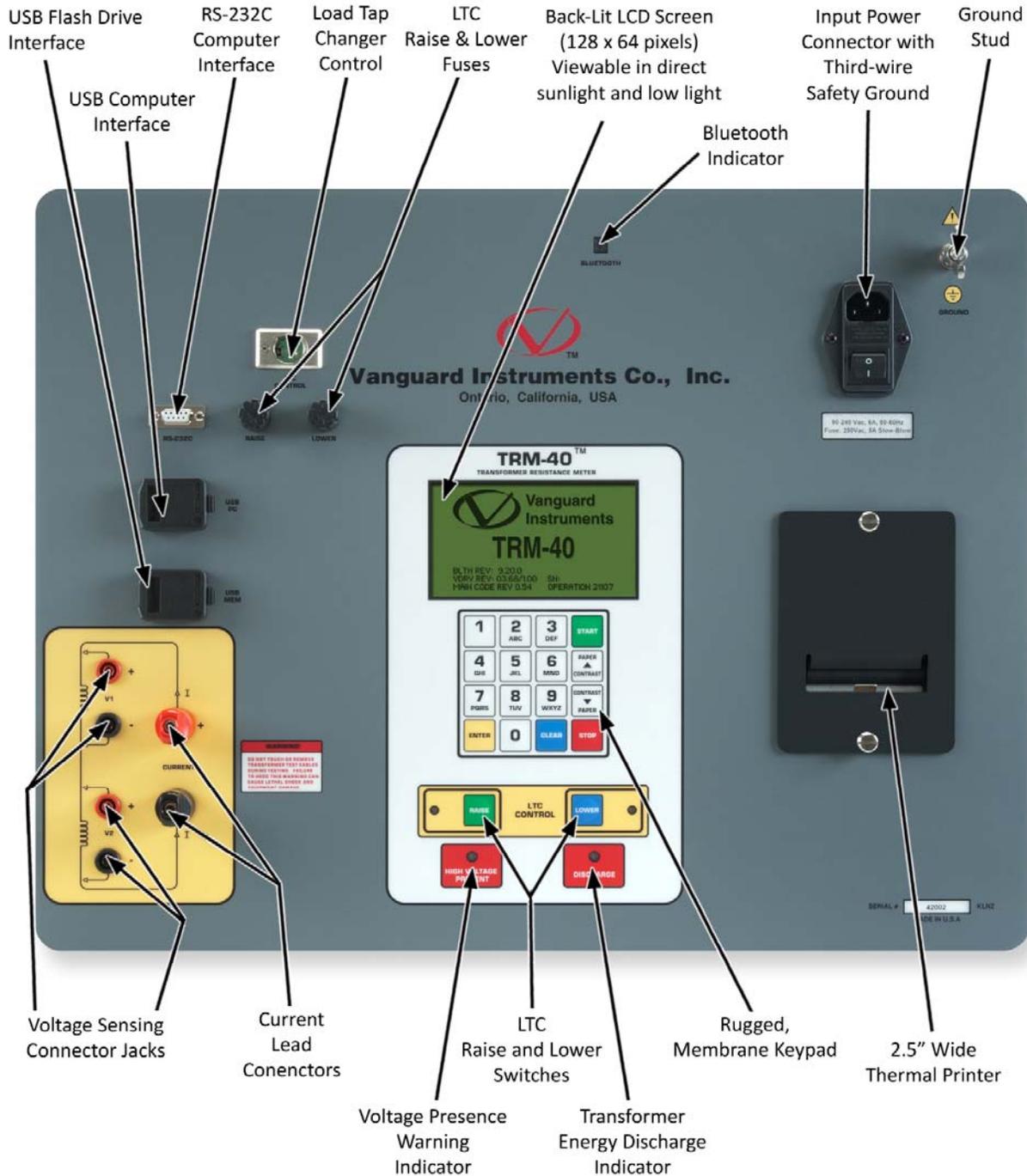
Figure 1. TRM-20/40 Controls and Indicators

2.0 PRE-TEST SETUP

2.1 Operating Voltages

The TRM's operating voltages are 90-240 Vac, 50/60 Hz.

2.2 LCD Screen Contrast Control

To increase the LCD screen contrast, press and hold the **[PAPER ∧ Contrast]** key for two seconds.

To decrease the LCD screen contrast, press and hold the **[PAPER ∨ Contrast]** key for two seconds.

2.3 Printer Paper Control

To advance the TRM printer paper, press and release the **[PAPER ∧ Contrast]** key.

To retract the TRM printer paper, press and release the **[PAPER ∨ Contrast]** key.

2.4 Printer Paper

The TRM's built-in thermal printer uses 2.5-inch 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 Company is highly recommended. Additional paper can be ordered from the following sources:

Vanguard Instruments Co, Inc.
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   Configuring the LTCA Software for use with the TRM

The TRM can be used with a PC using the Vanguard LTCA software. Follow the steps below to properly connect the TRM and configure the LTCA application to recognize the unit.

a. Install the LTCA software (please see the LTCA software user's manual for details).

b. Connect the TRM to the PC by connecting a USB cable from an open USB port on the PC to the unit's "USB PC" port.

c. Turn on the power on the TRM.

d. If this is the first time you are connecting the unit to the PC, Windows will recognize it as a new device and automatically install necessary drivers. If using Windows XP, you may be prompted to install drivers. Select the automatic installation option and Windows will locate the generic drivers necessary.

e. Please note that although the unit is connected via USB, it uses an internal serial interface to communicate with the PC. As such, it will appear in the windows Device Manager as a USB Serial Port. Open the Device Manager from the Windows Control Panel and note the COM port number. For example, in the installation shown below, the TRM is shown as COM10 (USB Serial Port).
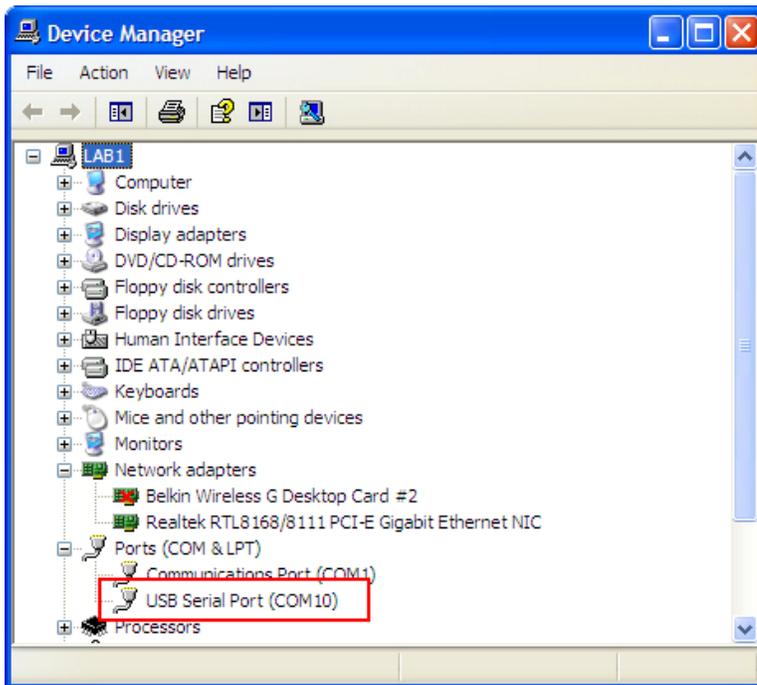
f. Launch the LTCA application and then click on the "Settings" icon. The following window will be displayed:
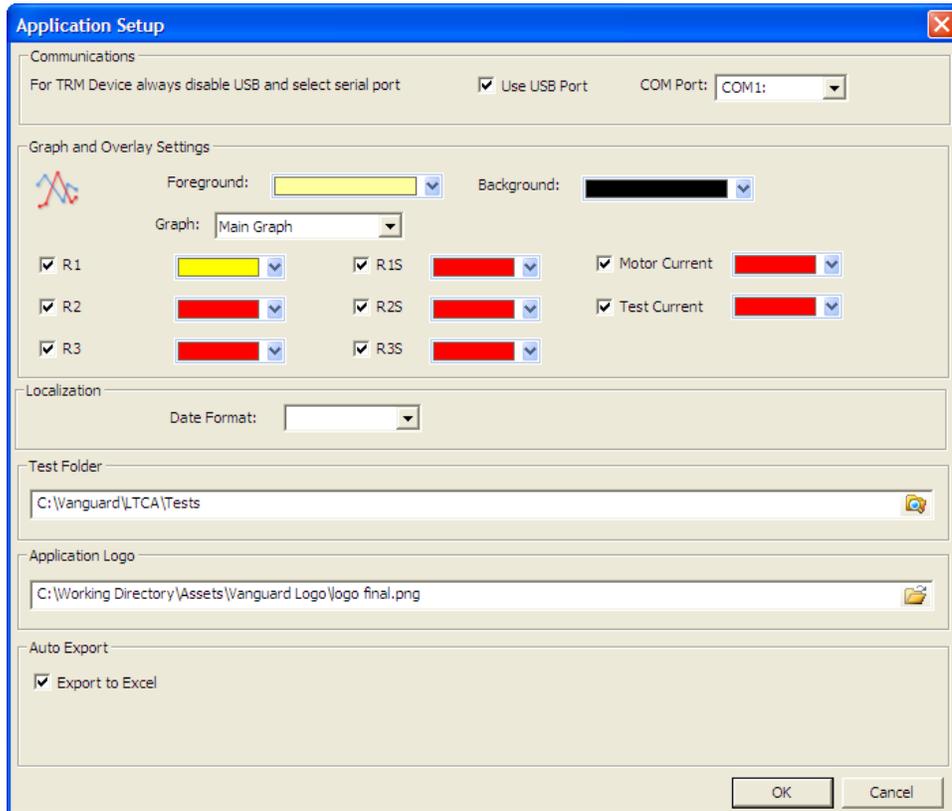
Make sure the "User USB Port" is UN-checked. Then, from the "COM Port" drop-down menu, select the COM port that corresponds to the port that the TRM is connected to. Then click the OK button. The LTCA software will now recognize the TRM.

3.2   Connecting the TRM to a PC via Bluetooth

The TRM can also be connected wirelessly to a PC using Bluetooth. To connect the unit via Bluetooth, it must first be paired with the PC. Follow the steps below to pair the TRM to a PC via Bluetooth:

For Windows XP:

a. Make sure the TRM is turned on. Then double click on the Bluetooth system tray icon (on the bottom right corner of your computer screen):

b. The "My Bluetooth Places" window will be displayed:
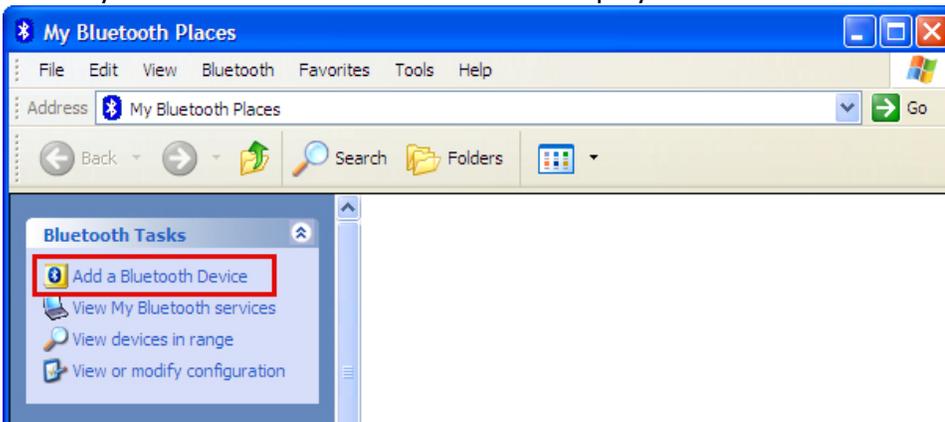
Click on "Add a Bluetooth Device" on the left window pane.

c. The Bluetooth Setup Wizard window will be displayed. Click on the "Next" button. The PC will scan for nearby devices and list all available Bluetooth devices:
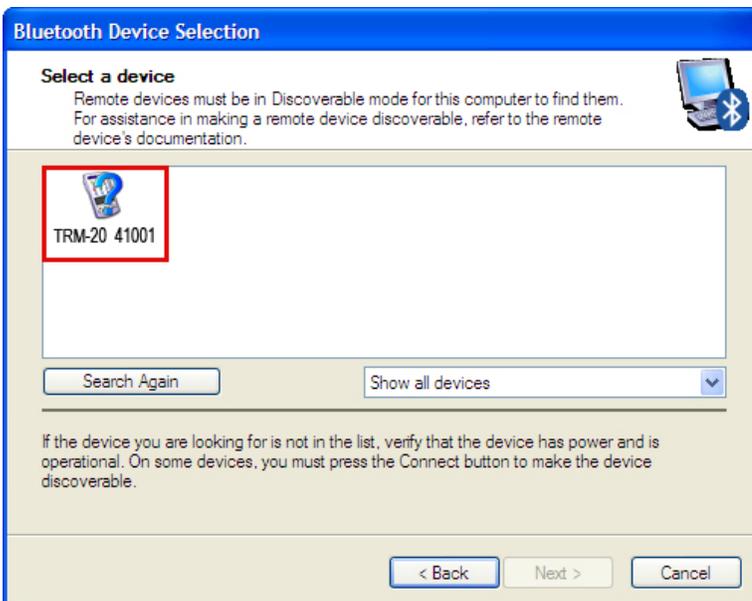
The TRM will be listed as "TRM S/N" where S/N is the device's serial number. Click on the icon for the TRM and then click on the "Next" button.

d. The following window will be displayed asking for a secret key to connect to the TRM:
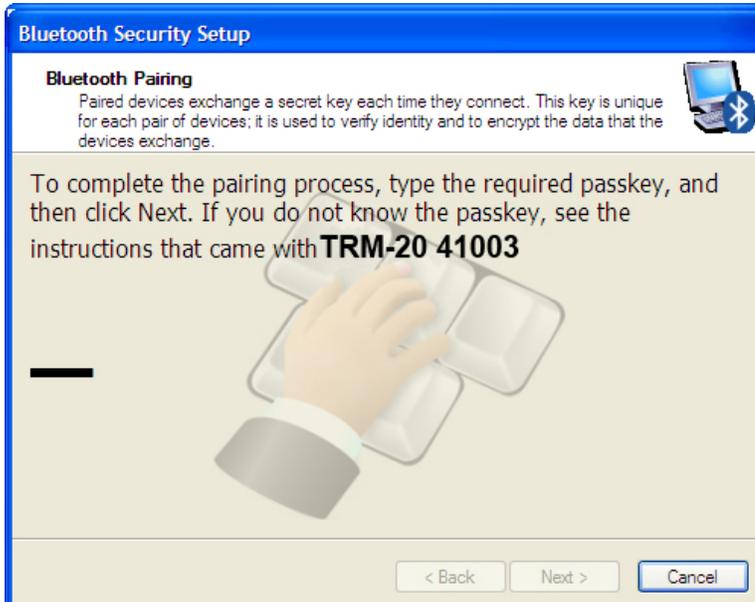
Type the word "default" (without the quotes and in all lower-case) and then click on the "Next" button.

e. The following window will be displayed with the option to connect to the TRM as a serial port:
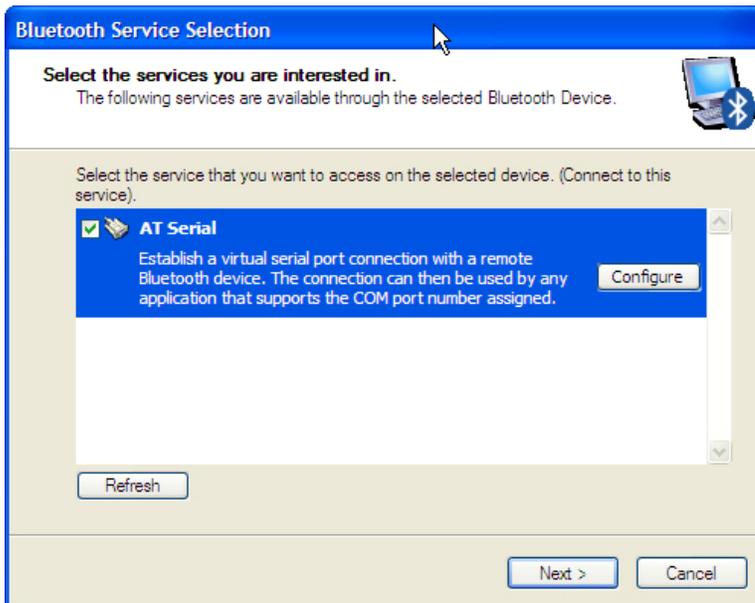
Make sure to check the box next to "AT Serial" and then click on the "Next" button.

f. The following confirmation screen will be displayed:

Click on the "Finish" button.

g. The TRM-20 will now be displayed in the "My Bluetooth Places" window:
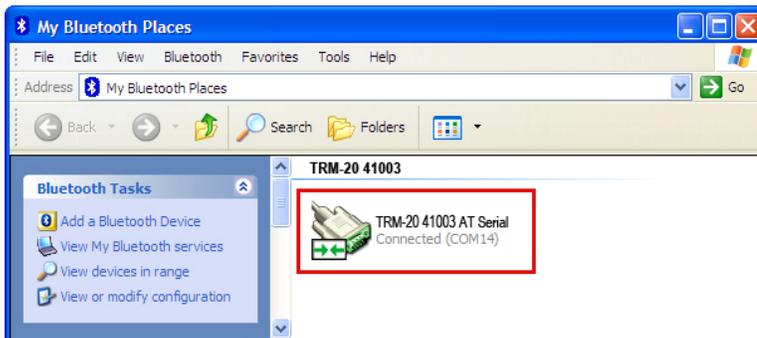
Note the port number listed under the device name. In the above case, the port number is COM14. Use this port number in the LTCA software to connect to the TRM.

For Windows 7:

a. Make sure the TRM is turned on. Then double click on the Bluetooth system tray icon (on the bottom right corner of your computer screen):
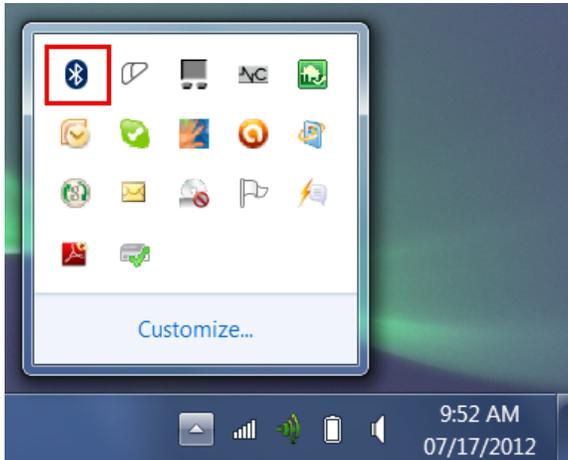
b. The "Bluetooth Devices" window will be displayed:
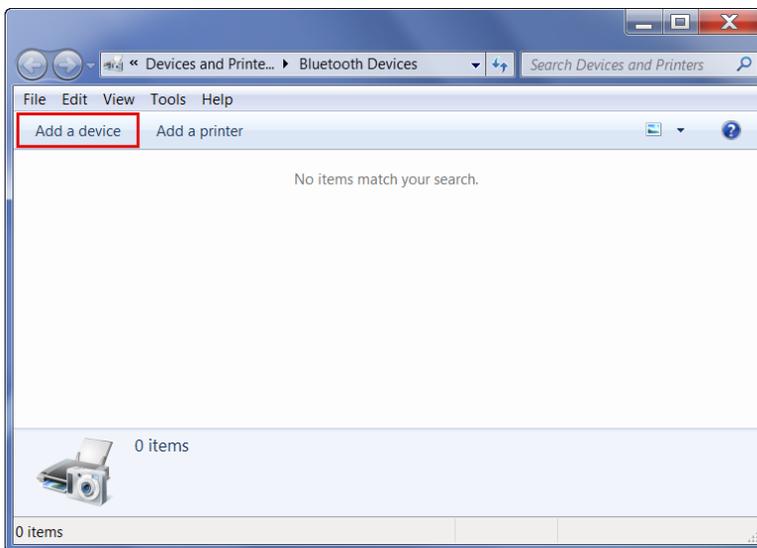
Click on "Add a device".

c. All nearby Bluetooth devices will be listed:
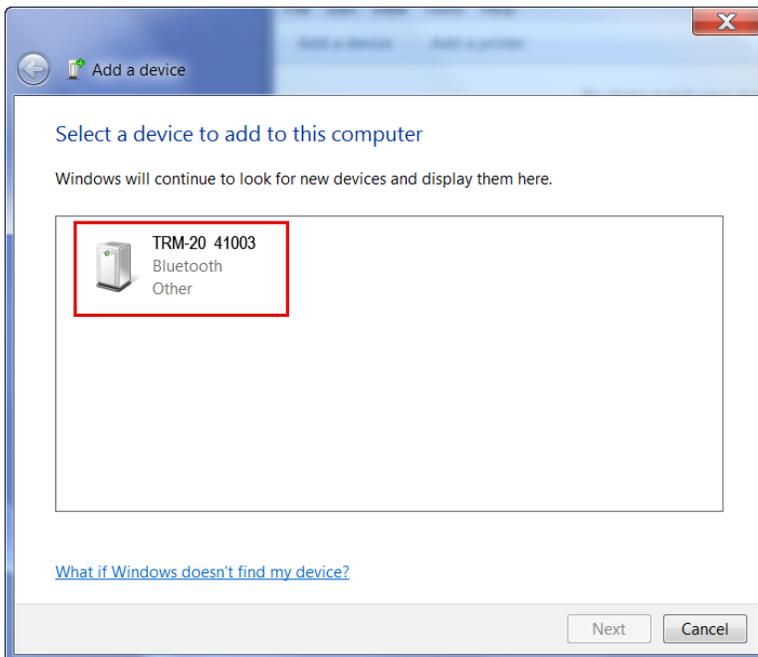
The TRM will be listed as "TRM S/N" where S/N is the device's serial number. Click on the icon for the TRM and then click on the "Next" button.

d. The device pairing screen will be displayed:
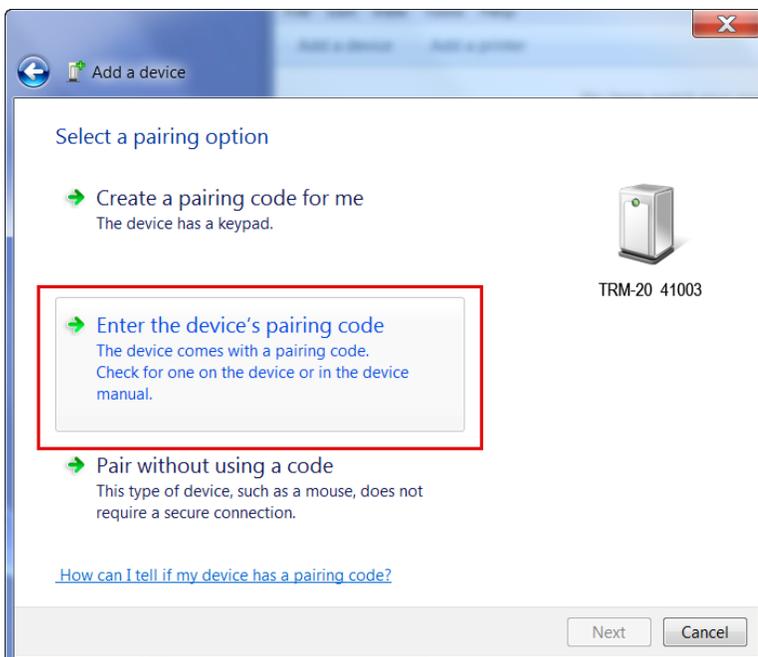
Click on "Enter the device's pairing code" option.

e. The following window will be displayed:
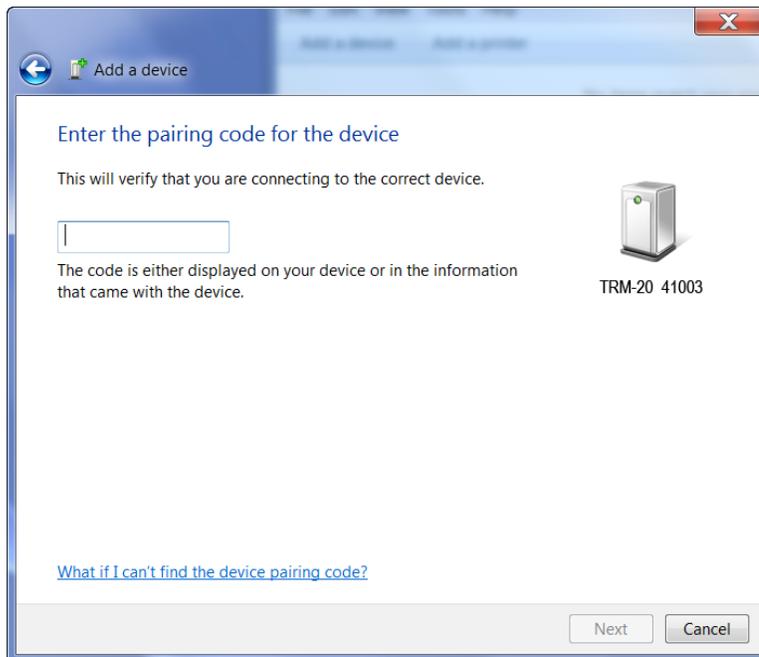
Type the word "default" (without the quotes and in all lower-case) in the text box and click on the "Next" button.

f. The following screen will be displayed:
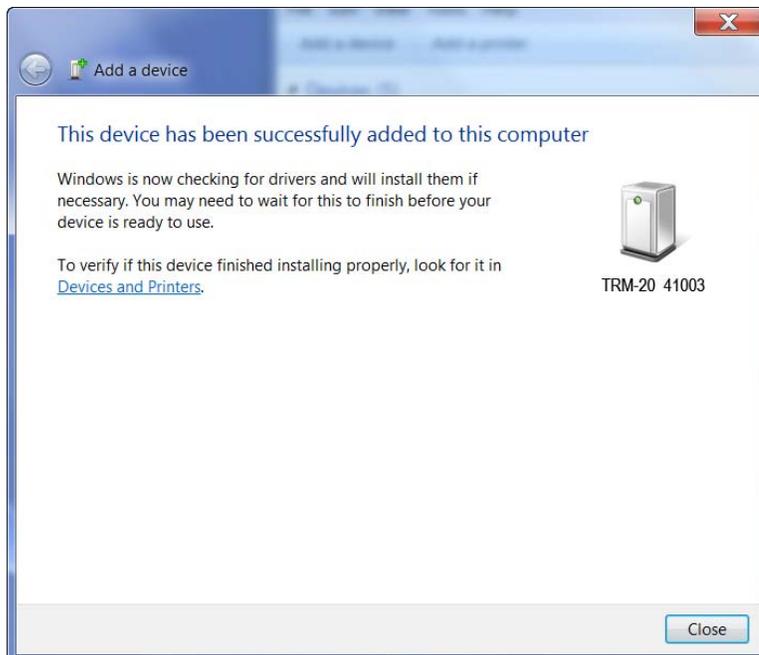
Click on the "Close" button.

g. The TRM will now be listed under "Bluetooth Devices":
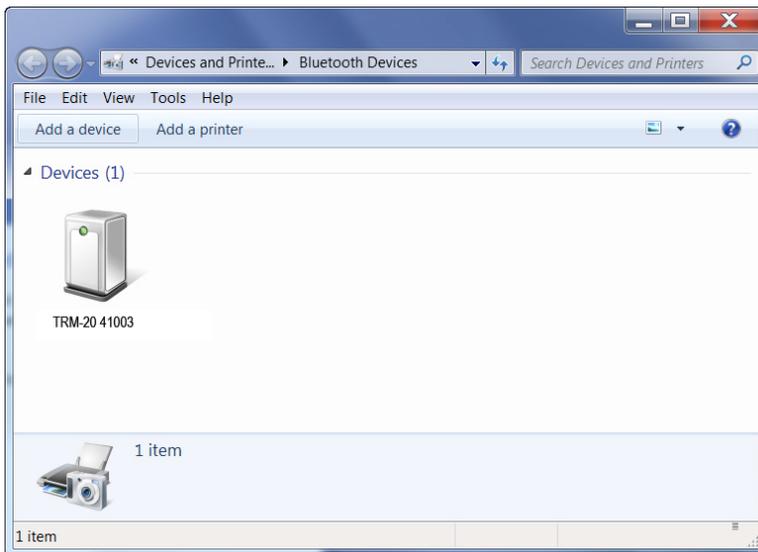
Right click on the TRM-20 icon and select "Properties" from the pop-up menu.

h. The properties window will be displayed. Click on the "Hardware" tab:
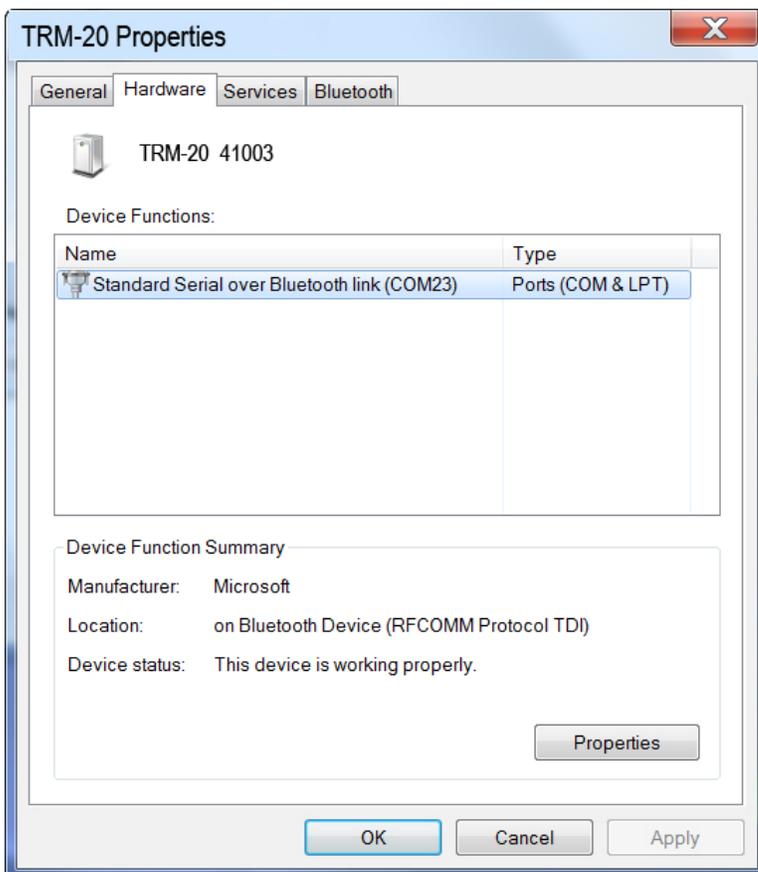
Note the port number listed after the device name (COM23 in the above example). Use this port number in the LTCA software to connect to the TRM.

3.3   Typical Connections to a Load Tap Changer (LTC)
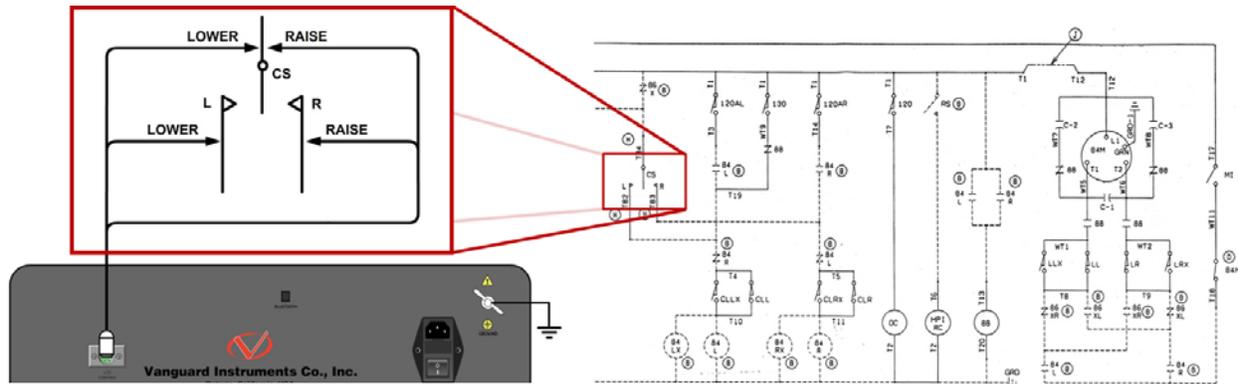
Figure 2. Typical Connections to a Load Tap Changer (LTC)

3.4   Typical TRM-20/40 Cable Connections

⚠️ **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 electric shock to personnel and/or damage to the equipment.**
	• Disconnect the test clips from the transformer bushing only after the TRM has completely discharged the transformer. Always disconnect the test clips slowly from the transformer bushing to prevent an accidental flash-over.
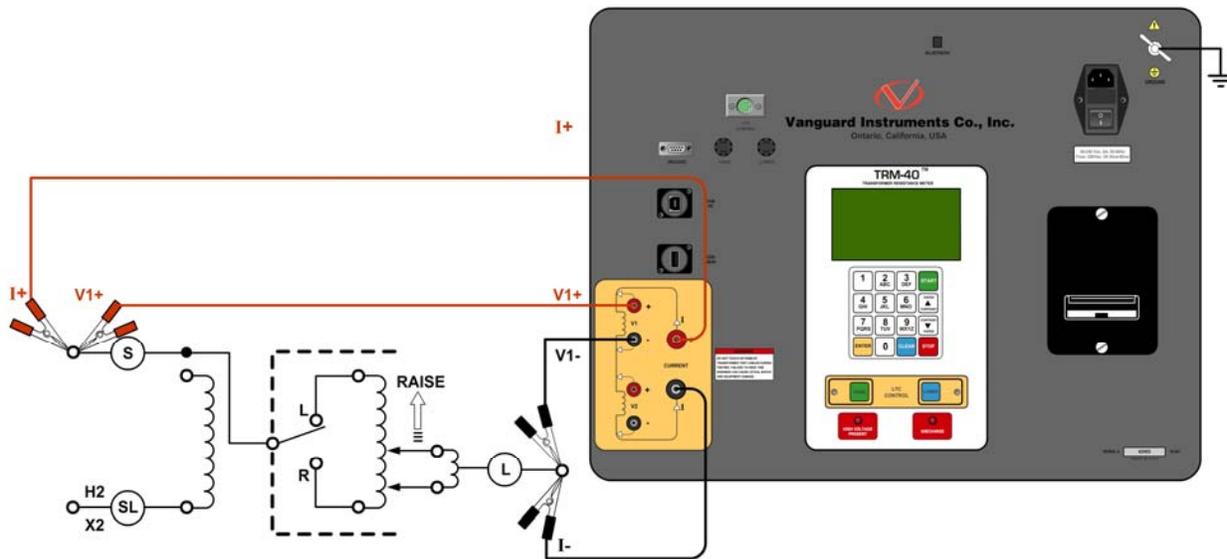
Figure 3. Typical TRM Connections Diagram for A Dynamic Resistance Test
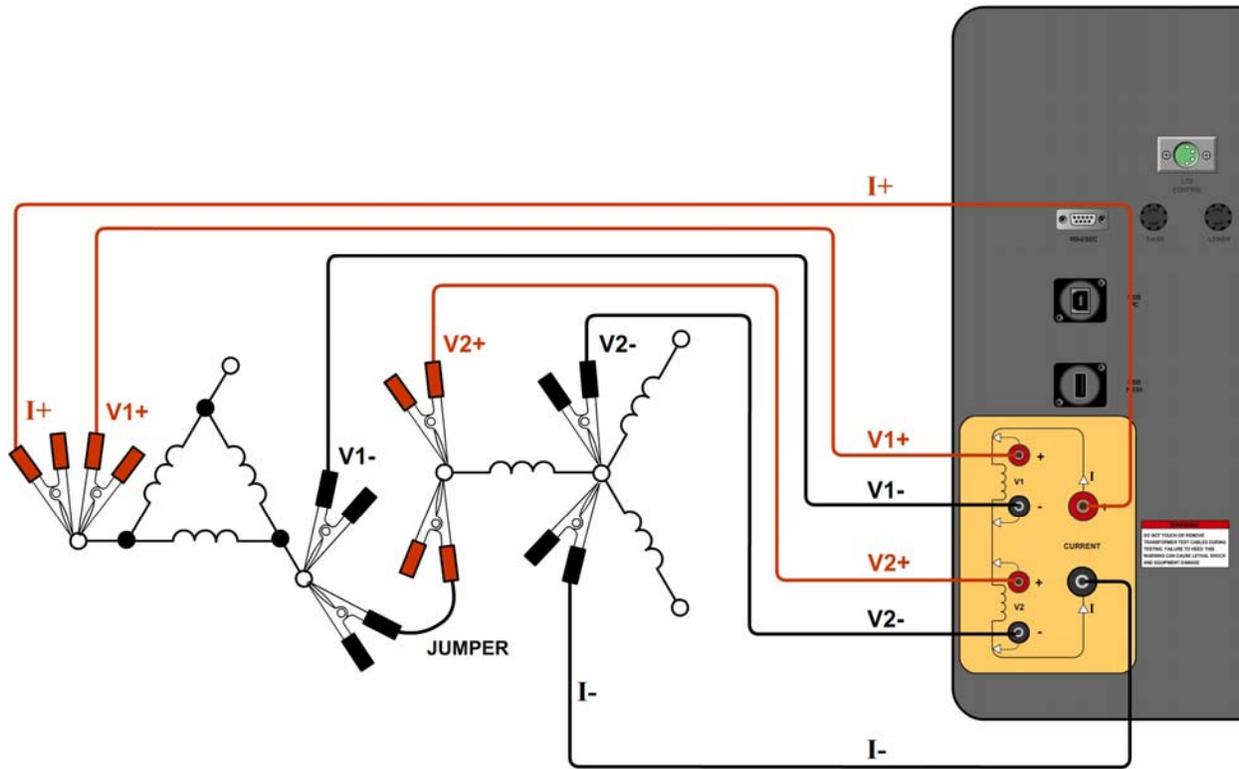
Figure 4. Typical TRM Connections Diagram for 2 Windings

3.5 General Procedures

The main steps for using the TRM are outlined below:

a. Ground the TRM to the substation ground.

> ⚠️ **WARNING** Always connect the TRM to the substation ground before connecting any test lead to any transformer bushing. Failure to follow this procedure may damage the TRM.

b. Plug the TRM 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 TRM.

f. The unit will self-calibrate, and then you will be presented with the "START-UP" menu as shown below:

```
1. RUN TEST           11/01/11
                      09:06:21
2. SETUP           22°C   72°F
3. USER DIAGNOSTICS
```
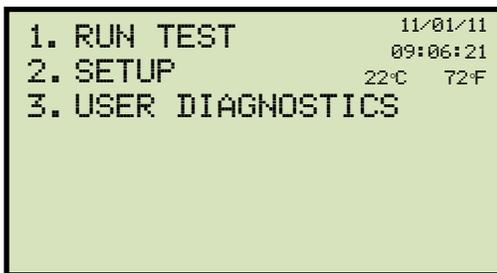
3.6   Entering Test Record Header Information

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         11/01/11
                    09:06:21
2. SETUP         22°C    72°F
3. USER DIAGNOSTICS
```

      Press the **[2]** key (*SETUP*).

   b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. SAVE/RESTORE RECORD
4. SET TIME
5. SET LANGUAGE
```
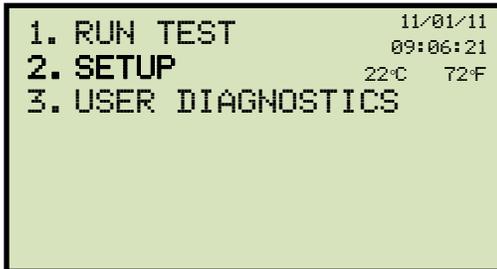
      Press the **[1]** key (*RECORD ID*).

   c. The following screen will be displayed:

```
COMPANY:

_

 ↑/↓ TO POSITION

"ENTER" TO ACCEPT
```
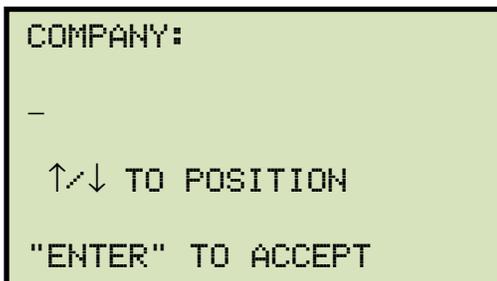
      Type the company name using the alpha-numeric keypad.

      When pressing a key, the corresponding number on the key will be displayed first. Pressing the key again will display the first letter on the key. Pressing the key again will display the second letter on the key. For example, to type the letter "A", you must press the **[2]** key twice. To erase the character at the cursor position, press the **[CLEAR]** key. Press the **[PAPER ∧ Contrast]** key to move to the next character. Press the **[PAPER ∨ Contrast]** key to move to the previous character. Press the **[ENTER]** key when you are done typing the company name.

d. The following screen will be displayed:

```
STATION:

 _

  ↑/↓ TO POSITION

"ENTER" TO ACCEPT
```

Type the station name using the alpha-numeric keypad and then press the **[ENTER]** key.

e. The following screen will be displayed:

```
CIRCUIT:

 _

  ↑/↓ TO POSITION

"ENTER" TO ACCEPT
```

Type the circuit information using the alpha-numeric keypad and then press the **[ENTER]** key.

f. The following screen will be displayed:

```
MANUFACTURER:

 _

  ↑/↓ TO POSITION

"ENTER" TO ACCEPT
```

Type the manufacturer name using the alpha-numeric keypad and then press the **[ENTER]** key.

g. The following screen will be displayed:

```
MODEL:

_

 ↑∕↓ TO POSITION

"ENTER" TO ACCEPT
```

Type the model information using the alpha-numeric keypad and then press the
[ENTER] key.

h. The following screen will be displayed:

```
SERIAL NUMBER:

_

 ↑∕↓ TO POSITION

"ENTER" TO ACCEPT
```

Type the serial number using the alpha-numeric keypad and then press the **[ENTER]**
key.

i. The following screen will be displayed:

```
KVA RATING:

_

 ↑∕↓ TO POSITION

"ENTER" TO ACCEPT
```

Type the transformer's KVA rating using the alpha-numeric keypad and then press the
[ENTER] key.

j.   The following screen will be displayed:

```
OPERATOR:

_

 ↑╱↓ TO POSITION

"ENTER" TO ACCEPT
```

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

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

3.7 Setting the Date and Time

To set the date and time:

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

```
1. RUN TEST          11/01/11
                     09:06:21
2. SETUP          22℃    72℉
3. USER DIAGNOSTICS
```

Press the **[2]** key (*SETUP*)

b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. SAVE/RESTORE RECORD
4. SET TIME
5. SET LANGUAGE
```

Press the **[4]** key (*SET TIME*).

c. The following screen will be displayed:

```
        ENTER DATE

        MM-DD-YY

        _
```

Type the current date using the keypad. The following screen will be displayed:

```
        ENTER TIME

        HH:MM:SS

        _
```

Enter the time using the keypad. When the time has been entered, you will be immediately returned to the "START-UP" menu.

3.8 Setting the Interface Language

Follow the steps below to set the interface language (English, Spanish, or Turkish):

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

```
1. RUN TEST              11/01/11
2. SETUP                 09:06:21
3. USER DIAGNOSTICS    22°C   72°F
```

Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. SAVE/RESTORE RECORD
4. SET TIME
5. SET LANGUAGE
```

Press the **[5]** key (*SET LANGUAGE*).

c. The following screen will be displayed:

```
1. ENGLISH
2. TURKISH
3. SPANISH
```

Select the preferred interface language by pressing the corresponding key on the keypad (**[1]**, **[2]**, or **[3]**). The interface language will be set and a confirmation screen will be displayed as shown below:

```
        ENGLISH SET
```

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

3.9   Performing a Resistance Test

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

```
1. RUN TEST              11/01/11
2. SETUP                 09:06:21
3. USER DIAGNOSTICS   22°C   72°F
```

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

b. The following screen will be displayed:

```
1. RESISTANCE TEST
2. SPECIAL RES TEST
3. DYNAMIC LTC TEST
4. DEGAUSS WINDING
```

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

c. The following screen will be displayed:

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

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

d. The following screen will be displayed:

```
1. V1, V2   RES TEST
2. V1 ONLY  RES TEST
```

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

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

e. The following menu will be displayed:

```
SELECT TEST CURRENT:
1. 1A
2. 5A
3. 10A
4. 20A
5. 40A
6. CUSTOM
```

Select the test current by pressing the corresponding numeric key on the keypad. Press the **[6]** key (*CUSTOM*) if you would like to enter a custom test current and then enter the current (between 1A-40A) on the next screen.

f. 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=225.0
3. MANUALLY ENTER TK
```

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

Press the **[2]** key (*ALUMINUM, Tk=225.0*) to select aluminum as the winding material. **Continue to step g.**

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 TK
    "ENTER" TO ACCEPT
```

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

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

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

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

g. The following screen will be displayed:

```
       D.U.T. TEMP:

    25.0°C    77.0°F


      ↑↓ TO ADJUST TK
    "ENTER" TO ACCEPT
```

Use the **[PAPER ∧ Contrast]** and **[PAPER ∨ Contrast]** keys to adjust the D.U.T. (Device Under Test) temperature.

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

h. The following screen will be displayed:

```
     REFERENCE TEMP:

    75.0°C    167.0°F


      ↑↓ TO ADJUST TK
    "ENTER" TO ACCEPT
```

Use the **[PAPER ∧ Contrast]** and **[PAPER ∨ Contrast]** keys to adjust the reference temperature.

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

i.   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.

j.   The following screen will be displayed:

```
- V1 & V2 TEST -
   10 AMP TEST

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

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

k.   The following screen will be displayed momentarily:

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

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

```
     *XFMR CHARGING*

       PLEASE WAIT...



  ** XFMR ENERGIZED! **
```

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.

l.   The TRM determines when the resistance reading is stable and displays the resistance values on the LCD screen as shown below:

```
    TEST IN PROGRESS   14

  I   =      10.01 AMPS
  R1  =       1.465 mΩ
  R2  =       1.448 mΩ
```

The TRM 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 TRM's internal working memory. You can store up to 99 readings 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 3.10 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   14
  ===> SAVING TEST <===
  I   =      10.01 AMPS
  R1  =       1.465 mΩ
  R2  =       1.448 mΩ

  ** XFMR ENERGIZED! **
```

Once the data is saved, the following screen will be displayed:

```
    TEST IN PROGRESS    14
   ===> TEST SAVED! <===
 I    =     10.01 AMPS
 R1   =      1.465 mΩ

 R2   =      1.448 mΩ


  ** XFMR ENERGIZED! **
```

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

```
         TEST RESULTS

 I    =     10.01 AMPS
 R1   =      1.465 mΩ

 R2   =      1.448 mΩ


```

Press any key to continue.

m. The following screen will be displayed:

```
 PRINT TEST RESULTS?
 1. YES
 2. NO



```

1. *YES*

   Press the **[1]** key (*YES*) to print the test results on the built-in thermal printer. A sample test results printout is shown in Figure 5. **Continue to step n.**

2. *NO*

   Press the **[2]** key (*NO*) to bypass printing of the test results. **Continue to step n.**

n. The following screen will be displayed:

```
KEEP THIS READING?
1. YES
2. NO
```

1. *YES*

   Press the **[1]** key (*YES*) to save the reading. One of the following screens will be displayed:

   The following screen will be displayed if there is no previous data in the memory:

   ```
   ===> TEST SAVED! <===
   ```

   The following screen will be displayed if previous data for the same test type is stored in the memory:

   ```
   PREVIOUS DATA IN BUF
   11/03/11      14:49:09
   1. APPEND PREV. DATA
   2. CLEAR PREV. DATA
   ```

   The TRM retains the current test results in its working memory. When a test is finished, the user can append the new test results to the previous test results in the working memory, as long as the unit's power has not been turned off between tests.

   Press the **[1]** key (*APPEND PREV. DATA*) to append the current test results to the previous test results in the working memory.

   Press the **[2]** key (*CLEAR PREV. DATA*) to only save the current test results and discard any previous data from the working memory.

   In either case, press any key and **continue to step o**.

2. *NO*

   If you do not wish to save the reading, press the **[2]** key (*NO*) and **continue to step o.**

o. The following screen will be displayed:

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

Press the **[1]** key (*YES*) to run another test. **Return to step b.**

Press the **[2]** key (*NO*) if you do not want to run another test. **Continue to step p.**

p. The following screen will be displayed:

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

1. *YES*

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

2. *NO*

   Press the **[2]** key (*NO*) if you do not want to save the test record. The following screen will be displayed:

```
ARE YOU SURE?
DATA WILL BE LOST!
1. DO NOT SAVE RECORD
2. SAVE RECORD
```

Press the **[1]** key (*DO NOT SAVE RECORD*) if you do not want to save the record. You will be returned to the "START-UP" menu.

Press the **[2]** key (*SAVE RECORD*) to save the record. **Continue to step q.**

q. The following screen will be displayed:

```
RECORD NUMBER 01
HAS BEEN SAVED!
```

> The record number is automatically assigned and incremented by the TRM.
> **NOTE**

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

```
        TEST  RESULTS
DATE: 11/04/11   TIME: 09:17:17

COMPANY:   VIC
STATION:   LAB
CIRCUIT:   16R TO 16L
MFR:       VIC
MODEL:     TRM40
SN:        42003
KVA RTG:   75KVA
OPERATOR:  VN

        V1 & V2 TEST

       TESTED AT 10 AMPS

R1  = 1.464 MILLI-OHMS

R2  = 1.448 MILLI-OHMS

I   = 10.004 AMPS

TAP/WINDING: _____

DATE: 11/04/11   TIME: 09:17:17
```

Figure 5. Typical Resistance Test Results Printout

3.10   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 TRM 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 TRM then instructs the user to change to the next tap position and repeat the testing process.

Use the steps below to perform an LTC/Voltage Regulator Test:

a.   Start from the "START-UP" menu:
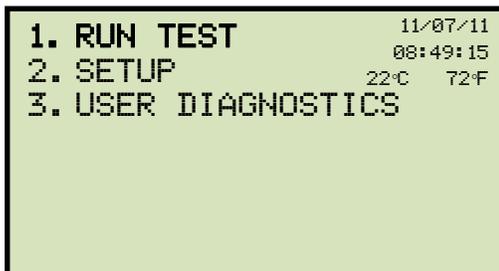
```
1. RUN TEST          11/07/11
2. SETUP             08:49:15
3. USER DIAGNOSTICS  22°C   72°F
```

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

b.   The following screen will be displayed:

```
1. RESISTANCE TEST
2. SPECIAL RES TEST
3. DYNAMIC LTC TEST
4. DEGAUSS WINDING
```

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

c.   The following screen will be displayed:

```
LTC OR VTG REGULATOR?
1. YES
2. NO
```
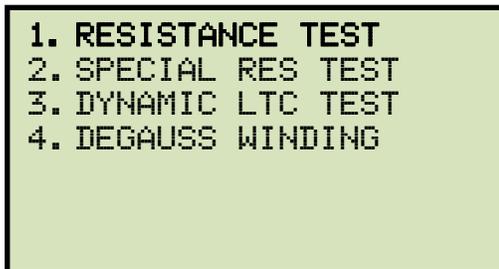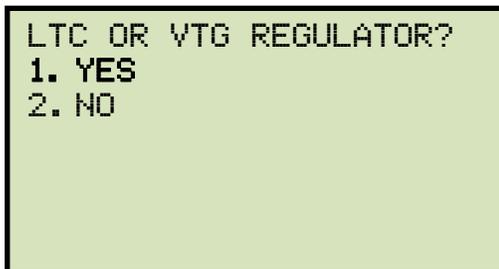
Press the **[1]** key (*YES*).

d. The following screen will be displayed

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

Type the number of taps the LTC or Voltage Regulator has using the alpha-numeric keypad, and then press the **[ENTER]** key. We will enter "3" for our example.

e. The following screen will be displayed:

```
3 LOWER, -N-, 3 RAISE

IS THIS CORRECT?
1.YES
2.NO
```

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

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

f. The following screen will be displayed:

```
1. V1, V2   RES TEST
2. V1 ONLY  REST TEST
```

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

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

g. The following screen will be displayed:

```
SELECT TEST CURRENT:
1. 1A
2. 5A
3. 10A
4. 20A
5. 40A
6. CUSTOM
```

Select the test current by pressing the corresponding numeric key on the keypad. Press the **[6]** key (*CUSTOM*) if you would like to enter a custom test current and then enter the current (between 1A-40A) on the next screen.

h. 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=225.0
   3. MANUALLY ENTER TK
   ```

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

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

   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 TK
  "ENTER" TO ACCEPT
```

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

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

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

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

i. The following screen will be displayed:
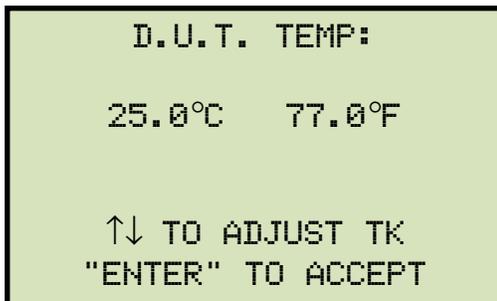
```
    D.U.T. TEMP:

  25.0°C    77.0°F


   ↑↓ TO ADJUST TK
  "ENTER" TO ACCEPT
```

Use the **[PAPER** ∧ **Contrast]** and **[PAPER** ∨ **Contrast]** keys to adjust the D.U.T. (Device Under Test) temperature.

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

j. The following screen will be displayed:
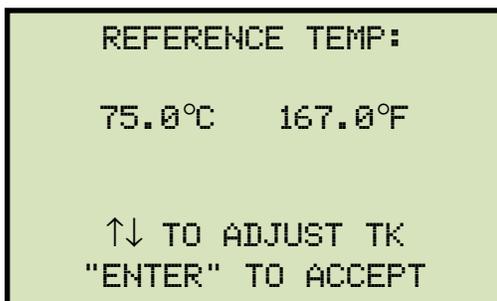
```
   REFERENCE TEMP:

  75.0°C    167.0°F


   ↑↓ TO ADJUST TK
  "ENTER" TO ACCEPT
```

Use the **[PAPER** ∧ **Contrast]** and **[PAPER** ∨ **Contrast]** keys to adjust the reference temperature.

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

> The TRM will calculate the equivalent resistance value at this new temperature.
>
> **NOTE**

k. The following screen will be displayed:

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

Press any key to continue.

l. The following screen will be displayed:

```
 - V1 & V2 TEST -
   40 AMP TEST
 SET TAP TO 3 LOWER
"START" TO RUN TEST
        OR
  "STOP" TO ABORT
```

Set the LTC or Voltage Regulator tap position to the position indicated on the screen. To change tap positions, press and hold the **[RAISE]** or **[LOWER]** LTC control button on the front panel. Release the button when the tap position has been set to the position indicated on the screen. Press the **[START]** key.

m. The following screen will be displayed momentarily:

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

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

```
     *XFMR CHARGING*

       PLEASE WAIT...

 I   =   1.01 AMPS

 ** XFMR ENERGIZED! **
```

n. The TRM determines when the resistance reading is stable and displays the resistance values on the LCD screen as shown below:

```
    TEST IN PROGRESS   14

 I    =      40.04 AMPS
 R1   =      1.461 mΩ
 R2   =      1.469 mΩ

 ** XFMR ENERGIZED! **
```

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

o. The following screen will be displayed:

```
    TEST IN PROGRESS   14
 ===> SAVING TEST <===
 I    =      40.04 AMPS
 R1   =      1.461 mΩ
 R2   =      1.469 mΩ

 ** XFMR ENERGIZED! **
```

Once the reading has been saved, the following screen will be displayed momentarily:

```
    TEST IN PROGRESS   14
 ===> TEST SAVED! <===
 I    =      40.04 AMPS
 R1   =      1.461 mΩ
 R2   =      1.469 mΩ
```

p. After saving the readings, the following screen will be displayed:
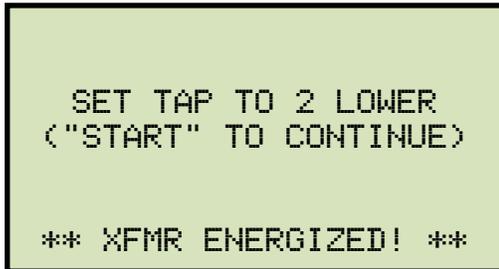
```
   SET TAP TO 2 LOWER
 ("START" TO CONTINUE)


 ** XFMR ENERGIZED! **
```

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

The TRM will continue the test and display the results as in step n. **Repeat steps l through o** for all "Lower" positions and then through all "Raise" positions.

q. The following screen will be displayed after the last "Raise" position's resistance reading is stored:
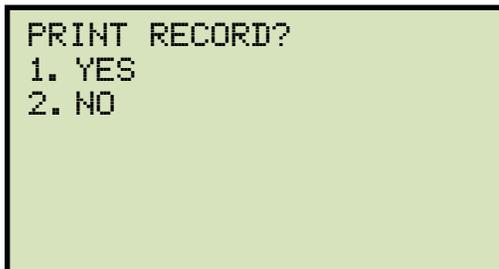
```
PRINT RECORD?
1. YES
2. NO
```

1. *YES*
   Press the **[1]** key (*YES*) to print the test results on the built-in thermal printer. A Typical LTC/Voltage Regulator test report is shown in Figure 6. **Continue to step r.**

2. *NO*
   Press the **[2]** key (*NO*) to bypass printing of the test results. **Continue to step r.**

r. The following screen will be displayed:

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

1. *YES*
   Press the **[1]** key (*YES*) to save the test record. The following screen will be displayed:

```
RECORD NUMBER 02
HAS BEEN SAVED!
```

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

2. *NO*

If you do not wish to save the test record, press the **[2]** key (*NO*). The following screen will be displayed:
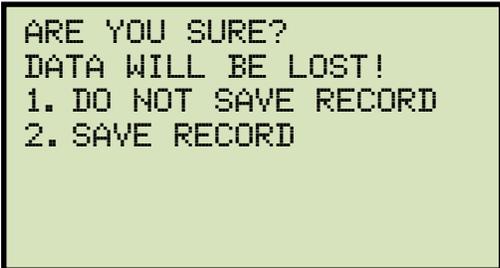
```
ARE YOU SURE?
DATA WILL BE LOST!
1. DO NOT SAVE RECORD
2. SAVE RECORD
```

Press the **[1]** key (*DO NOT SAVE RECORD*) to NOT save the test record. You will be returned to the "START-UP" menu.

```
TEST RESULTS
DATE: 11/04/11  TIME: 09:27:07

COMPANY:  VIC
STATION:  LAB
CIRCUIT:  16R TO 16L
MFR:      VIC
MODEL:    TRM40
SN:       42003
KVA RTG:  75KVA
OPERATOR: VN

    V1 & V2 STATIC LTC TEST
      TESTED AT 40 AMPS

TAP = 3 LOWER

R1  = 1.461 MILLI-OHMS

R2  = 1.470 MILLI-OHMS

I   = 40.043 AMPS


TAP = 2 LOWER

R1  = 1.836 MILLI-OHMS

R2  = 1.820 MILLI-OHMS

I   = 40.037 AMPS


TAP = 1 LOWER

R1  = 3.232 MILLI-OHMS

R2  = 3.210 MILLI-OHMS

I   = 40.037 AMPS
```

```
Test results continued

TAP = NEUTRAL

R1  = 3.435 MILLI-OHMS

R2  = 3.412 MILLI-OHMS

I   = 40.034 AMPS


TAP = 1 RAISE

R1  = 3.553 MILLI-OHMS

R2  = 3.528 MILLI-OHMS

I   = 40.032 AMPS


TAP = 2 RAISE

R1  = 2.138 MILLI-OHMS

R2  = 2.115 MILLI-OHMS

I   = 40.030 AMPS


TAP = 3 RAISE

R1  = 1.434 MILLI-OHMS

R2  = 1.431 MILLI-OHMS

I   = 40.030 AMPS
```

Figure 6. Typical LTC/Voltage Regulator Test Report Printout

3.11 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 one minute intervals. Use the steps below to perform a Special Resistance Test:

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

```
1. RUN TEST          11/07/11
2. SETUP             08:49:15
3. USER DIAGNOSTICS  22°C   72°F
```

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

b. The following screen will be displayed:

```
1. RESISTANCE TEST
2. SPECIAL RES TEST
3. DYNAMIC LTC TEST
4. DEGAUSS WINDING
```

Press the **[2]** key (*SPECIAL RES TEST*).

c. The following screen will be displayed:

```
1. V1, V2   SPEC TEST
2. V1 ONLY  SPEC TEST
```

Press the **[1]** key (*V1, V2 SPEC TEST*) to perform a V1 & V2 special resistance test. Continue to step d.

Press the **[2]** key (*V1 ONLY SPEC TEST*) to perform a V1 special resistance test.

d. The following screen will be displayed:

```
  ENTER SPECIAL TEST
  TIME MINUTES (1-45)



         _
```

Enter the test time (between 1 to 45 minutes) using the alpha-numeric keypad, and then press the **[ENTER]** key.

e. The following screen will be displayed:

```
SELECT TEST CURRENT:
1. 1A
2. 5A
3. 10A
4. 20A
5. 40A
6. CUSTOM
```

Select the test current by pressing the corresponding numeric key on the keypad. Press the **[6]** key (*CUSTOM*) if you would like to enter a custom test current and then enter the current (between 1A-40A) on the next screen.

f. 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=225.0
    3. MANUALLY ENTER TK
    ```

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

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

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 TK
  "ENTER" TO ACCEPT
```

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

You can decrease the Tk value by 0.5°C increments by pressing the **[PAPER ∨ Contrast]** 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 i.**

g. The following screen will be displayed:

```
     D.U.T. TEMP:

  25.0°C   77.0°F


  ↑↓ TO ADJUST TK
  "ENTER" TO ACCEPT
```

Use the **[PAPER ∧ Contrast]** and **[PAPER ∨ Contrast]** keys to adjust the D.U.T. (Device Under Test) temperature.

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

h. The following screen will be displayed:

```
    REFERENCE TEMP:

  75.0°C    167.0°F



  ↑↓ TO ADJUST TK
 "ENTER" TO ACCEPT
```

Use the **[PAPER ∧ Contrast]** and **[PAPER ∨ Contrast]** keys to adjust the reference temperature.

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

i. 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.

j. The following screen will be displayed:

```
   - V1 & V2 TEST -
      40 AMP TEST


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

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

k. The following screen will be displayed momentarily:

```
        CALIBRATING
        PLEASE WAIT...



```

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

```
      *XFMR CHARGING*

        PLEASE WAIT...

   I  =   1.01 AMPS

  ** XFMR ENERGIZED! **
```

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.

l. The TRM determines when the resistance reading is stable and shows the resistance value on the LCD screen as shown below (the first line shows the remaining test time):

```
 REMAINING TIME = 00:59

  I   =     40.04 AMPS
  R1  =      1.844 mΩ
  R2  =      2.025 mΩ

  ** XFMR ENERGIZED! **
```

When the pre-defined test time has elapsed, the following screen will be displayed:

```
        TEST RESULTS

  I   =     40.04 AMPS
  R1  =      1.839 mΩ
  R2  =      2.051 mΩ

  ** XFMR ENERGIZED! **
```

Press any key to continue.

m. The following screen will be displayed:

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

1. YES

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

2. NO

Press the **[2]** key (*NO*) if you do not want to save the test record. The following screen will be displayed:

```
ARE YOU SURE?
DATA WILL BE LOST!
3. DO NOT SAVE RECORD
4. SAVE RECORD
```

Press the **[1]** key (*DO NOT SAVE RECORD*) if you do not want to save the record. You will be returned to the "START-UP" menu.

Press the **[2]** key (*SAVE RECORD*) to save the record. **Continue to step m.**

n. The following screen will be displayed:

```
RECORD NUMBER 03
HAS BEEN SAVED!
```

NOTES

- The record number is automatically assigned and incremented by the TRM.

- Once the test record has been saved, it can be recalled and printed (3.15.3 and 3.15.4 for further information). Figure 7 shows a typical Special Test report printout.

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

```
┌─────────────────────────────────┐
│     RECORD NUMBER 79            │
├─────────────────────────────────┤
│                                 │
│     TEST  RESULTS               │
│                                 │
├─────────────────────────────────┤
│ DATE: 11/07/11   TIME: 14:59:54 │
├─────────────────────────────────┤
│ COMPANY:   VIC                  │
│ STATION:   LAB                  │
│ CIRCUIT:   16R TO 16L           │
│ MFR:       VIC                  │
│ MODEL:     TRM40                │
│ SN:        42003                │
│ KVA RTG:   75KVA                │
│ OPERATOR: VN                    │
├─────────────────────────────────┤
│      V1 & V2 SPECIAL TEST       │
│       TESTED AT 20 AMPS         │
├─────────────────────────────────┤
│ T = 0 MIN                       │
│     R1  = 1.702 MILLI-OHMS      │
│     R2  = 1.963 MILLI-OHMS      │
│     I   = 20.016 AMPS           │
├─────────────────────────────────┤
│ T = 1 MIN                       │
│     R1  = 1.701 MILLI-OHMS      │
│     R2  = 1.968 MILLI-OHMS      │
│     I   = 20.017 AMPS           │
└─────────────────────────────────┘
```

Figure 7. Typical Special Test Report Printout

3.12 Performing a Dynamic LTC Test

The Dynamic LTC Test is used to conduct a resistance test while the LTC or Voltage Regulator is switching taps. The test will run for 240 seconds to allow the LTC or Voltage Regulator enough time to switch through all of the taps during the test. The resistance data is recorded continuously during the test period. Use the following steps to perform a Dynamic LTC Test.

NOTE	Dynamic LTC Test results can only be saved to an external USB Flash drive. If you would like to save your test results, please be sure to connect a USB Flash drive to the unit before performing this test.

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

```
1. RUN TEST            11/07/11
2. SETUP               08:49:15
3. USER DIAGNOSTICS  22°C   72°F
```

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

b. The following screen will be displayed:

```
1. RESISTANCE TEST
2. SPECIAL RES TEST
3. DYNAMIC LTC TEST
4. DEGAUSS WINDING
```

Press the **[3]** key (*DYNAMIC LTC TEST*).

c. The following screen will be displayed:

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

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

d. The following screen will be displayed:

```
      SET LTC/VREG TO
   LOWEST TAP POSITION.


        PRESS
   ANY KEY WHEN READY
```

Set the LTC or Voltage Regulator to the lowest position either manually or by pressing and holding the LTC **[LOWER]** button. Press any key to continue.

e. The following warning screen will be displayed:

```
   DYNAMIC LTC TEST


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

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

f. The following screen will be displayed momentarily:

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

After the TRM has finished its internal calibration, the following screen will be displayed:

```
     *XFMR CHARGING*

      PLEASE WAIT...

   I  =  1.01 AMPS

  ** XFMR ENERGIZED! **
```

When the TRM has determined that the resistance reading is stable, the following screen will be displayed:

```
READY TO CAPTURE DATA

    PRESS "ENTER"
      - OR -
  LTC RAISE/LOWER
 TO START TIMING...
```

Press the **[ENTER]** key or the LTC **[RAISE]** or **[LOWER]** key to continue.

g. The TRM will start capturing data and the following screen will be displayed:

```
   RUNNING DYNAMIC
   LTC TEST T=239



   "STOP" TO END TEST
** XFMR ENERGIZED! **
```

The second line on the screen will display the remaining time for the test. While the TRM captures data, you can press the LTC **[RAISE]** or **[LOWER]** button to cycle through the LTC or Voltage Regulator's taps. You can wait for the remainder of the test time or you can press the **[STOP]** key at any time to end the test. If you have completed cycling through the taps, it is recommended to stop the test manually. If the test is performed for the duration of 240 seconds, the graph printout will be rather long!

h. When the test time has expired or the test is stopped manually, the following screen will be displayed.

```
   PRINTING REPORT
   PLEASE WAIT...
```

The test results will be printed on the unit's built-in thermal printer. A sample test results printout is shown in Figure 8. The following screen will be displayed when printing is finished:

```
SAVE THIS RECORD TO
THUMB DRIVE?
1.YES
2.NO
```

1. *YES*

   Press the **[1]** key (*YES*) to save the test results to the connected USB Flash drive. The following screen will be displayed:

   ```
   REC_001 SAVED TO
   THUMB DRIVE.
   ```
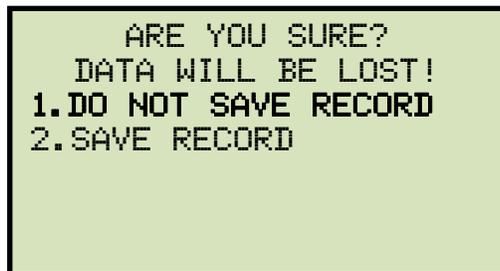
   Press any key to return to the "START-UP" menu.

2. *NO*

   Press the **[2]** key (*NO*) if you do not want to save the test results. The following screen will be displayed:

   ```
         ARE YOU SURE?
       DATA WILL BE LOST!
   1.DO NOT SAVE RECORD
   2.SAVE RECORD
   ```

   Press the **[1]** key (*DO NOT SAVE RECORD*). You will be returned to the "START-UP" menu.

TEST RESULTS

DATE: 11/22/11   TIME: 15:42:19

COMPANY:
STATION:
CIRCUIT:
MFR:
MODEL:
SN:
KVA RTG:
OPERATOR:

. DYNAMIC LTC TEST

TESTED AT 10 AMPS

VOLTAGE PLOT

MARKERS AT 1S INTERVALS

Voltage Plot Continued

Nominal contact transition

Typical open contact transition results in a higher voltage spike compared to nominal contact transition
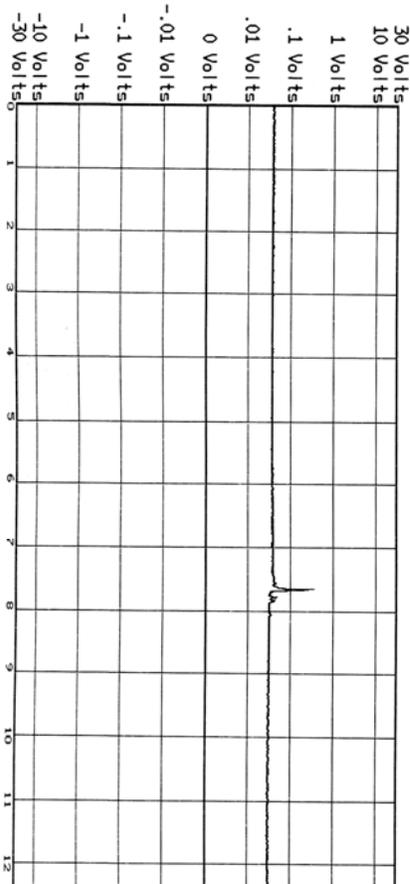
Figure 8. Typical Dynamic LTC Test Results Printout Showing an Opened Circuit

3.13   Performing a Diagnostic Test

In diagnostic mode, the TRM can run a resistance test, display the sense voltages, and test current on the TRM. This feature can be used to verify the TRM's voltage and current readings against an external meter. Use the steps below to perform a diagnostic test:
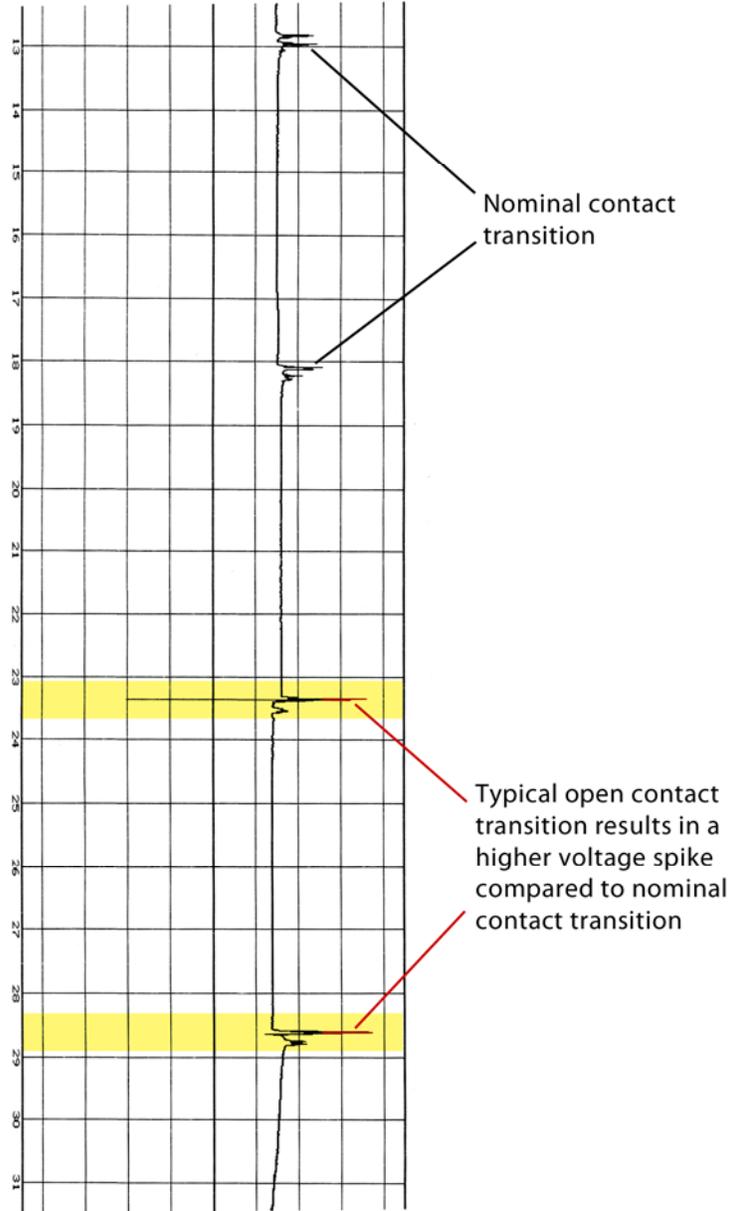
a. Start from the "START-UP" menu:

```
1. RUN TEST              11/07/11
                         08:49:15
2. SETUP             22°C    72°F
3. USER DIAGNOSTICS
```

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

b. The following screen will be displayed:

```
SELECT TEST CURRENT:
1. 1A
2. 5A
3. 10A
4. 20A
5. 40A
6. CUSTOM
```

Select the test current by pressing the corresponding numeric key on the keypad. Press the **[6]** key (*CUSTOM*) if you would like to enter a custom test current and then enter the current (between 1A-40A) on the next screen.

c. The following warning screen will be displayed:

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

Press any key to continue.

d. The following screen will be displayed:

```
 - USER DIAG TEST -
"START" TO RUN TEST
        OR
 "STOP" TO ABORT
```

Press the **[START]** key.

e. The V1, V2, and test current (I) will be displayed as shown below:

```
    USER DIAGNOSTICS

    V1 = 35.86 mV
    V2 = 38.43 mV
     I = 20.020 A

** XFMR ENERGIZED! **
```

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

3.14   Demagnetizing the Transformer Core

You can demagnetize the transformer core using the steps below:

a.   Start from the "Start-Up" menu:

```
1. RUN TEST           11/07/11
2. SETUP              08:49:15
3. USER DIAGNOSTICS   22°C  72°F
```

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

b.   The following screen will be displayed:

```
1. RESISTANCE TEST
2. SPECIAL RES TEST
3. DYNAMIC LTC TEST
4. DEGAUSS WINDING
```

Press the **[4]** key (*DEGAUSS WINDING*).

c.   The following screen will be displayed:

```
DEGAUSS CURRENT:
1. 0.5 AMP
2. 1 AMP
3. 2 AMPS
4. 5 AMPS
5. 10 AMPS
```

Select the degaussing current by pressing the corresponding key on the alpha-numeric keypad.

d.   The following screen will be displayed:

```
THIS MAY TAKE SEVERAL
MINUTES TO COMPLETE

"ENTER" TO CONTINUE
```

Press the **[ENTER]** key to continue.

e. The degaussing process will start and updates will be displayed on the screen as shown below:

```
  * DEGAUSSING XFMR *

-> SETTING CORE...



 ** XFMR ENERGIZED! **
```

```
  * DEGAUSSING XFMR *

   SETTING CORE...
-> CHARGING REVERSE


 ** XFMR ENERGIZED! **
```

```
  * DEGAUSSING XFMR *

   SETTING CORE...
   CHARGING REVERS
-> RESETTING CORE

 ** XFMR ENERGIZED! **
```
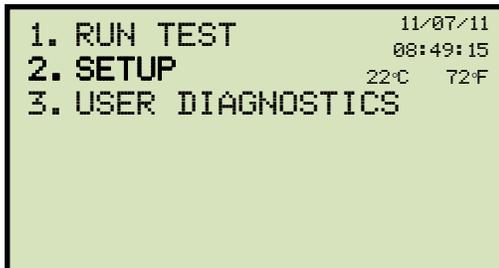
When the process is complete, you will be returned to the "START-UP" menu.

3.15 Working with Test Records

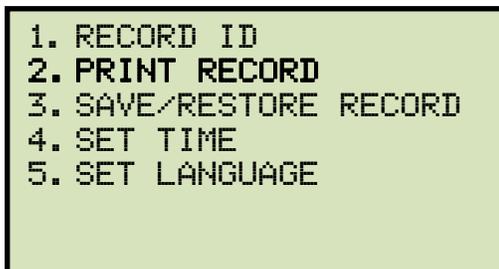### 3.15.1. Viewing the Contents of the Working Memory

Whenever a test is performed and the reading is kept, the data is temporarily stored in the TRM's working memory. You can view the test reading in the unit's working memory using the steps below:

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

```
1. RUN TEST          11/07/11
                     08:49:15
2. SETUP          22°C   72°F
3. USER DIAGNOSTICS
```

Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. SAVE/RESTORE RECORD
4. SET TIME
5. SET LANGUAGE
```

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

c. The following screen will be displayed:

```
        PRINT RECORD
1. PRINT TO LCD
2. PRINT TO PRINTER
```
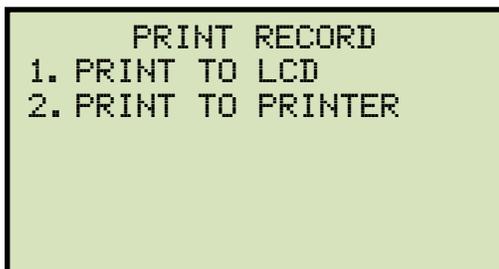
  1. *PRINT TO LCD*

   Press the **[1]** key (*PRINT TO LCD*) to view the test record on the LCD screen. Use the **[PAPER ∨ Contrast]** key to scroll to the next page. Press the **[STOP]** key when you are done viewing the test record, and you will be returned to the "START-UP" menu.

2. *PRINT TO PRINTER*

Press the **[2]** key (*PRINT TO PRINTER*) to print the test record on the unit's thermal printer. You will then be returned to the "START-UP" menu.

3.15.2. Saving Test Results to a Test Record

After performing a test, the user is presented the option to save the test results to the unit's Flash EEPROM or to a USB Flash Drive. If the test results are not saved immediately after performing a test, they will still remain in the working memory and can be saved later, as long as a new test has not been performed and the unit has not been turned off. Follow the steps below to save the test results from the working memory to a test record (the following procedure can also be used to re-save a restored test record to a new memory location or to a USB Flash Drive):

a. Perform a test or restore a test record to the working memory, and then start from the "START-UP" menu:

```
1. RUN TEST            11/07/11
2. SETUP               08:49:15
3. USER DIAGNOSTICS  22°C    72°F
```

Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. SAVE/RESTORE RECORD
4. SET TIME
5. SET LANGUAGE
```

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

c. The following screen will be displayed:

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

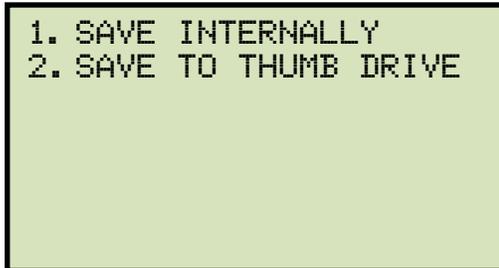> **NOTE** Option 5 (*COPY TO THUMB DRIVE*) will be listed only if a USB Flash drive is connected to the Auto-Ohm.

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

If a USB Flash drive is connected to the unit, continue to step d.

If a USB Flash drive is NOT connected to the unit, continue to step e.

d. The following screen will be displayed:

```
1. SAVE INTERNALLY
2. SAVE TO THUMB DRIVE
```

1. *SAVE INTERNALLY*

    Press the **[1]** key (*SAVE INTERNALLY*) to save the test record to the unit's Flash EEPROM. **Continue to step e.**

2. *SAVE TO THUMB DRIVE*

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

```
REC_001 SAVED TO
THUMB DRIVE
```
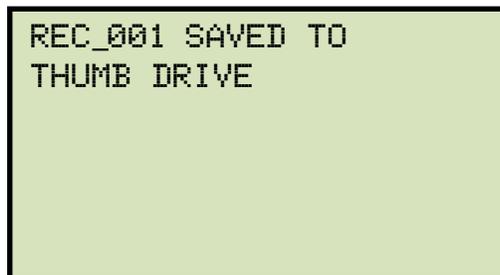
    Press any key to return to the "START-UP" menu.

e. The following screen will be displayed:

```
RECORD NUMBER 2
HAS BEEN SAVED!
```
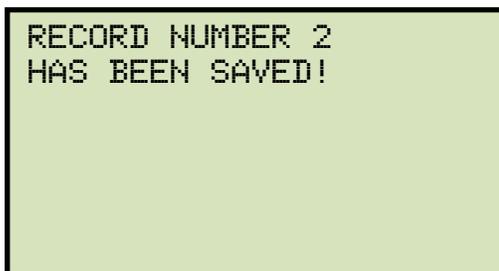
Press any key to return to the "START-UP" menu.

3.15.3. Restoring a Test Record From Flash EEPROM

Use the steps below to restore a test record from the TRM's internal Flash EEPROM to the working memory:

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

```
1. RUN TEST          11/09/11
                     12:13:15
2. SETUP          22°C   72°F
3. USER DIAGNOSTICS
```

Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. SAVE/RESTORE RECORD
4. SET TIME
5. SET LANGUAGE
```

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

c. The following screen will be displayed:

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

> Option 5 (*COPY TO THUMB DRIVE*) will be listed only if a USB Flash drive is connected to the unit.
>
> **NOTE**

Press the **[1]** key (*RESTORE RECORD*)

d. The following screen will be displayed:

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

NOTE

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

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

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

The following screen will be displayed:

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

Continue with the steps below.

1. *ENTER RECORD NUMBER*

Press the **[1]** key (*ENTER RECORD NUMBER*) if you know the record number that you would like to restore. The following screen will be displayed:

```
      RESTORE RECORD
        NUMBER:
```

Type the record number using the alpha-numeric keypad and then press the **[ENTER]** key. The following screen will be displayed:

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

Press the **[1]** key (*YES*) if you would like to print the restored test record on the unit's built-in thermal printer. You will be returned to the "START-UP" menu after printing is finished.

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

2. *SCROLL TO SELECT*

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

```
    RECORDS DIRECTORY

"UP" TO SCROLL FWD
"DWN" TO SCROLL RVS
```

Press the **[PAPER ∧ Contrast]** key or the **[PAPER ∨ Contrast]** key to display the next or previous test record, respectively. The basic test record information will be displayed as shown below:

```
#1  08/26/11  16:47
NUM OF TESTS: 2
V1, V2 TEST
```

When you have located the test record that you would like to restore, press the **[ENTER]** key. The following screen will be displayed:

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

Press the **[1]** key (*YES*) if you would like to print the restored test record on the unit's built-in thermal printer. You will be returned to the "START-UP" menu after printing is finished.

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

3.15.4. Restoring a Test Record From a USB Flash Drive

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

a. Make sure the USB Flash drive containing the test record(s) is inserted in the TRM's USB Flash drive port ("USB MEM" port). Then start from the "START-UP" menu:

```
1. RUN TEST          11/10/11
                     12:13:15
2. SETUP          22°C   72°F
3. USER DIAGNOSTICS
```

Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. SAVE/RESTORE RECORD
4. SET TIME
5. SET LANGUAGE
```

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

c. The following screen will be displayed:

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

Press the **[1]** key (*RESTORE RECORD*)

d. The following screen will be displayed:

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

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

e. The following screen will be displayed:

```
RESTORE THUMB DRIVE

        REC_
```

Type the record number that you would like to restore using the alpha-numeric keypad and then press the **[ENTER]** key.

f. The test record will be restored to the unit's working memory, and the following screen will be displayed:

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

Press the **[1]** key (*YES*) if you would like to print the restored test record on the unit's built-in thermal printer. You will be returned to the "START-UP" menu after printing is finished.

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

3.15.5. Copying Test Records to a USB Flash Drive

Use the steps below to copy one or all test records from the unit's Flash EEPROM 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            11/11/11
2. SETUP               13:13:15
3. USER DIAGNOSTICS  22℃   72℉
```

Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. SAVE/RESTORE RECORD
4. SET TIME
5. SET LANGUAGE
```

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

c. The following screen will be displayed:

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

Press the **[5]** key (*COPY TO THUMB DRIVE*).

d. 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*) to copy a single test record from the unit's Flash EEPROM to the connected USB Flash drive. The following screen will be displayed:

   ```
    ENTER RECORD NUMBER
   TO COPY TO FLASH DRV

       NUMBER:
   ```

   Type the record number using the alpha-numeric keypad and then press the **[ENTER]** key. The test record will be copied to the USB Flash drive and the following screen will be displayed:

   ```
   REC_011 SAVED TO
   THUMB DRIVE
   ```

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

2. *COPY ALL RECORDS*

Press the **[2]** key (*COPY ALL RECORDS*) to copy all test records from the TRM's Flash EEPROM to the connected USB Flash drive. All test records will be copied from the unit to the connected USB Flash drive. The following screen will be displayed when the process is finished:

```
ALL RECORDS HAVE BEEN
TRANSFERRED TO THUMB
DRIVE!
```

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

3.15.6. Printing a Test Record Directory

Use the steps below to print a directory of the test records stored in the TRM's Flash EEPROM:

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

```
1. RUN TEST        11/10/11
2. SETUP           12:13:15
3. USER DIAGNOSTICS 22°C  72°F
```

Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. SAVE/RESTORE RECORD
4. SET TIME
5. SET LANGUAGE
```

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

c. The following screen will be displayed:

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

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

d. The following screen will be displayed:

```
     PRINT DIRECTORY

 1. FULL DIRECTORY
 2. SHORT DIRECTORY
```

Press the **[1]** key (*FULL DIRECTORY*) to print the entire directory of test records. After the directory is printed, you will be returned to the "START-UP" menu.

Press the **[2]** key (*SHORT DIRECTORY*) to print a short directory. This lists the last 10 records stored in the TRM's memory. After the directory is printed, you will be returned to the "START-UP" menu.

A typical test record directory printout is shown in Figure 9.

```
TEST DIRECTORY

RECORD NUMBER: 74
DATE/TIME: 11/04/11   09:49:48
V1 & V2 SPECIAL TEST   T=1 MIN
NUMBER OF TESTS: 2
STATION:   LAB
CIRCUIT:   16R TO 16L
MFR:       VIC
MODEL:     TRM40
S/N:

RECORD NUMBER: 73
DATE/TIME: 11/04/11   09:27:07
V1 & V2 STATIC LTC TEST
NUMBER OF TESTS: 7
STATION:   LAB
CIRCUIT:   16R TO 16L
MFR:       VIC
MODEL:     TRM40
S/N:

RECORD NUMBER: 72
DATE/TIME: 11/04/11   09:17:17
V1 & V2 TEST
NUMBER OF TESTS: 4
STATION:   LAB
CIRCUIT:   16R TO 16L
MFR:       VIC
MODEL:     TRM40
S/N:

RECORD NUMBER: 63
DATE/TIME: 10/04/11   09:30:16
V1 ONLY TEST
NUMBER OF TESTS: 1
STATION:
CIRCUIT:
MFR:
MODEL:
S/N:
```

Figure 9. Typical Test Record Directory Printout

3.15.7. Erasing Test Records from the Flash EEPROM

Follow the steps below to erase test records from the unit's Flash EEPROM:

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

```
1. RUN TEST          11/10/11
2. SETUP             12:13:15
3. USER DIAGNOSTICS  22°C   72°F
```

Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. SAVE/RESTORE RECORD
4. SET TIME
5. SET LANGUAGE
```

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

c. The following screen will be displayed:

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

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

d. The following screen will be displayed:

```
        ERASE RECORD

1.  ERASE SINGLE REC.
2.  ERASE ALL RECORDS

      "STOP" TO EXIT
```

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

```
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 REC.
2.  ERASE ALL RECORDS

      "STOP" TO EXIT
```

Continue with the steps below.

1. *ERASE SINGLE REC.*
    Press the **[1]** key (*ERASE SINGLE REC.*) to erase a single record. The following screen will be displayed:

```
        ERASE RECORD
        NUMBER:
```

Type the record number that you would like to erase, and then press the **[ENTER]** key. The following screen will be displayed:

```
RECORD NUMBER 21
ERASED!
```

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

2. *ERASE ALL RECORDS*

Press the **[2]** key (*ERASE ALL RECORDS*) to erase all records stored in the TRM's Flash EEPROM. The following screen will be displayed:

```
   ERASE ALL RECORDS!
      ARE YOU SURE?

   "ENTER" TO CONTINUE
```

You can press the **[STOP]** key to cancel the process and return to the "START-UP" menu.

Press the **[ENTER]** key to proceed with deleting all the test records from the unit's Flash EEPROM. The following screen will be displayed during the erasure process:

```
   ERASING RECORDS

    PLEASE WAIT...
```

The following screen will be displayed when all test records have been completely erased:

```
   RECORDS ERASED!
```

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

3.16   Erasing Test Records from a USB Flash Drive

Follow the steps below to erase test records from a 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              11/10/11
                         12:13:15
2. SETUP              22°C    72°F
3. USER DIAGNOSTICS
```

Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. SAVE/RESTORE RECORD
4. SET TIME
5. SET LANGUAGE
```

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

c. The following screen will be displayed:

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

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

d. The following screen will be displayed:

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

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

e. The following screen will be displayed:

```
        ERASE RECORD

  1. ERASE SINGLE REC.
  2. ERASE ALL RECORDS

      "STOP" TO EXIT
```

    1. *ERASE SINGLE REC.*

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

```
      ERASE THUMB DRIV

          REC_
```

      Type the record number that you would like to erase using the alpha-numeric keypad and then press the **[ENTER]** key. The test record will be erased from the USB Flash drive and the following screen will be displayed:

```
  THUMB DRIVE REC001
  ERASED!
```

      Press any key to continue. You will be returned to the beginning of step e. Press the **[STOP]** key to return to the "START-UP" menu.

    2. *ERASE ALL RECORDS*

      Press the **[2]** key (*ERASE ALL RECORDS*) to delete all test records from the connected USB Flash drive. The following warning screen will be displayed:
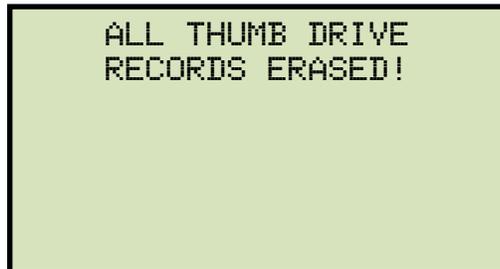
```
  ERASE ALL THUMB DRIVE
  RECORDS!

       ARE YOU SURE?

    "ENTER" TO CONTINUE
```

Press the **[STOP]** key if you do not want to erase all the test records. You will be returned to the "START-UP" menu.

Press the **[ENTER]** key to proceed with deleting all the test records from the connected USB Flash drive. The following screen will be displayed when all the records have been erased:

```
ALL THUMB DRIVE
RECORDS ERASED!
```

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

3.17   Converting Resistance Measurements

The TRM 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 = 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 constant used for the winding material
        Tk = 234.5 for copper
        Tk = 240.0 for aluminum

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