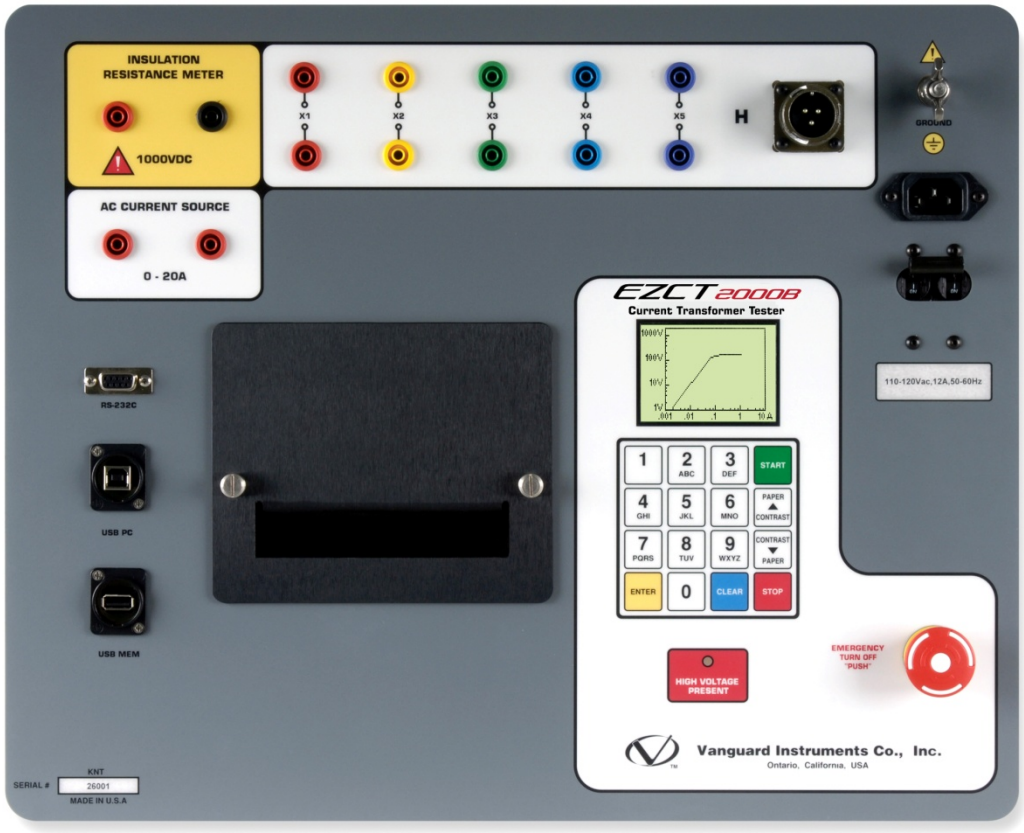
EZCT-2000B™

DIGITAL CURRENT-TRANSFORMER TESTER

USER'S MANUAL



Vanguard Instruments Company, Inc.
1520 S. Hellman Ave.
Ontario, California 91761, USA

TEL: (909) 923-9390
FAX: (909) 923-9391

June 2014
Revision 1.9

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 EZCT-2000B, or cause errors in the test results. Vanguard Instruments Company, Inc. assumes no liability for unsafe or improper use of the EZCT-2000B.

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 WARNINGS AND CAUTIONS

The EZCT-2000B can produce a voltage up to 2,000 Vac that can cause severe injury and/or equipment damage. Due to this reason, the EZCT-2000B shall be used only by **trained operators**.

The EZCT-2000B's X output terminals are rated to 2,000 Vac working voltage. Any voltage above 2,000 Vac will damage the input circuitry. Please see section 3.2 for further information.

All devices under test shall be **off-line** and **fully isolated**. Never attempt to test any current transformer still connected to a circuit. All current transformer terminals shall be isolated before conducting any test with the EZCT-2000B.

Always ground the EZCT-2000B to a substation ground before connecting the test cables to a transformer.

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 EZCT-2000B 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:

- A key or switch on the EZCT-2000B is indicated as **[KEY]**.
- Menu options are referenced as (*MENU OPTION*).
- Screen and menu names are referenced as "SCREEN/MENU NAME".
- The terms "test record" and "test shot" are used interchangeably.
- The terms "USB Flash drive" and "USB thumb drive" are used interchangeably.
- EZCT-2000B LCD screen output is shown as:

```
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 EZCT-2000B is Vanguard's third-generation microprocessor-based current transformer test set. Designed specifically for CT testing, the EZCT-2000B has the following outstanding features that can greatly increase productivity and save time during the commissioning stage:

- Performs CT excitation, current-ratio, polarity, and phase angle tests
- Measures insulation resistance and winding resistance of the CT secondary windings
- Measures the CT's secondary burden

The EZCT-2000B's test leads can be connected to all the CT output terminals, and the complete CT test can be performed automatically without any operator intervention.

Saturation Test

The CT saturation test is performed in compliance with the ANSI/IEEE C57.13.1 and IEC 60044 standards. Test voltage ranges from 50, 300, 500,1200 and 2000 Vac can be selected for the saturation test. The test voltage is raised and lowered automatically by the EZCT-2000B. The saturation test voltage and current data is collected and stored in the EZCT-2000B's internal memory. Knee point voltages (ANSI 10/50, IEC 10/50, IEEE-30, IEEE-45) are calculated and printed on the test report.

All of the EZCT-2000B's test leads can be connected to the CT output terminals (X1, X2, X3, X4 and X5), and there is no lead switching required during testing. This convenient arrangement allows for testing any of the 10 possible combinations of X1 to X5. Up to 10 saturation tests can be stored in one record. Once the test is completed, the test report and CT excitation curves can be printed on the built-in thermal printer.

CT Ratio and Polarity Test

The CT current-ratio is determined using the ANSI/IEEE C57.12.90 measurement method. A test voltage is applied on any two terminals (X1 to X5) of the CT, and the induced voltage is measured through the H1 and H2 terminals of the CT. The CT current-ratio is displayed and also stored in memory. The current-ratio is measured from 0.8 to 5,000. The CT winding polarity is displayed as a "+" sign (in-phase) or a "-" sign (out-of-phase) and is annotated with the phase angle in degrees. The CT current-ratio error and phase displacement is also calculated based on the CT burden (or rated power) and rated current.

CT Winding Resistance Test

The EZCT-2000B can measure the DC resistance of the CT winding under test. The DC winding resistance reading range is from 100 micro-ohms to 10 Ohms. Equivalent winding resistance values at different temperatures are also provided in the report.

CT Winding Insulation Resistance Test

The EZCT-2000B can also measure the insulation resistance of the CT's secondary winding using a test voltage up to 1000 Vdc. The DC winding resistance reading range is from 2 to 500 Mega-ohms. The insulation resistance test results are displayed and printed on the report.

CT Burden Test

The EZCT-2000B can measure the CT's secondary burden by injecting a 1A or 5A test current into the load. The CT burden measurements (Voltage, current, Cos φ, and burden impedance) are displayed on the screen and printed on the test report. This important test verifies the actual CT burden before putting the CT in service, thus avoiding any potential configuration conflicts.

Current Source

The EZCT-2000B's programmable current source (0-20A, 0-15Vac) can be used to verify CT loads. The on-time timer and output current are displayed on the LCD screen.

Test Record Header Information

Test record header information, including the company, substation name, circuit ID, manufacturer, mode, CT serial number, and the operator's name, can be stored with each record. In addition to the test record header, a 20-character test description for each test in the record (10 tests per record) can also be entered.

User Interface and Display

The EZCT-2000B features a back-lit LCD screen (128 x 64 dot graphic) that is clearly viewable in both bright sunlight and low-light levels. An alpha-numeric keypad is used to enter test information and to control the unit's functions.

Built-in Thermal Printer

A 4.5-inch wide built-in thermal printer can print the CT test results and saturation curves.

Internal Test Record Storage Capacity

The EZCT-2000B can store up to 140 test records in Flash EEPROM. Each test record may contain up to 10 saturation curves, current-ratio readings, polarity and DC resistance readings, insulation test results, and load burden test results. Test records can be recalled and printed by the built-in thermal printer. Test records can also be transferred to a PC using the RS-232C port, USB port, or via the USB Flash drive interface port.

Internal Test Plan Storage Capacity

The EZCT-2000B can store up to 128 CT test plans in Flash EEPROM. A test plan is comprised of the saturation test voltage, current range selection, CT nameplate ratios, and CT winding terminal combinations (X1 to X5) for each test and also includes the insulation and CT load burden test definitions. Up to 10 test definitions can be stored per test plan. The ability to store test plans makes CT testing an extremely simple process. To perform a test, the EZCT-2000B is connected to the CT terminals and a test plan is selected to run.

Creating test plans for the EZCT-2000B is also a simple process. A test plan can be created using the EZCT-2000B's keypad or can be created on a PC (with provided software) and then downloaded to the EZCT-2000B via the RS-232C or USB ports. For added convenience, test plans can also be copied from a USB Flash drive to the EZCT-2000B via the USB Flash drive interface.

Computer Interface

The EZCT-2000B can be used as a stand-alone unit or can be computer-controlled. It can be connected to a PC via the standard RS-232C or USB port. In computer-controlled mode, test records can be downloaded from the EZCT-2000B's memory, or CT tests can be run from the PC. A Windows® XP/Vista-based Current Transformer Analysis software application is provided with the EZCT-2000B and can be used to transfer test records from the EZCT-2000B to a PC. Test plans can also be created with the provided software. Additionally, tabulated test records can be exported to Microsoft® Excel.

1.2 Furnished Test Accessories

The EZCT-2000B comes furnished with the following:

- 1 Power Cord
- 5 20-foot X Cable Sets
- 1 35-foot H Cable Set
- Current Source Cables
- Insulation Test Cables
- Ground Cables
- Transportation Case

1.3 Technical Specifications

Table 1. EZCT-2000B Technical Specifications

TYPE	Portable current-transformer test set
PHYSICAL SPECIFICATIONS	19"W X 13"H x 15.8" D (48.3 cm x 33.0 cm x 40.1 cm); Weight: 73 lbs (33.1 kg)
INPUT POWER	100 – 120 Vac or 200 – 240 Vac (factory pre-set), 50/60 Hz
MEASUREMENT METHOD	ANSI/IEEE C57.12.90, IEC 60044-1, and ANSI/IEEE C57.13.1 standards
TEST OUTPUT VOLTAGES	0 – 50 Vac @ 10A max; 0 – 300 Vac @ 10A max; 0 – 500 Vac @ 5A max; 0 – 1200 Vac @ 1.2A max; 0 – 2000 Vac @ 1A max
CURRENT SOURCE	1 – 20A @ 0 – 15 Vac
CURRENT SOURCE DISPLAY	Test current and current on-time
VOLTAGE READING RANGE	0 – 2,200 Vac; Accuracy: ±1.0% of reading, ±1 V
CURRENT READING RANGE	0 – 10A; Accuracy: ±1.0% of reading, ±0.02A
CT CURRENT RATIO RANGE	0.8 – 999: 0.1%; 1000 – 1999: 0.3%; 2,000 – 5,000: 1%
PHASE ANGLE MEASUREMENT	0 – 360 degrees; Accuracy: ± 1.0 degree)
RESISTANCE READING RANGE	100 micro-ohms – 10 ohms; Accuracy: 2% of reading, ± 1 count
INSULATION RESISTANCE READING RANGE	2 Mega-ohms – 500 Mega-ohms; Accuracy: 3% of reading, 500 Vdc or 1000 Vdc test voltage
DISPLAY	Back-lit LCD Screen (128 x 64 dot graphic); viewable in bright sunlight and low-light levels
PRINTER	Built-in 4.5-inch wide thermal printer
COMPUTER INTERFACES	One RS-232C (115,000 Baud) port, One USB port
EXTERNAL DATA STORAGE	One USB Flash drive interface port
PC SOFTWARE	Windows® XP/Vista-based CT Analysis software is included with the purchase price
INTERNAL TEST RECORD STORAGE	Stores 140 test records. Each test record may contain up to 10 saturation curves, current-ratio readings, polarity and DC resistance readings, insulation resistance test results, and CT load burden test results.
INTERNAL TEST PLAN STORAGE	Stores 128 test plans. A test plan consists of the saturation test voltage, current selection, CT nameplate ratios, and CT winding terminal combinations (X1 to X5) for each test.
SAFETY	Designed to meet UL 6110A-1 and CAN/CSA C22.2 No. 1010.1-92 standards
ENVIRONMENT	Operating: -10°C to 50°C (15°F to +122°F); Storage: -30°C to 70°C (-22°F to +158°F)
CABLES	Five 20-foot X cable sets, One 35-foot H cable set, current source cables, insulation test cables, power cord, ground cable. A transportation case is included with the purchase price.
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 EZCT-2000B Controls and Indicators

The EZCT-2000B'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 EZCT-2000B. 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.

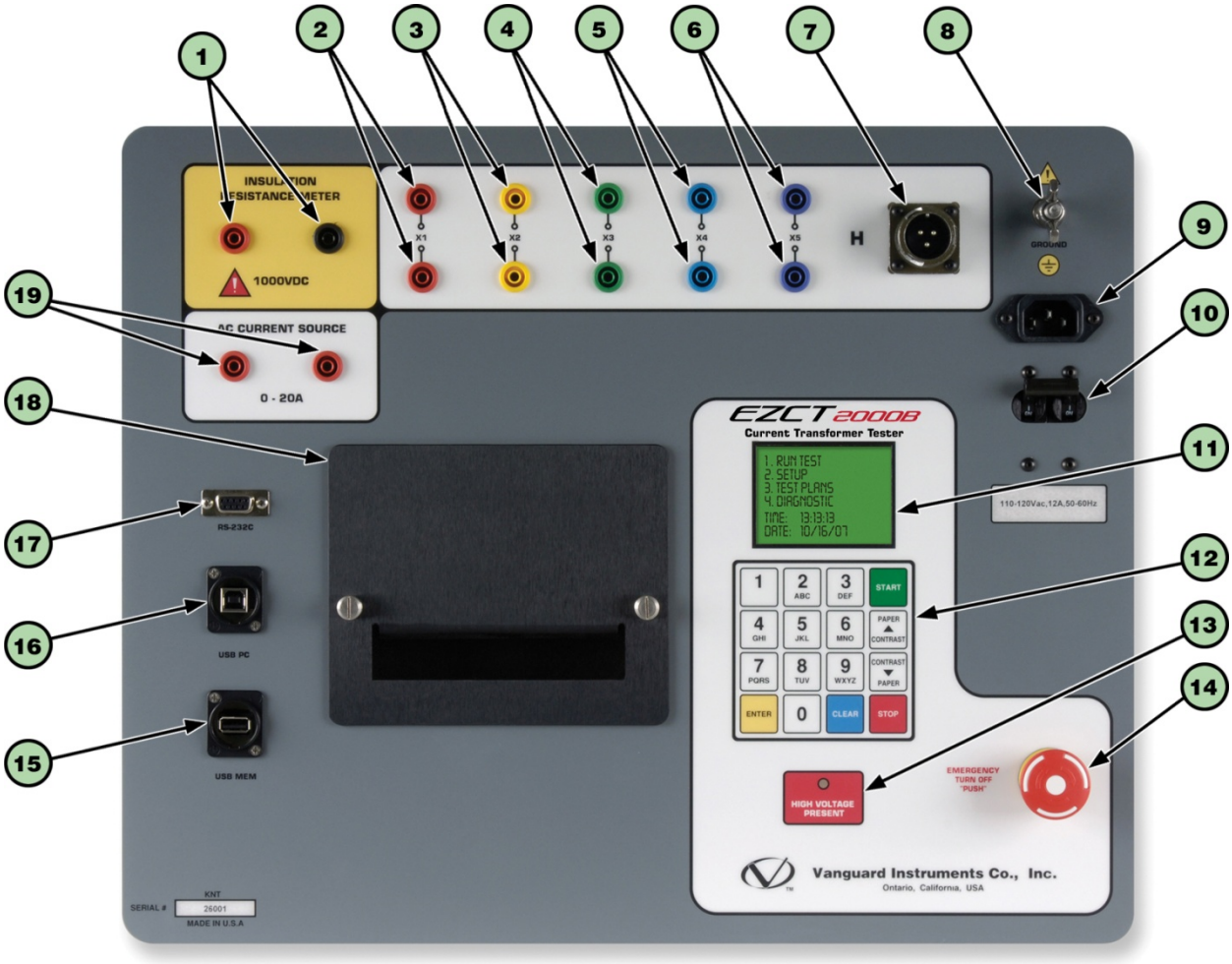


Figure 1. EZCT-2000B Controls and Indicators

Table 2. Functional Descriptions of EZCT-2000B Controls and Indicators

Item Number	Panel Markings	Functional Description
1	INSULATION RESISTANCE METER	Insulation resistance meter connectors.
2-6	X1, X2, X3, X4, X5	Current transformer excitation voltage connectors. Each set of connectors contains a test voltage connector and sensing connector. The EZCT-2000B's X output terminals are rated to 2000 Vac working voltage. **Any voltage above 2000 Vac will damage the input circuitry**.
7	H	Current transformer primary input test cable connector.
8	GROUND	Grounding stud.
9	None	AC receptacle.
10	100-120Vac, 12A 50-60Hz	Power switch with built-in circuit breaker.
11	None	Back-lit graphic LCD screen (128 x 64); viewable in bright sunlight and low light levels.
12	None	Rugged, alpha-numeric membrane keypad
13	HIGH VOLTAGE PRESENT	LED warning indicator that is illuminated when high voltage is present.
14	EMERGENCY TURN OFF "PUSH"	Emergency turn off switch.
15	USB MEM	USB Flash drive interface.
16	USB PC	USB PC interface.
17	RS-232C	RS-232C PC interface. Baud rate is set for 115KB, 8 data bits, 2 stop bits.
18	None	Built-in 4.5-inch wide thermal printer.
19	AC CURRENT SOURCE 0 – 20A	AC current source connectors.

2.0 PRE-TEST SETUP

2.1 Operating Voltages

The EZCT-2000B's operating voltage is preset at the factory for 100-120 Vac, 50/60 Hz or 200-240 Vac, 50/60 Hz.

2.2 LCD Screen Contrast Control

To increase the LCD screen contrast, press and hold the **[PAPER ∧ Contrast]** key for two seconds. Release the button when the desired contrast level has been reached.

To decrease the LCD screen contrast, press and hold the **[PAPER ∨ Contrast]** key for two seconds. Release the button when the desired contrast level has been reached.

2.3 Printer Paper Control

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

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

2.4 Printer Paper

The EZCT-2000B's built-in thermal printer uses 4.5-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-4 paper

BG Instrument Co.
13607 E. Trent Avenue
Spokane, WA 99216
Tel: 509-893-9881
Fax: 509-893-9803
Part Number: VIC TP-4 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.

2.6 Computer Interface Ports

The EZCT-2000B features one USB and one RS-232C PC interface port. A Windows-based "Current Transformer Analysis" software application is supplied with the EZCT-2000B. For further information, please see the software user's manual.

3.0 OPERATING PROCEDURES

3.1 EZCT-2000B Cable Connections

Always connect the EZCT-2000B to the substation ground before connecting any test cables. The EZCT-2000B is supplied with five 20-foot X test cables and one 35-foot H cable. The X cable connections are required to run the current transformer excitation test. The H and X cable connections are required to run the transformer turns-ratio test. A typical excitation and ratio test connection is shown in Figure 2. The insulation resistance test connection is shown in Figure 3. The burden test connection is shown in Figure 4. The current source test connection is shown in Figure 5. Transformer bushing CT connections for Delta and Y transformers are shown in Figure 6 and Figure 7, respectively.

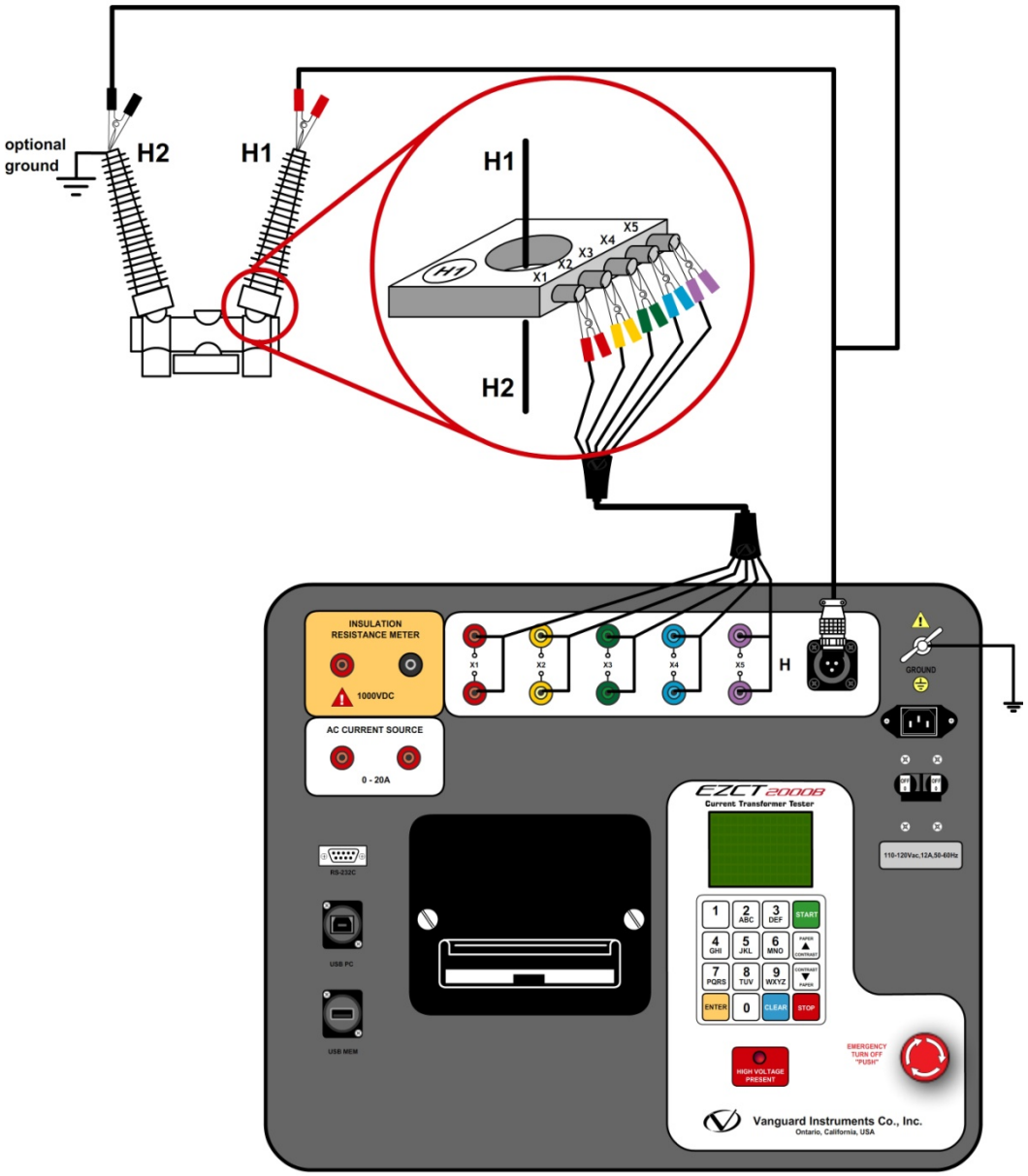


Figure 2. Typical EZCT-2000B Excitation and Ratio Test Cable Connection

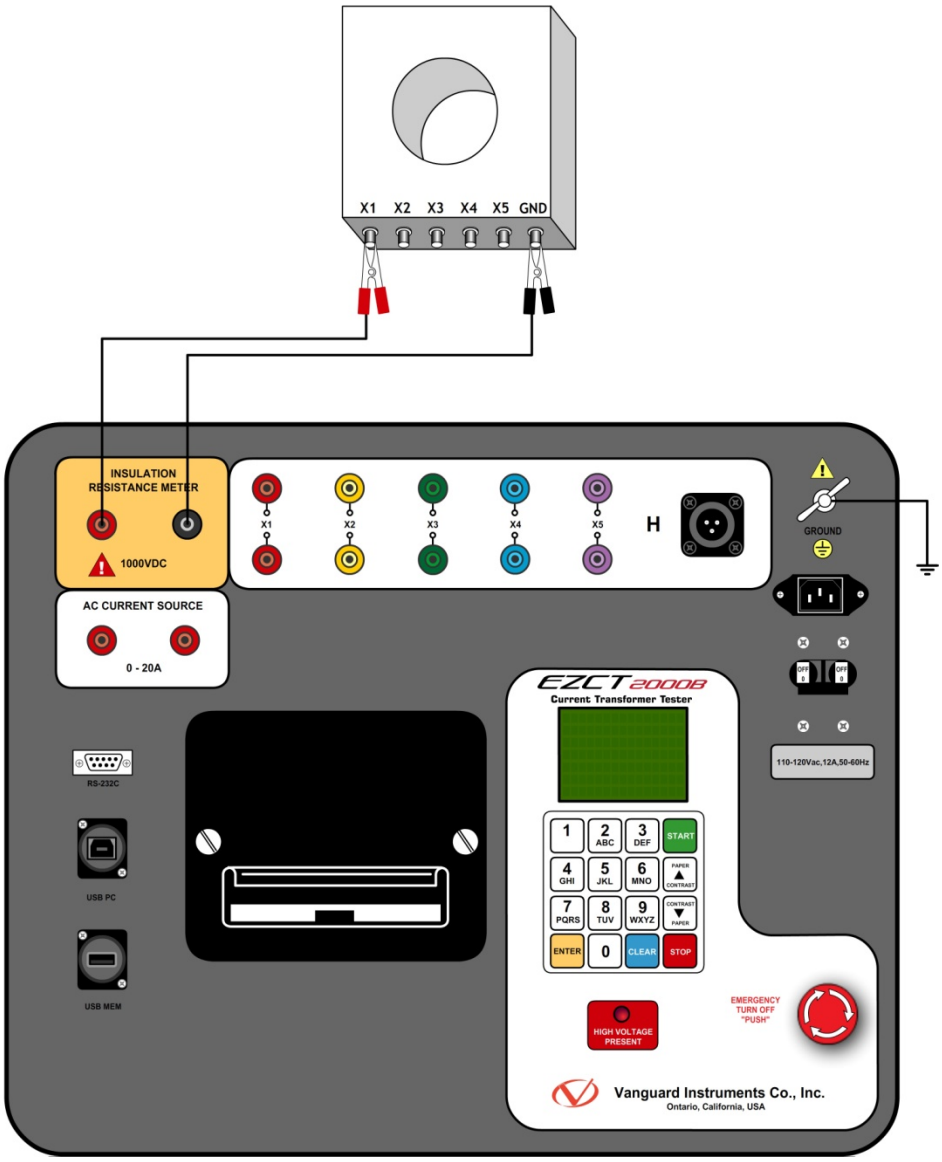


Figure 3. EZCT-2000B Insulation Resistance Test Cable Connection

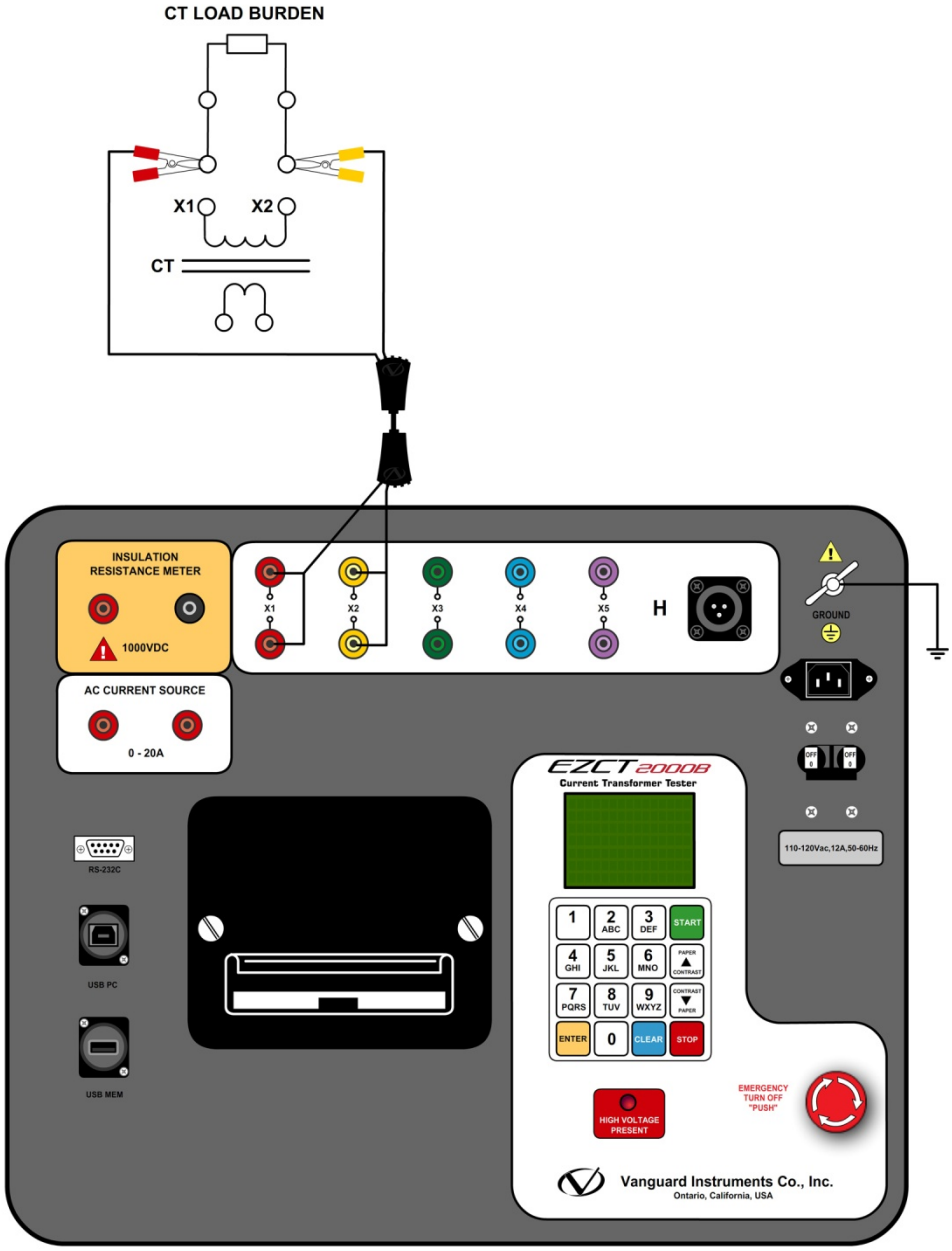


Figure 4. EZCT-2000B CT Load Burden Test Cable Connection

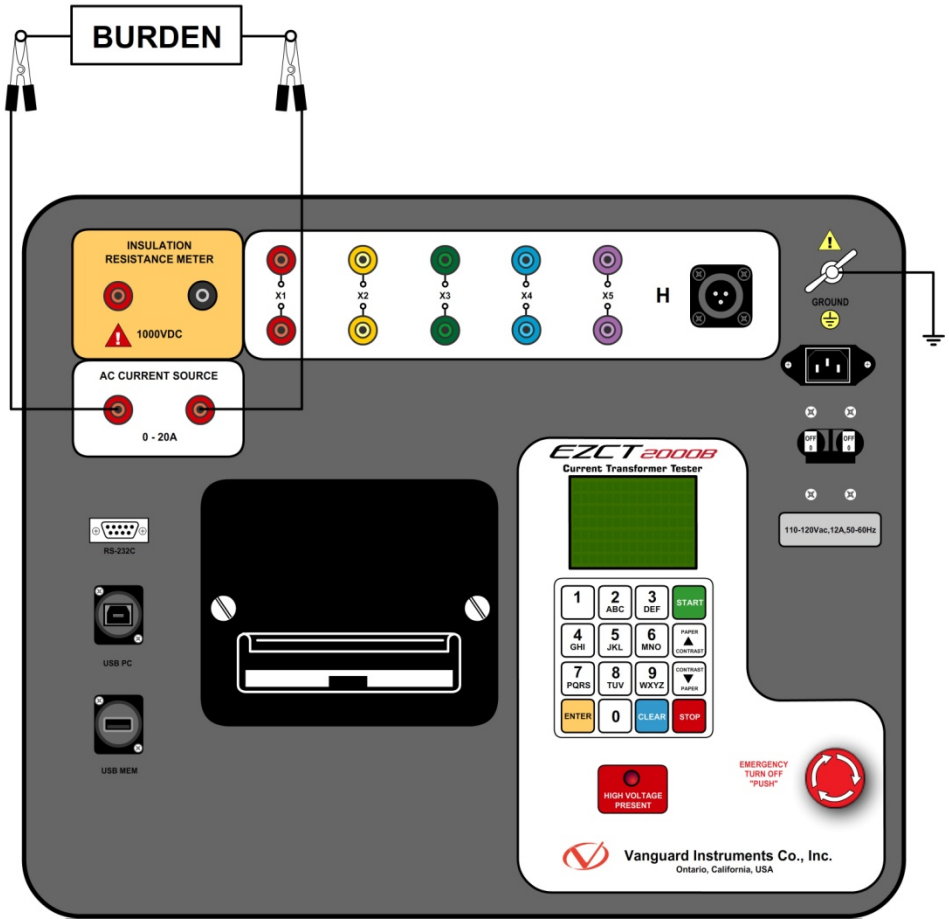


Figure 5. EZCT-2000B Typical Current Source Connection

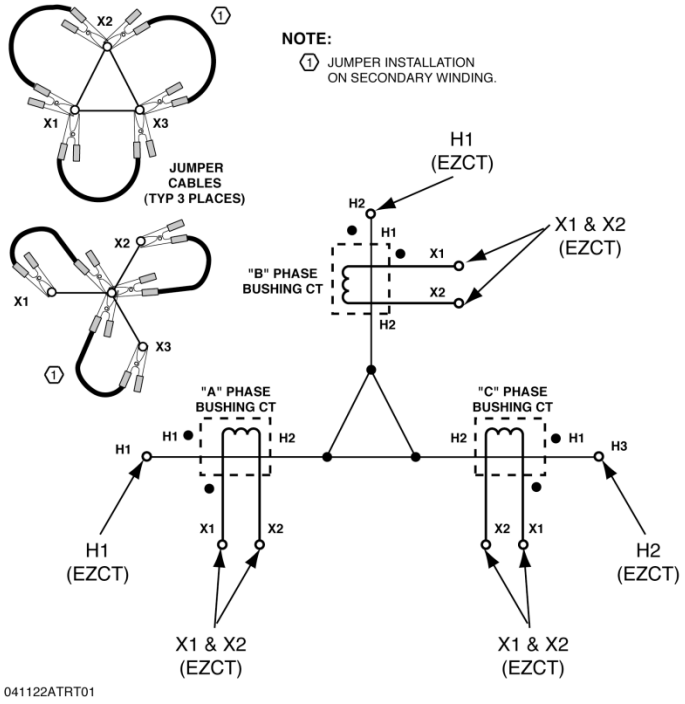


Figure 6. Bushing CT Connection on Delta Transformer

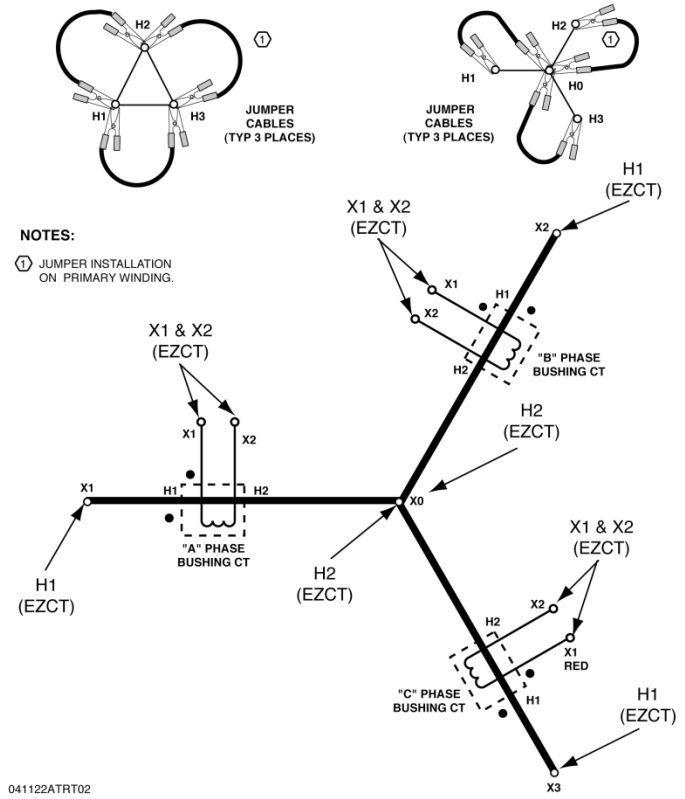


Figure 7. Bushing CT Connection on Y Transformer

3.2 EZCT-2000B X Input Voltage Warning

The EZCT-2000B X output terminals are rated to 2,000 Vac working voltage. Any voltage present at these terminals above 2,000 Vac may damage the X sense circuitry, cause false readings, or both. An example of a typical situation where this may occur is shown in Figure 8 below.

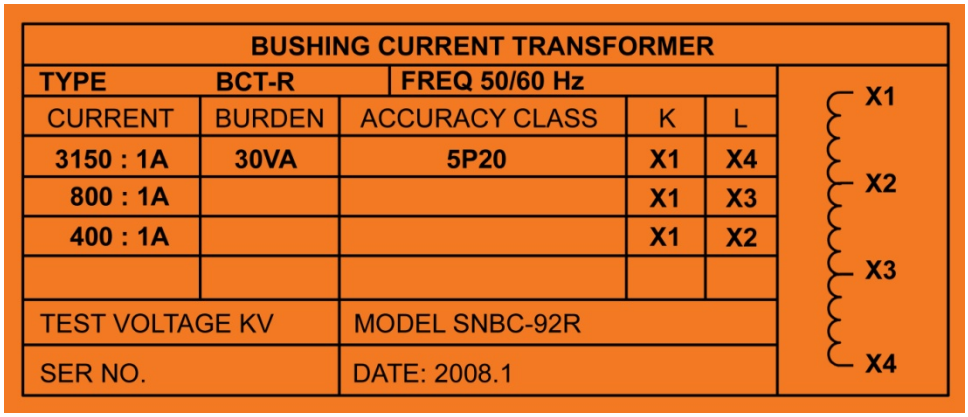


Figure 8. Sample CT Name Plate

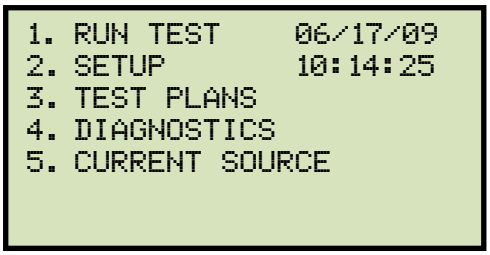
For the above example CT, the turns ratio between X1-X4 is 3150 to 1. The turns ratio between X1-X2 is 400 to 1. The turns ratio between X1-X4 and X1-X2 is 7.88 (3150/400). If a test voltage of 300 Vac is applied to the X1-X2 terminals, a voltage of 2,364 Vac (300 Vac x 7.88) will be induced at the X1-X4 terminals. If all the test leads are connected to the EZCT-2000B and the excitation test is performed on the X1-X2 terminals, the voltage induced at the X1-X4 terminals will exceed 2,000 Vac as the voltage across the X1-X2 terminals increases above 250 Vac. A "Flash-Over" condition may occur and damage the EZCT-2000B. In this case, the user should only connect the X1-X2 leads and run its excitation test, then connect the X4 lead before running the X1-X4 excitation test.

3.3 Performing Tests

3.3.1. Entering Test Record Header Information

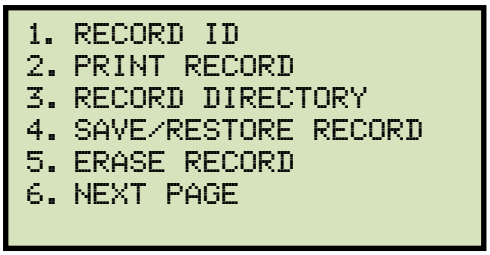
You can enter the test record header information before performing tests. The record header includes identifying information such as the company, station, circuit, model number, etc. Once the header information has been entered, it will apply to all subsequent test records. To enter the header information:

a. When the unit is turned on and the firmware has been loaded, you will be presented with the "START-UP" menu as shown below:



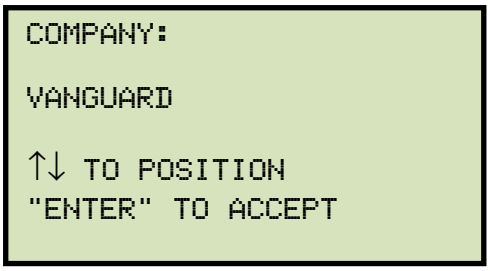
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:



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

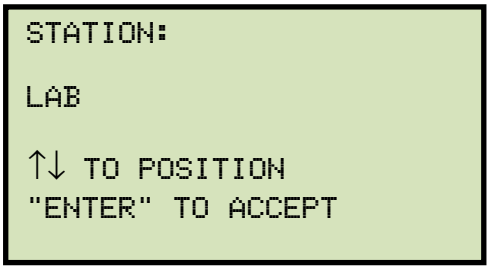
c. The following screen will be displayed:



Type the company name using the alpha-numeric keypad.

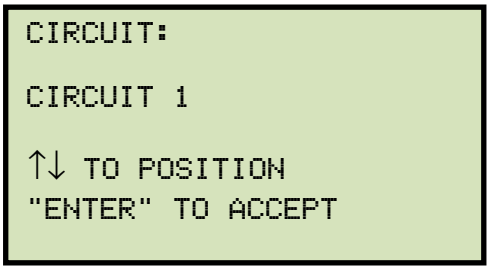
When pressing a key, the corresponding number on the key will be displayed first. Pressing the key again will display the first letter on the key. Pressing the key again will display the second letter on the key. For example, to type the letter "A", you must press the **[2]** key twice. To erase the 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:



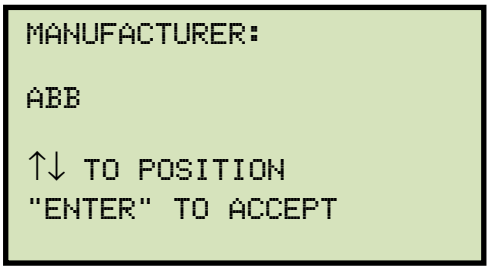
Type the station name using the alpha-numeric keypad and then press the **[ENTER]** key.

e. The following screen will be displayed:



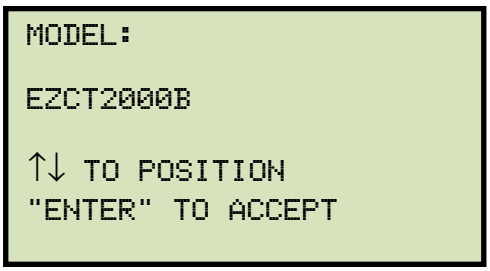
Type the circuit information using the alpha-numeric keypad and then press the **[ENTER]** key.

f. The following screen will be displayed:



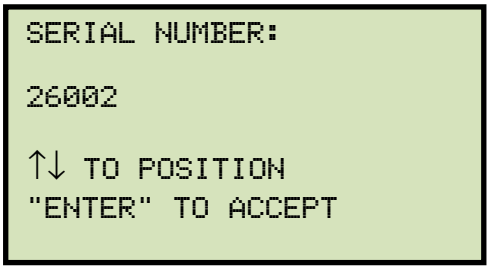
Type the manufacturer name using the alpha-numeric keypad and then press the **[ENTER]** key.

g. The following screen will be displayed:



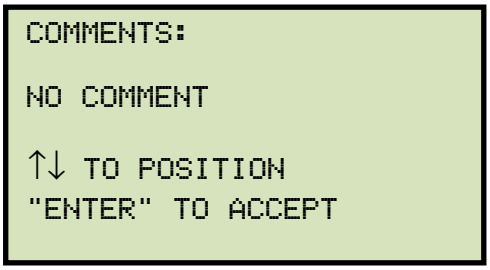
Type the model information using the alpha-numeric keypad and then press the **[ENTER]** key.

h. The following screen will be displayed:



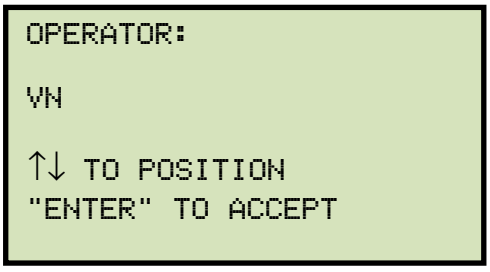
Type the serial number using the alpha-numeric keypad and then press the **[ENTER]** key.

i. The following screen will be displayed:



Enter any relevant comments using the alpha-numeric keypad and then press the **[ENTER]** key.

j. The following screen will be displayed:

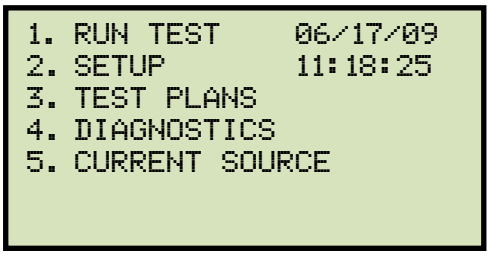


Type the operator's name using the alpha-numeric keypad and then press the **[ENTER]** key. All header information will be saved, and you will be returned to the "START-UP" menu.

3.3.2. Performing Resistance, Excitation, and Ratio Tests

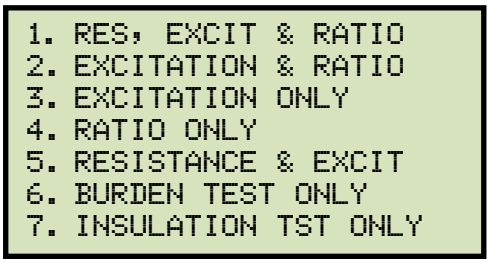
The following procedure describes the general steps for performing excitation, resistance, and ratio tests.

a. When the EZCT-2000B is turned on, it will first go through a start-up cycle and load the firmware. Then the "START-UP" menu will be displayed as shown below:



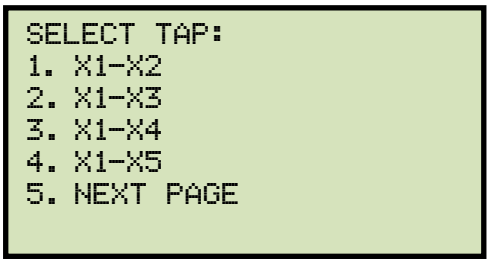
Press the **[1]** key (*RUN TEST*) to start a test.

b. The following screen will be displayed:



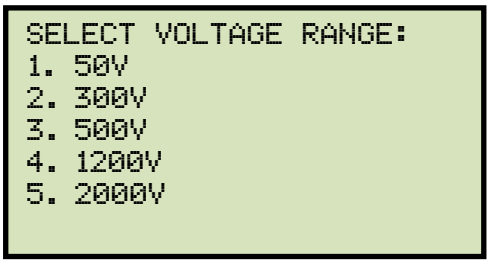
Select the test type by pressing the corresponding key **([1]** - **[5])**

c. The following screen will be displayed:



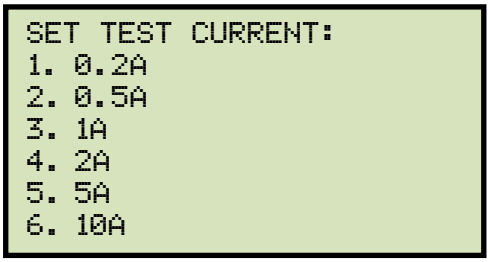
Select the tap connection by pressing the corresponding key **([1]** - **[4])**. If the tap connection is not listed, press the **[5]** key to view the next page of options.

d. If the selected test included an excitation test, the following screen will be displayed:



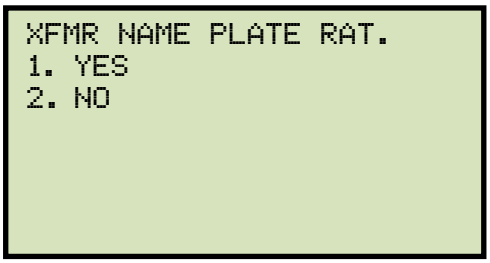
Select a test voltage range by pressing the corresponding key (**[1]** - **[5]**).

e. If the selected test included an excitation test, the following screen will be displayed:



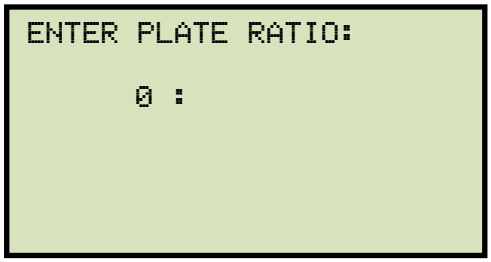
Select the maximum test current for the excitation test by pressing the corresponding key **([1]** - **[6])**.

f. If the selected test included a ratio test, the following screen will be displayed:



1. *YES*

   Press the **[1]** key if you would like to enter the CT nameplate values. The following screen will be displayed:

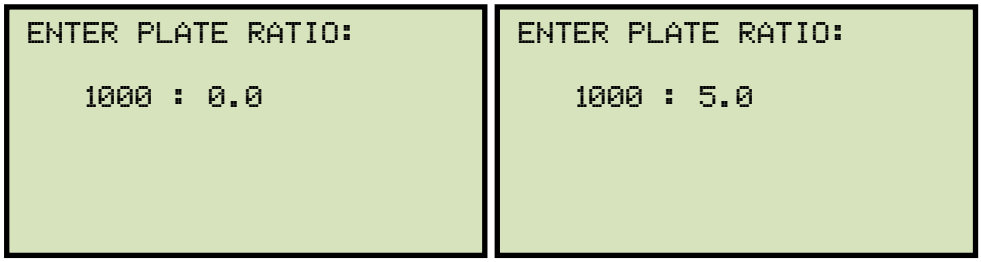


   Type the first number using the keypad.

NOTE

You can press the **[CLEAR]** key to restart a field entry if necessary.

Press the **[ENTER]** key. The following screen will be displayed:

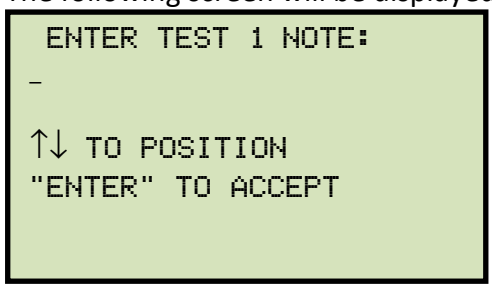


Type the second number using the keypad and then press the **[ENTER]** key. Continue to step g.

2. *NO*

   Press the **[2]** key if you do not want to enter the CT nameplate values. Continue to step g.

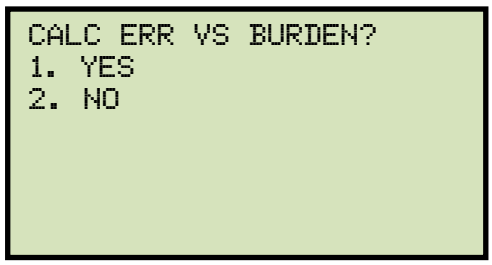
g. The following screen will be displayed:



Use the alpha-numeric keys on the keypad to enter a test note. The test note field is 20 characters long. One test note can be saved for each test.

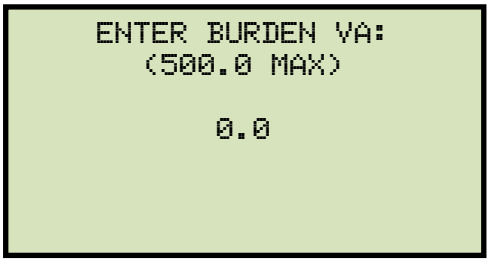
When pressing a key, the corresponding number on the key will be displayed first. Pressing the key again will display the first letter on the key. Pressing the key again will display the second letter on the key. For example, to type the letter "A", you must press the **[2]** key twice. To erase the character at the cursor position, press the **[CLEAR]** key. Press the **[PAPER ∧ Contrast]** button 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 note.

h. The following screen will be displayed:



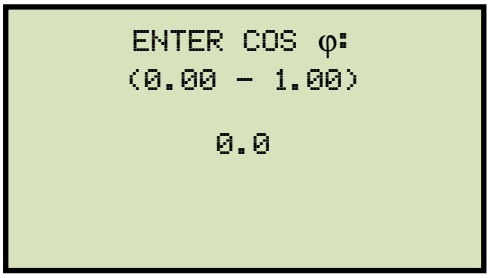
Press the **[1]** key (*YES*). Selecting this option will print the current ratio error table and current phase error table as part of the tabulated test results. Please see Figure 9, items 19 and 20.

i. The following screen will be displayed:



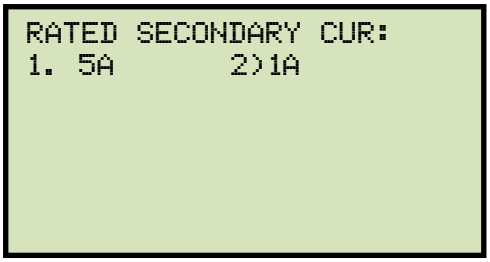
Type the burden value using the keypad and then press the **[ENTER]** key.

j. The following screen will be displayed:



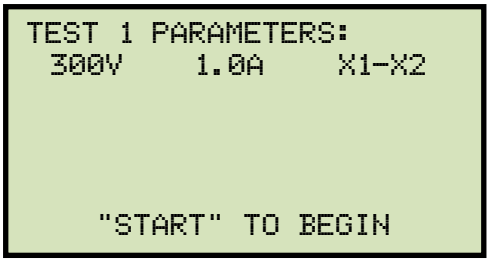
Type the Cos φ value using the keypad and then press the **[ENTER]** key.

k. The following screen will be displayed:



Select the rated secondary current by pressing the **[1]** key (*5A*) or **[2]** key (*1A*).

l. The following screen will be displayed showing a summary of the test parameters:



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

m. If the selected test included a resistance test, the following screen will be displayed momentarily:

```
CABLES ENERGIZED!
 300V    1.0A    X1-X2
DC RESISTANCE TEST
```

The following screen will then be displayed:

```
CABLES ENERGIZED!
 300V    1.0A    X1-X2
RESISTANCE = 215.1Ω
```

NOTE

The "HIGH VOLTAGE PRESENT" light will be illuminated to indicate that high voltage is present.

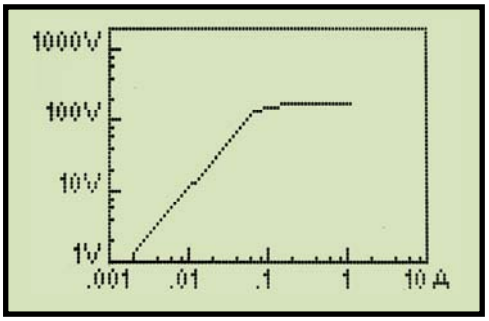
n. If the selected test included a ratio test, the following screen will be displayed momentarily:

```
CABLES ENERGIZED!
 300V    1.0A    X1-X2
I= 0.0004 AMPS
V= 34.2 VAC
```

The following screen will then be displayed:

```
RATIO TEST

VX = 99.5     VH = 0.497
I=0.0402      RAT=+199.88
```

When the testing is finished, the test results graph will be displayed:



Press any key on the keypad to continue.

o. The following screen will be displayed:

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

Press the **[1]** key (*YES*) if you would like to print the test results. The test results will be printed on the thermal printer. A typical EZCT-2000B tabulated test report printout is shown in Figure 9. A typical graphic report is shown in Figure 10.

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

p. The following screen will be displayed:

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

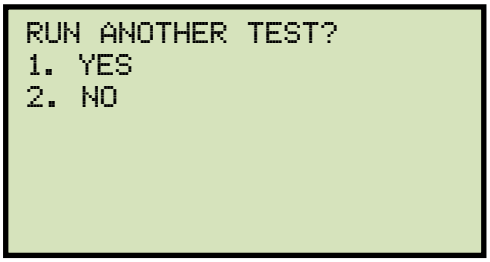
Press the **[1]** key (*YES*) to keep the test results.

q. The following screen will be displayed:

```
      TEST 1 SAVED
```

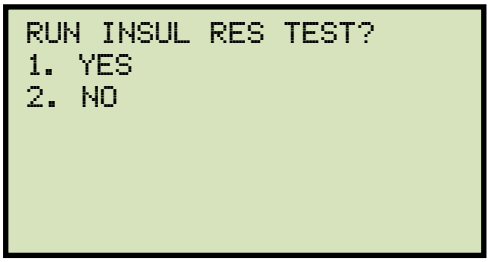
Press any key to continue.

r. The following screen will be displayed:



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

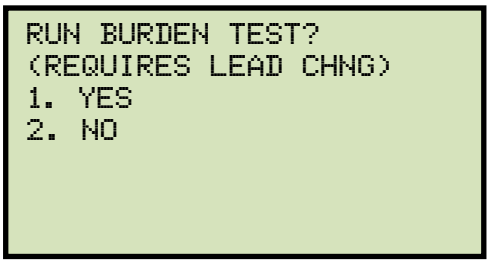
s. The following screen will be displayed:



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

If you would like to run the insulation resistance test as well, press the **[1]** key and then follow the instructions in section 3.3.4, steps c to f.

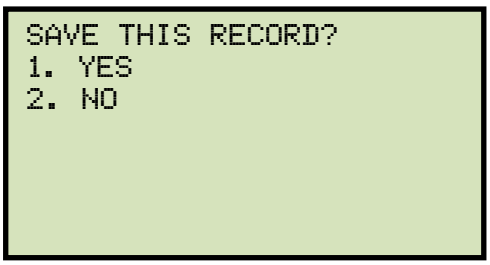
t. The following screen will be displayed:



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

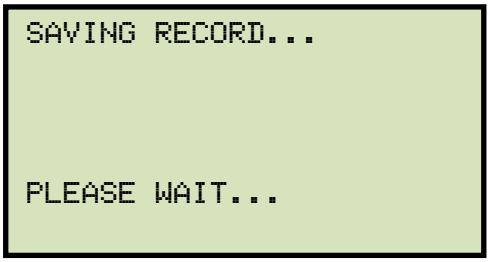
If you would like to run the burden test as well, press the **[1]** key and then follow the instructions in section 3.3.3, steps c to e.

u. The following screen will be displayed:

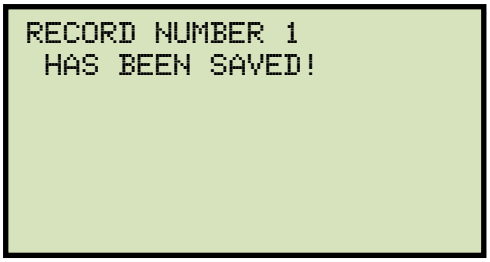


Press the **[1]** key (*YES*) to save the record.

The following screen will be displayed momentarily:



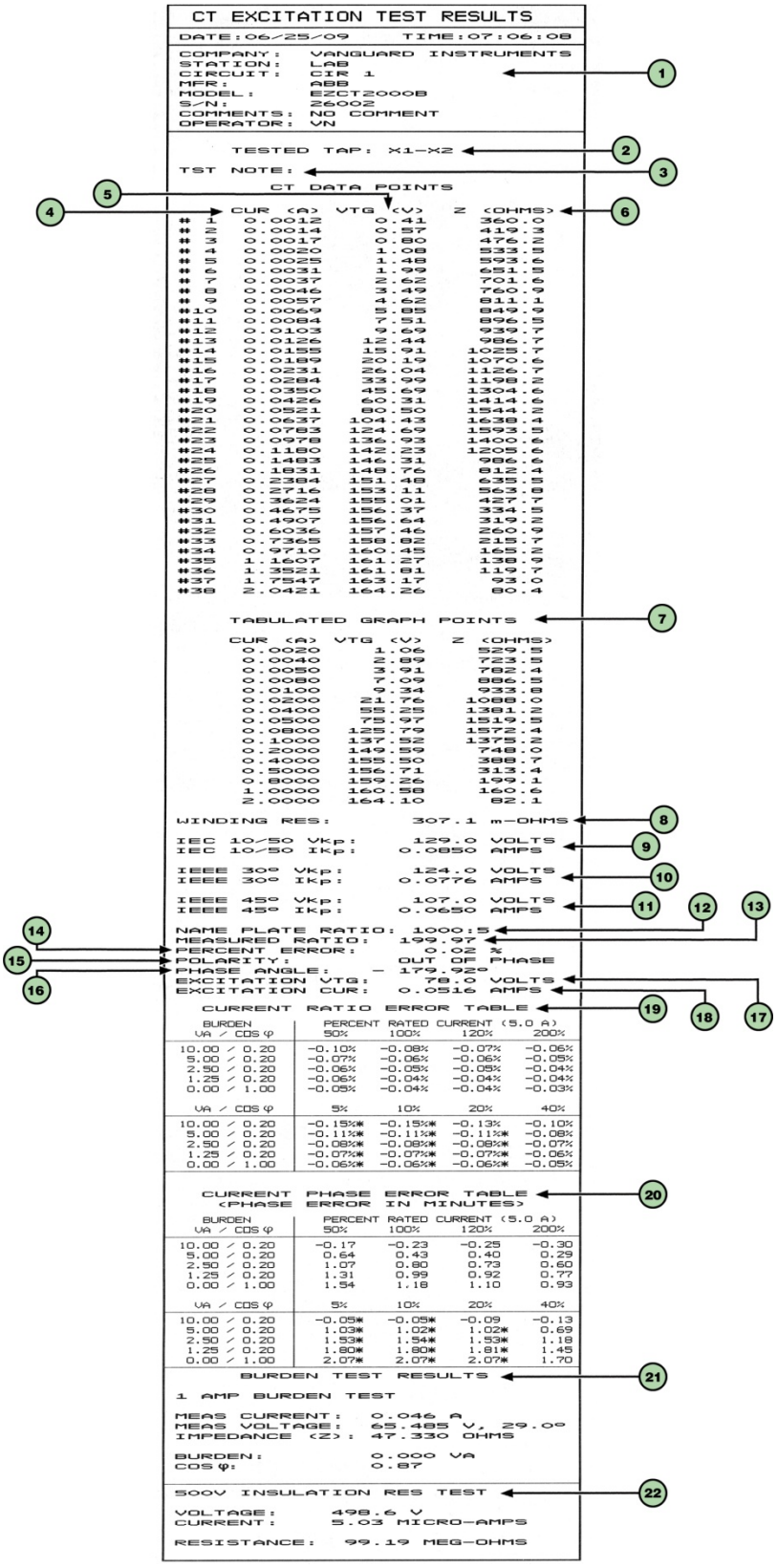
v. The following confirmation screen will then be displayed:



NOTE

The test record number is automatically assigned to each test record stored in the EZCT-2000B's Flash EEPROM.

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



CT EXCITATION TEST RESULTS

DATE:06/25/09 TIME:07:06:08

COMPANY: VANGUARD INSTRUMENTS
STATION: LAB
CIRCUIT: CIR 1
MFR: ABB
MODEL: EZCT2000B
S/N: 26002
COMMENTS: NO COMMENT
OPERATOR: VN

TESTED TAP: X1-X2

TST NOTE:

CT DATA POINTS

	CUR (A)	VTG (V)	Z (OHMS)
# 1	0.0012	0.41	360.0
# 2	0.0014	0.57	419.3
# 3	0.0017	0.80	476.2
# 4	0.0020	1.08	533.5
# 5	0.0025	1.48	593.6
# 6	0.0031	1.99	651.3
# 7	0.0037	2.62	701.6
# 8	0.0046	3.49	760.9
# 9	0.0057	4.62	811.1
#10	0.0069	5.85	849.9
#11	0.0084	7.51	896.5
#12	0.0103	9.69	939.7
#13	0.0126	12.44	986.7
#14	0.0155	15.91	1025.7
#15	0.0189	20.19	1070.6
#16	0.0231	26.04	1126.7
#17	0.0284	33.99	1198.2
#18	0.0350	45.69	1304.6
#19	0.0426	60.31	1414.6
#20	0.0521	80.50	1544.2
#21	0.0637	104.43	1638.4
#22	0.0783	124.69	1592.5
#23	0.0978	136.93	1400.6
#24	0.1180	142.23	1205.6
#25	0.1493	146.31	986.4
#26	0.1831	148.76	812.4
#27	0.2384	151.48	635.5
#28	0.2716	153.11	563.8
#29	0.3624	155.01	427.7
#30	0.4575	156.37	334.5
#31	0.4907	156.64	319.2
#32	0.6036	157.46	260.9
#33	0.7365	158.82	215.7
#34	0.9710	160.45	165.2
#35	1.1607	161.27	138.9
#36	1.3521	161.81	119.7
#37	1.7547	163.17	93.0
#38	2.0421	164.26	80.4

TABULATED GRAPH POINTS

CUR (A)	VTG (V)	Z (OHMS)
0.0020	1.06	529.5
0.0040	2.89	723.5
0.0050	3.91	782.1
0.0080	7.09	886.5
0.0100	9.34	933.8
0.0200	21.76	1088.0
0.0400	55.25	1381.2
0.0500	75.97	1519.5
0.0800	125.79	1572.4
0.1000	137.52	1375.2
0.2000	149.59	748.0
0.4000	155.50	388.7
0.5000	156.71	313.4
0.8000	159.26	199.1
1.0000	160.58	160.6
2.0000	164.10	82.1

WINDING RES: 307.1 m-OHMS

IEC 10/50 Vkp: 129.0 VOLTS
IEC 10/50 Ikp: 0.0850 AMPS

IEEE 30° Vkp: 124.0 VOLTS
IEEE 30° Ikp: 0.0776 AMPS

IEEE 45° Vkp: 107.0 VOLTS
IEEE 45° Ikp: 0.0650 AMPS

NAME PLATE RATIO: 1000:5
MEASURED RATIO: 199.97
PERCENT ERROR: 0.02 %
POLARITY: OUT OF PHASE
PHASE ANGLE: - 179.92°
EXCITATION VTG: 78.0 VOLTS
EXCITATION CUR: 0.0516 AMPS

CURRENT RATIO ERROR TABLE

BURDEN VA / COS φ	PERCENT RATED CURRENT (5.0 A) 50%	100%	120%	200%
10.00 / 0.20	-0.10%	-0.08%	-0.07%	-0.06%
5.00 / 0.20	-0.07%	-0.06%	-0.06%	-0.05%
2.50 / 0.20	-0.06%	-0.05%	-0.05%	-0.04%
1.25 / 0.20	-0.06%	-0.04%	-0.04%	-0.04%
0.00 / 1.00	-0.05%	-0.04%	-0.04%	-0.03%

VA / COS φ	5%	10%	20%	40%
10.00 / 0.20	-0.15%*	-0.15%*	-0.13%	-0.10%
5.00 / 0.20	-0.11%*	-0.11%*	-0.11%*	-0.08%
2.50 / 0.20	-0.08%*	-0.08%*	-0.08%*	-0.07%
1.25 / 0.20	-0.07%*	-0.07%*	-0.07%*	-0.06%
0.00 / 1.00	-0.06%*	-0.06%*	-0.06%*	-0.05%

CURRENT PHASE ERROR TABLE
(PHASE ERROR IN MINUTES)

BURDEN VA / COS φ	PERCENT RATED CURRENT (5.0 A) 50%	100%	120%	200%
10.00 / 0.20	-0.17	-0.23	-0.25	-0.30
5.00 / 0.20	0.64	0.43	0.40	0.29
2.50 / 0.20	1.07	0.80	0.73	0.60
1.25 / 0.20	1.31	0.99	0.92	0.77
0.00 / 1.00	1.54	1.18	1.10	0.93

VA / COS φ	5%	10%	20%	40%
10.00 / 0.20	-0.05*	-0.05*	-0.09	-0.13
5.00 / 0.20	1.03*	1.02*	1.02*	0.69
2.50 / 0.20	1.53*	1.54*	1.53*	1.18
1.25 / 0.20	1.80*	1.80*	1.81*	1.45
0.00 / 1.00	2.07*	2.07*	2.07*	1.70

BURDEN TEST RESULTS

1 AMP BURDEN TEST

MEAS CURRENT: 0.046 A
MEAS VOLTAGE: 65.485 V, 29.0°
IMPEDANCE (Z): 47.330 OHMS

BURDEN: 0.000 VA
COS φ: 0.87

500V INSULATION RES TEST

VOLTAGE: 498.6 V
CURRENT: 5.03 MICRO-AMPS

RESISTANCE: 99.19 MEG-OHMS

Figure 9. Typical EZCT-2000B Tabulated Report Printout

Table 3. Descriptions of Tabulated Test Results Elements

Item Number	Description
1	Test record header information.
2	The EZCT-2000B X terminals (taps) that were selected for this test.
3	Test note for this particular test. The test note can be up to 20-characters long.
4	Recorded excitation current readings on the CT secondary winding.
5	Recorded excitation test voltages applied to the CT secondary winding.
6	Impedance calculated at each data point.
7	The voltage, current, and impedance data points recorded on the graph grid-marks.
8	Measured DC resistance value of CT under test.
9	IEC 10/50 knee point voltage and excitation current (IEC 60044-1 10/50). This knee point voltage is the same as the ANSI 10/50 knee point voltage.
10	IEEE 30° knee point voltage and excitation current.
11	IEEE 45° knee point voltage and excitation current.
12	CT nameplate turns ratio.
13	Measured turns ratio.
14	Turns ratio percentage error.
15	Polarity of the CT.
16	Measured phase angle.
17	Excitation voltage used in CT turns ratio test.
18	Excitation current in turns ratio test.
19	Current ratio error table. This information will be printed only if you selected "YES" for the "CALC ERR VS BURDEN?" option when running a test. See section 3.3.2, step h for details.
20	Current phase error table. This information will be printed only if you selected "YES" for the "CALC ERR VS BURDEN?" option when running a test. See section 3.3.2, step h for details.
21	Burden test results. This information will be printed only if you chose to run the burden test. Please see section 3.3.2, step p for details.
22	Insulation resistance test results. This information will be printed only if you chose to run the insulation resistance test. Please see section 3.3.2, step o for details.

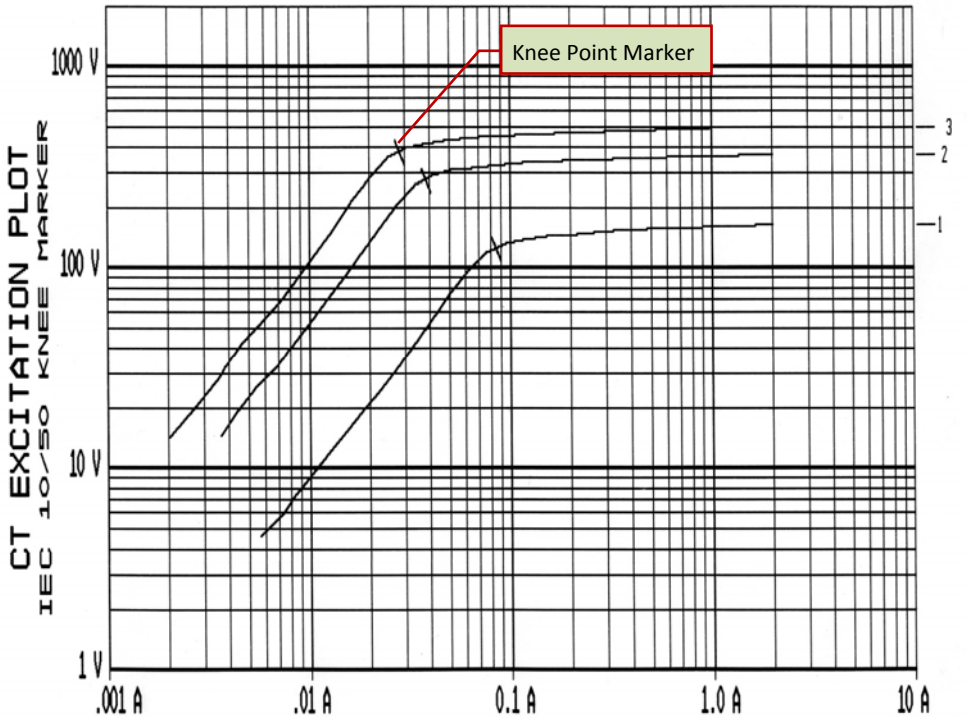
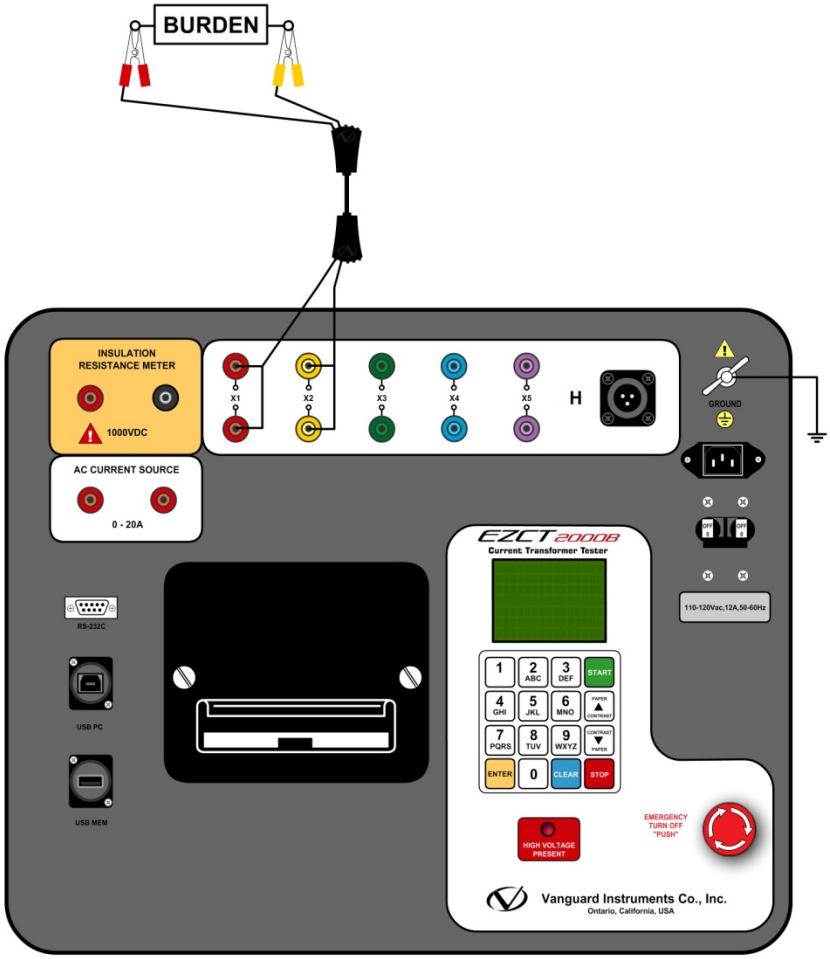


Figure 10. Typical EZCT-2000B Graphic Report with Multiple Plot Curves

3.3.3. Performing a CT Burden Test

The CT burden test verifies the actual CT burden before putting the CT in service. The CT's secondary burden is measured by injecting a 1A or 5A test current into the load. To perform a CT burden test:

a. Make connections per the figure below:



NOTE This test requires the X1 and X2 cables to be connected to the CT load burden.

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

```
1. RUN TEST     06/17/09
2. SETUP        09:25:32
3. TEST PLANS
4. DIAGNOSTICS
5. CURRENT SOURCE
```

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

c. The following screen will be displayed:

```
1. RES, EXCIT & RATIO
2. EXCITATION & RATIO
3. EXCITATION ONLY
4. RATIO ONLY
5. RESISTANCE & EXCIT
6. BURDEN TEST ONLY
7. INSULATION TST ONLY
```

Press the **[6]** key (*BURDEN TEST ONLY*).

d. The following screen will be displayed:

```
 ENTER TEST 1 NOTE:
_

↑↓ TO POSITION
"ENTER" TO ACCEPT
```

Use the alpha-numeric keypad to enter a test note and then press the **[ENTER]** key.

e. The following screen will be displayed:

```
BURDEN TEST CURRENT
1. 1A
2. 5A
```

Select the burden test current by pressing either the **[1]** key (*1A*) or the **[2]** key (*5A*).

f. The following screen will be displayed:

```
TEST 1 PARAMETERS:
    1 AMP BURDEN TEST

CONNECT X1-X2 CABLES
TO BURDEN NOW.

    "START" TO BEGIN
```

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

g. The following screen will be displayed:

```
    CABLES ENERGIZED!

      I=0.0016 AMPS
      V= 1.2   VAC
```

NOTE

The "HIGH VOLTAGE PRESENT" light will be illuminated to indicate that high voltage is present.

The following screen will be displayed momentarily:

```
    CABLES ENERGIZED!




      PLEASE WAIT...
```

Then the following screen will be displayed:

```
    CABLES ENERGIZED!

      I=0.0018 AMPS
      V= 1.3   VAC
```

When the test is completed, the test results will be displayed temporarily:

```
    CABLES ENERGIZED!
  BURDEN TEST RESULTS

        2.983 VA
      COS φ = 0.92
```

Then, the following screen will be displayed:

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

Print the **[1]** key (*YES*) if you would like to print the test results. The test results will be printed on the thermal printer. A typical burden test results report is shown in Figure 11.

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

h. The following screen will be displayed:

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

Press the **[1]** key (*YES*) to keep the test results.

i. The following screen will be displayed:

```
TEST 1 SAVED
```

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

j. The following screen will be displayed:

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

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

k. The following screen will be displayed:

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

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

The following screen will be displayed momentarily:

```
SAVING RECORD...



PLEASE WAIT...
```

l. The following confirmation screen will then be displayed:

```
RECORD NUMBER 1
 HAS BEEN SAVED!
```

Press the **[ENTER]** key and you will be returned to the "START-UP" menu.

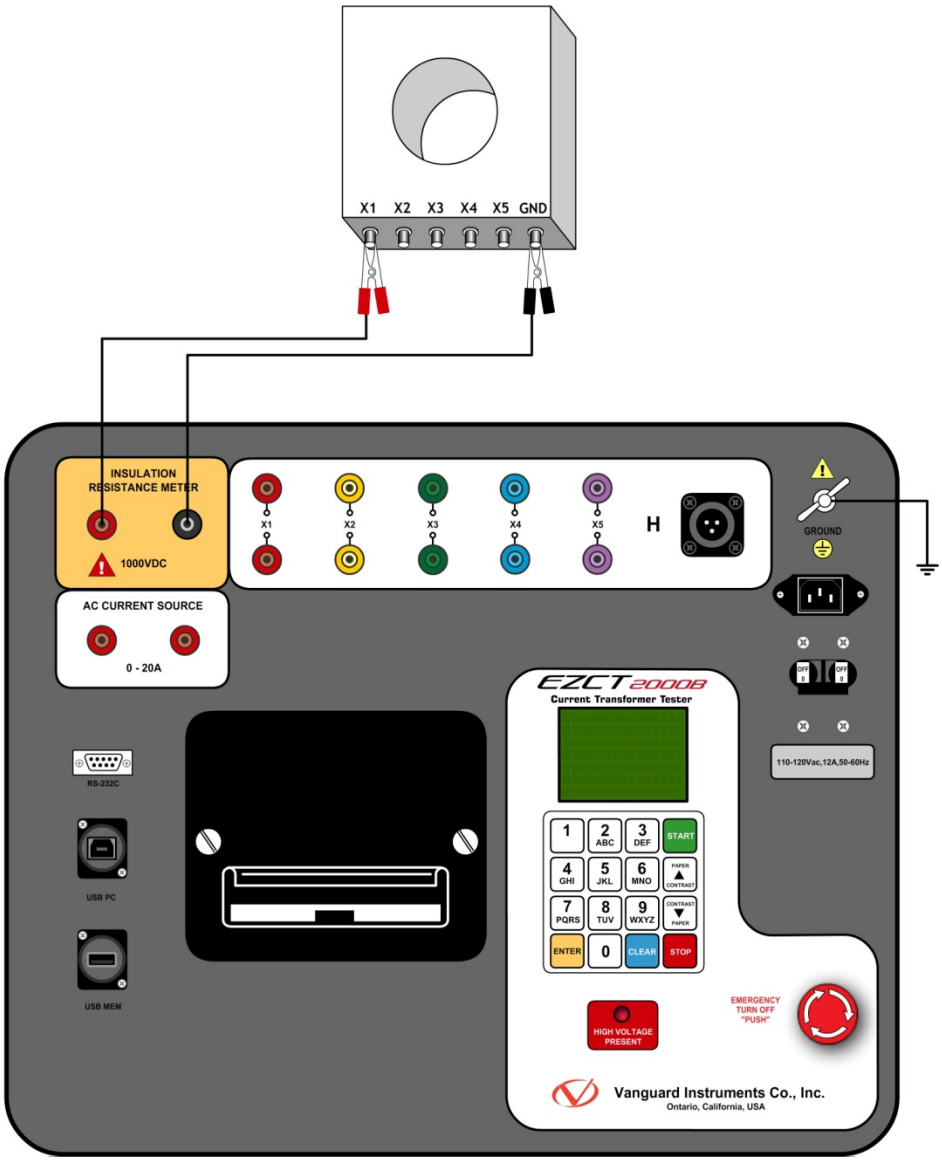
```
CT EXCITATION TEST RESULTS
DATE:06/18/09        TIME:10:11:57
COMPANY:    VANGUARD
STATION:
CIRCUIT:
MFR:
MODEL:
S/N:
COMMENTS:
OPERATOR:
TST NOTE:
        BURDEN TEST RESULTS
5 AMP BURDEN TEST
MEAS CURRENT:     5.002 A
MEAS VOLTAGE:     2.983 V, 23.1°
IMPEDANCE (Z):    0.60 OHMS
BURDEN:           15.02 VA
COS φ:            0.92
```

Figure 11. EZCT-2000B Typical Burden Test Results Report Printout

3.3.4. Performing an Insulation Resistance Test

To perform an insulation resistance test:

a. Make connections per the figure below:

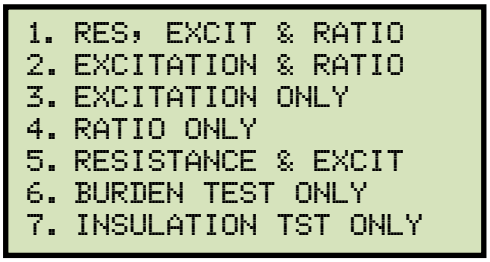


b. Start from the "START-UP" menu:

```
1. RUN TEST     06/17/09
2. SETUP        10:14:25
3. TEST PLANS
4. DIAGNOSTICS
5. CURRENT SOURCE
```

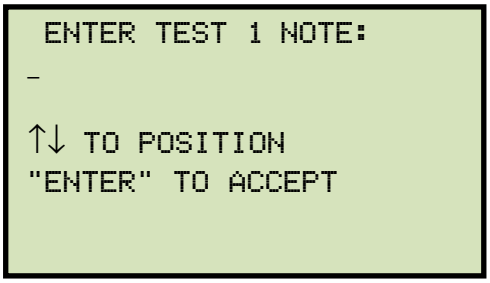
Press the **[1]** key (*RUN TEST*).

c. The following screen will be displayed:



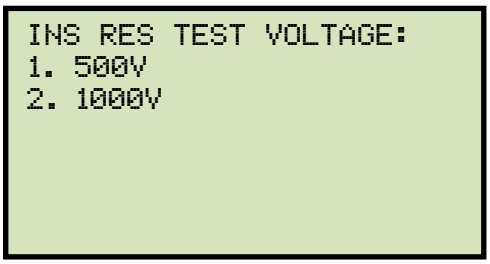
Press the **[7]** key (*INSULATION TST ONLY*)

d. The following screen will be displayed:



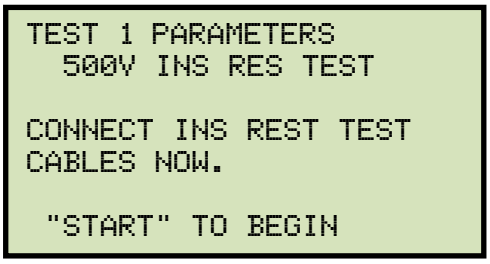
Use the alpha-numeric keypad to enter a test note and then press the **[ENTER]** key.

e. The following screen will be displayed:



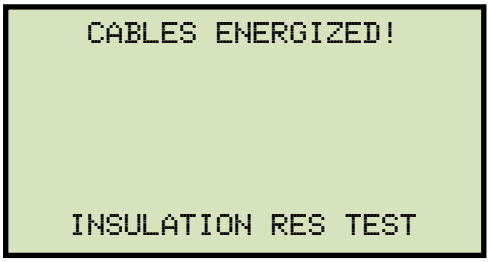
Select the test voltage by pressing either the **[1]** key (*500V*) or the **[2]** key (*1000V*).

f. The following screen will be displayed:



Connect the insulation resistance cables and then press the **[START]** key.

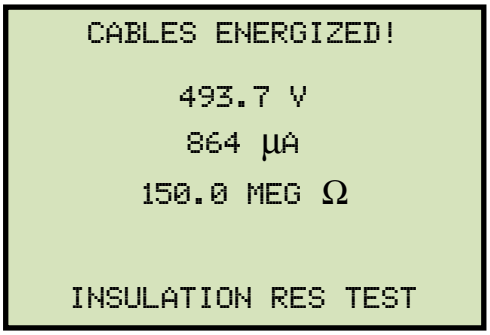
g. The following screen will be displayed:



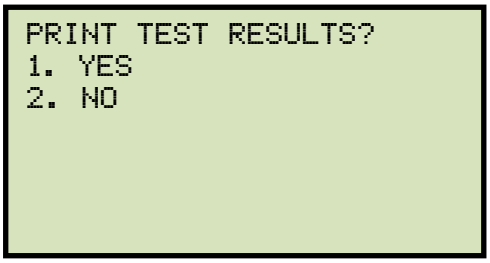
NOTE

The "HIGH VOLTAGE PRESENT" light will be illuminated to indicate that high voltage is present.

When the test is completed, the test results will be displayed temporarily:



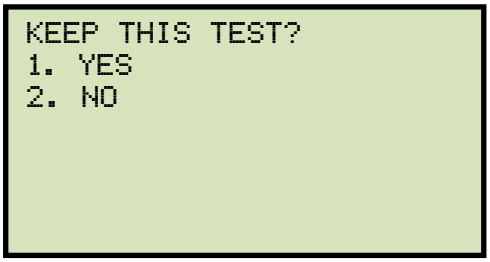
The following screen will then be displayed:



Print the **[1]** key (*YES*) if you would like to print the test results. The test results will be printed on the thermal printer. A typical insulation resistance test results report is shown in Figure 12.

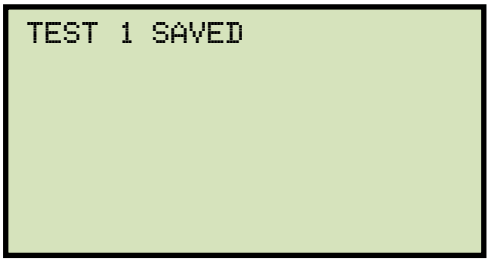
Press the **[2]** key (*NO*) if you do not want to print the test results.

h. The following screen will be displayed:



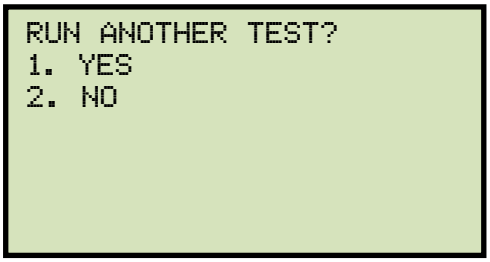
Press the **[1]** key (*YES*) to keep the test results.

i. The following screen will be displayed:



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

j. The following screen will be displayed:

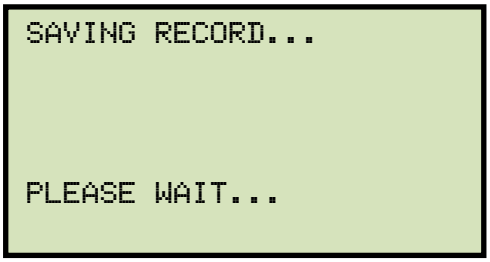


Press the **[2]** key (*NO*).

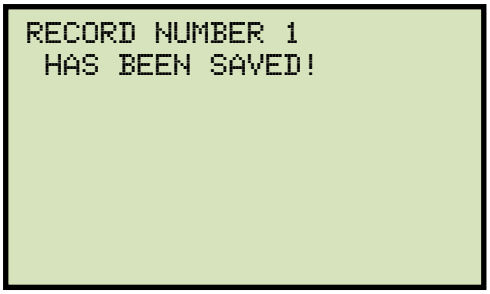
k. The following screen will be displayed:

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

The following screen will be displayed momentarily:



l. The following confirmation screen will then be displayed:



Press the **[ENTER]** key and you will be returned to the "START-UP" menu.

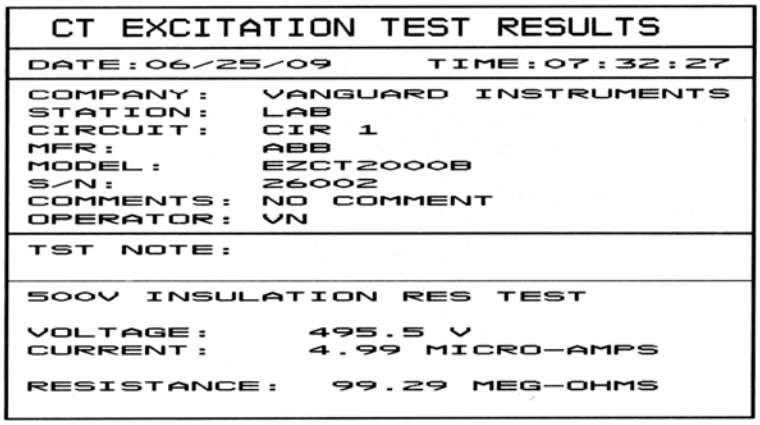
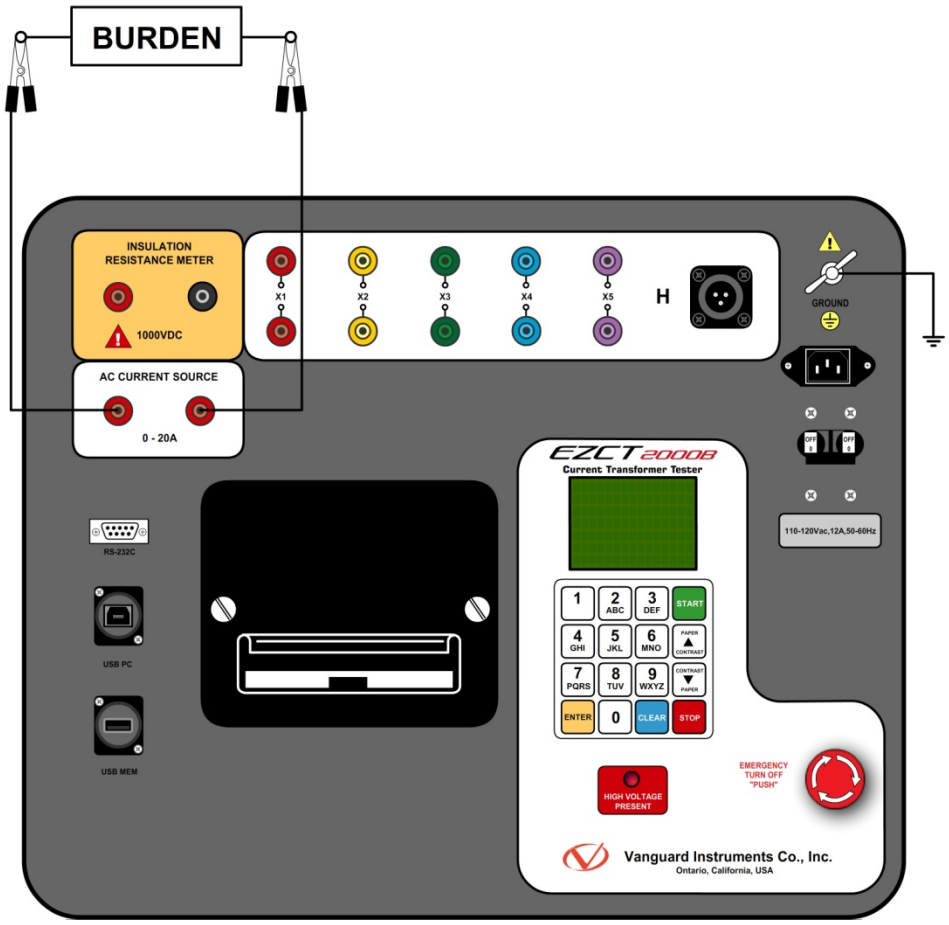


Figure 12. EZCT-2000B Typical Insulation Resistance Test Results Report Printout

3.3.5. Performing a Current Source Test

The EZCT-2000B's programmable current source can be used to verify CT loads. The EZCT-2000B can output up to a 20A current (0-15Vac). To perform a current source test:

a. Make connections per the figure below:

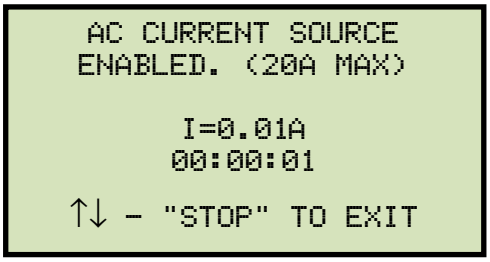


b. Start from the "START-UP" menu:

```
1. RUN TEST     06/17/09
2. SETUP        10:14:25
3. TEST PLANS
4. DIAGNOSTICS
5. CURRENT SOURCE
```

Press the **[5]** key (*CURRENT SOURCE*).

c. The following screen will be displayed:



Press and hold the **[PAPER ∧ Contrast]** key to increase the current. Press and hold the **[PAPER ∨ Contrast]** key to decrease the current. A timer will display the elapsed time that the current has been on.

NOTE

The EZCT-2000B is thermally protected and will automatically shut off if the transformer reaches an over-temperature condition. Since the EZCT-2000B can provide up to a 20A current, the transformer can get to thermal protection mode if operated for a long time at a high current. A very long cool-down period may be required for such cases.

d. Press the **[STOP]** key to turn off the current source and return to the "START-UP" menu.

3.4 Working With Test Records

3.4.1. Restoring and Printing a Test Record From Flash EEPROM

You can restore a test record from the EZCT-2000B's Flash EEPROM to the working memory. You can then print the restored test record on the unit's built-in thermal printer. To restore a test record:

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

```
1. RUN TEST     06/17/09
2. SETUP        07:39:39
3. TEST PLANS
4. DIAGNOSTICS
5. CURRENT SOURCE
```

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

b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. RECORD DIRECTORY
4. SAVE/RESTORE RECORD
5. ERASE RECORD
6. NEXT PAGE
```

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

c. 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 EZCT-2000B's "USB MEM" port, the following screen will be displayed instead of the above screen:

```
1. RESTORE RECORD
2. COPY TO THUMB DRIVE
```

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

The following screen will be displayed:

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

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

The following screen will then be displayed:

```
     RESTORE RECORD

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

Continue with the steps below.

1. *ENTER RECORD NUMBER*

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

   If you do not want to print the test record, press the **[2]** key (*NO*). The test record will be restored to the working memory, and you will be returned to the "START-UP" menu.

   If you would like to print the test record, press the **[1]** key (*YES*). Continue to step d.

2. *SCROLL TO SELECT*

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

```
    RECORD DIRECTORY

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

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

```
#1     06/08/09   10:11
5 TESTS
LAB
CIR 1
ABB
EZCT2000B
SN 1
```

When you have located the test record that you would like to restore, press the **[ENTER]** key.

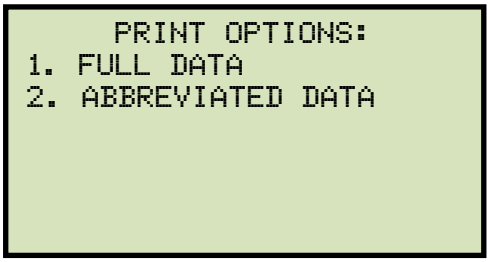
The following screen will be displayed:

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

If you do not want to print the test record, press the **[2]** key (*NO*). The test record will be restored to the working memory, and you will be returned to the "START-UP" menu.

If you would like to print the test record, press the **[1]** key (*YES*). Continue to step d.

d. The following screen will be displayed:



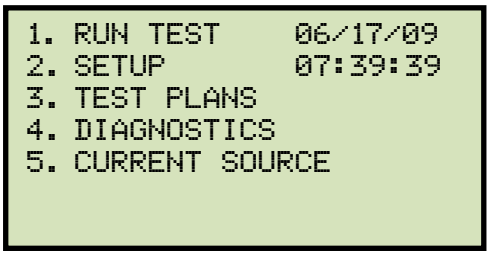
Press the **[1]** key to print the tabulated data and graphics results on the thermal printer. The test record will be restored to the working memory and will be printed on the thermal printer, and then you will be returned to the "START-UP" menu.

Press the **[2]** key to print the test report and graphic results on the thermal printer, without the excitation voltage and current data points. The test record will be restored to the working memory and will be printed on the thermal printer, and then you will be returned to the "START-UP" menu.

3.4.2. Restoring and Printing a Test Record From a USB Flash Drive

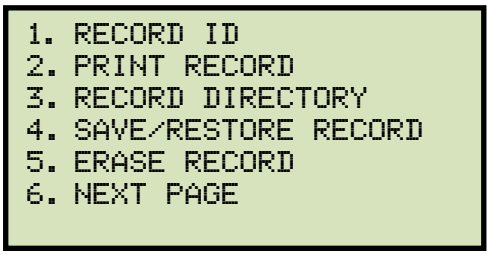
You can restore a test record from a USB Flash drive to the EZCT-2000B's working memory using the steps below:

a. Make sure the USB Flash drive containing the test record(s) is inserted in the EZCT-2000B's USB Flash drive port ("USB MEM" port). Then start from the "START-UP" menu:



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

b. The following screen will be displayed:

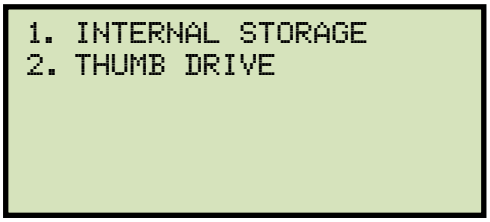


Press the **[4]** key (*SAVE/RESTORE RECORD*).

c. The following screen will be displayed:

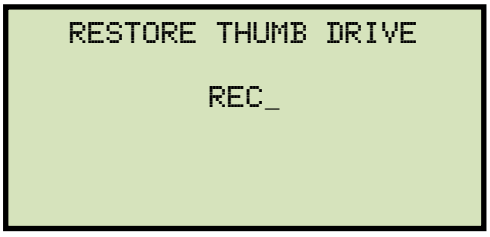
Press the **[1]** key (RESTORE RECORD).

d. The following screen will be displayed:



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

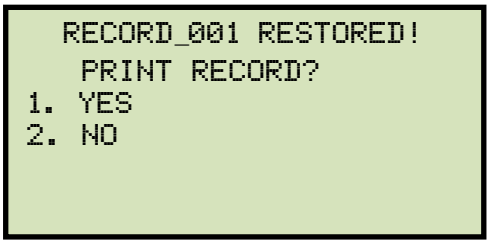
e. The following screen will be displayed:



Type the record number that you would like to restore and press the **[ENTER]** key. If you do not know the record number, you can print a test record directory. Please see section 3.4.5 for details.

f. The following screen will be displayed while the record is being restored:

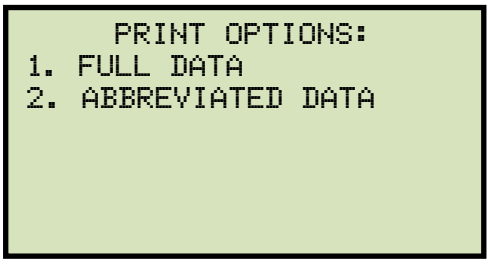
The following screen will be displayed once the test record has been restored:



If you do not want to print the test record, press the **[2]** key (*NO*). The test record will be restored to the working memory, and you will be returned to the "START-UP" menu.

If you would like to print the test record, press the **[1]** key (*YES*). Continue to step g.

g. The following screen will be displayed:



Press the **[1]** key to print the full tabulated data and graphics results on the thermal printer. After printing is finished, you will be returned to the "START-UP" menu.

Press the **[2]** key to print the test report and graphic results on the thermal printer, without the excitation voltage and current data points. After printing has finished, you will be returned to the "START-UP" menu.

3.4.3. Printing a Restored Test Record

You can print a test record at the time that it is restored from the Flash EEPROM (see section 3.4.1), or you can restore it to the working memory and print it later. To print the current test record in the working memory:

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

```
1. RUN TEST     06/17/09
2. SETUP        10:14:25
3. TEST PLANS
4. DIAGNOSTICS
5. CURRENT SOURCE
```

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

b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. RECORD DIRECTORY
4. SAVE/RESTORE RECORD
5. ERASE RECORD
6. NEXT PAGE
```

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

c. The following screen will be displayed:

```
     PRINT OPTIONS:
1. FULL DATA
2. ABBREVIATED DATA
```

NOTE

If there is no test record in the working memory, the following screen will be displayed:

```
    NO SHOTS TO PRINT!
```

Press any key to return to the "START-UP" menu. Please see section 3.4.1 for instructions on how to restore a test record.

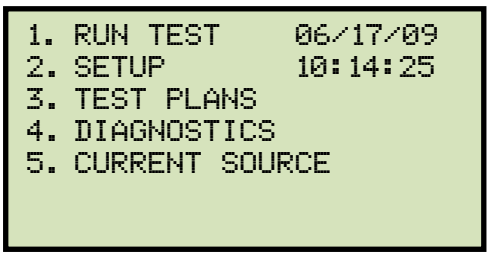
Press the **[1]** key to print the tabulated data and graphics results on the thermal printer. The test record will be printed on the thermal printer and you will be returned to the "START-UP" menu.

Press the **[2]** key to print the test report and graphic results on the thermal printer, without the excitation voltage and current data points. The test record will be printed on the thermal printer and you will be returned to the "START-UP" menu.

3.4.4. Printing a Directory of Test Records Stored in the EZCT-2000B's Memory

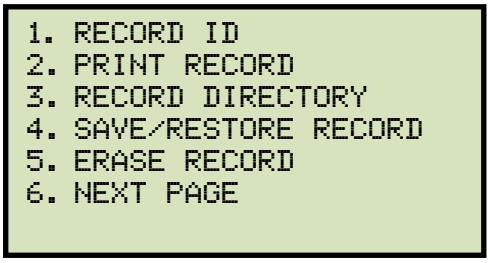
You can print a directory of all the test records stored in the EZCT-2000B's Flash EEPROM using the steps below:

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



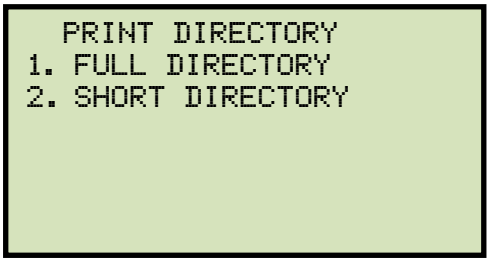
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:



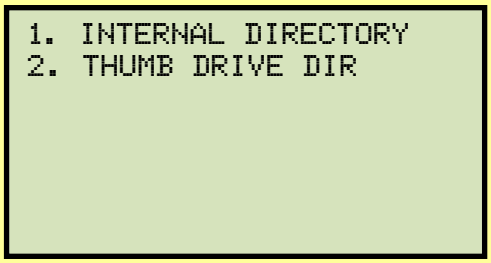
Press the **[3]** key (*RECORD DIRECTORY*).

c. The following screen will be displayed:

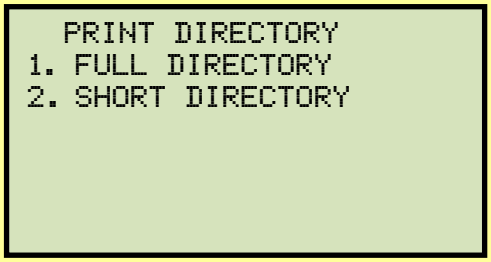


NOTE

The above screen will be displayed only if a USB Flash drive is NOT connected to the EZCT-2000B's USB Flash drive port. If a USB Flash drive is connected, the following screen will be displayed:



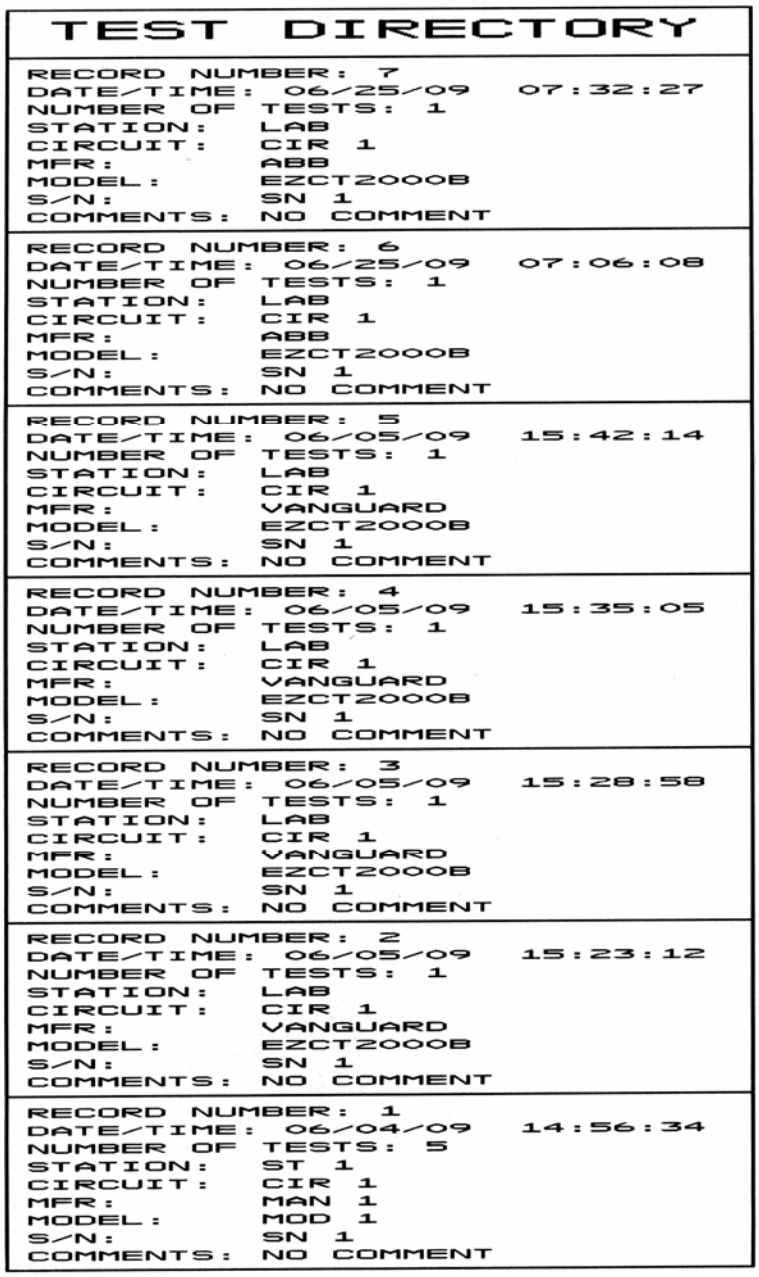
Press the **[1]** key (*INTERNAL DIRECTORY*). The following screen will be displayed:



Continue with the steps below:

Press the **[1]** key to print a full directory listing of all the test records stored in the EZCT-2000B's Flash EEPROM. The directory listing will be printed on the thermal printer and you will be returned to the "START-UP" menu. A sample directory listing printout is shown in Figure 13.

Press the **[2]** key to print a short directory listing of the stored test records. The short directory option prints the last 10 records stored in the EZCT-2000B's Flash EEPROM. The short directory listing will be printed on the thermal printer and you will be returned to the "START-UP" menu.



TEST DIRECTORY

RECORD NUMBER: 7
DATE/TIME: 06/25/09 07:32:27
NUMBER OF TESTS: 1
STATION: LAB
CIRCUIT: CIR 1
MFR: ABB
MODEL: EZCT2000B
S/N: SN 1
COMMENTS: NO COMMENT

RECORD NUMBER: 6
DATE/TIME: 06/25/09 07:06:08
NUMBER OF TESTS: 1
STATION: LAB
CIRCUIT: CIR 1
MFR: ABB
MODEL: EZCT2000B
S/N: SN 1
COMMENTS: NO COMMENT

RECORD NUMBER: 5
DATE/TIME: 06/05/09 15:42:14
NUMBER OF TESTS: 1
STATION: LAB
CIRCUIT: CIR 1
MFR: VANGUARD
MODEL: EZCT2000B
S/N: SN 1
COMMENTS: NO COMMENT

RECORD NUMBER: 4
DATE/TIME: 06/05/09 15:35:05
NUMBER OF TESTS: 1
STATION: LAB
CIRCUIT: CIR 1
MFR: VANGUARD
MODEL: EZCT2000B
S/N: SN 1
COMMENTS: NO COMMENT

RECORD NUMBER: 3
DATE/TIME: 06/05/09 15:28:58
NUMBER OF TESTS: 1
STATION: LAB
CIRCUIT: CIR 1
MFR: VANGUARD
MODEL: EZCT2000B
S/N: SN 1
COMMENTS: NO COMMENT

RECORD NUMBER: 2
DATE/TIME: 06/05/09 15:23:12
NUMBER OF TESTS: 1
STATION: LAB
CIRCUIT: CIR 1
MFR: VANGUARD
MODEL: EZCT2000B
S/N: SN 1
COMMENTS: NO COMMENT

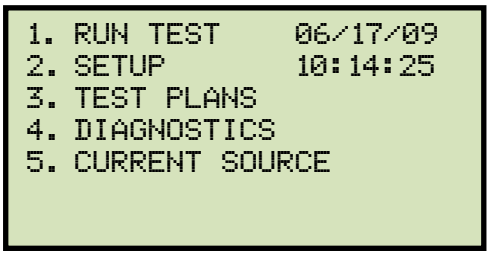
RECORD NUMBER: 1
DATE/TIME: 06/04/09 14:56:34
NUMBER OF TESTS: 5
STATION: ST 1
CIRCUIT: CIR 1
MFR: MAN 1
MODEL: MOD 1
S/N: SN 1
COMMENTS: NO COMMENT

Figure 13. Typical Internal Test Record Directory Printout

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

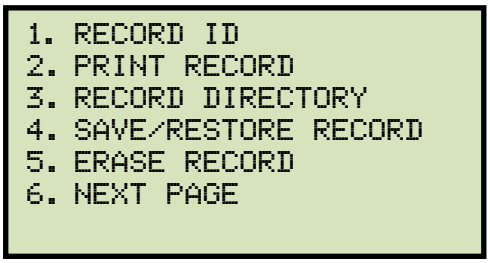
You can print a directory of all the test records stored in a USB Flash drive using the steps below:

a. Make sure the USB Flash drive is inserted in the EZCT-2000B's USB Flash drive port ("USB MEM" port). Then start from the "START-UP" menu:



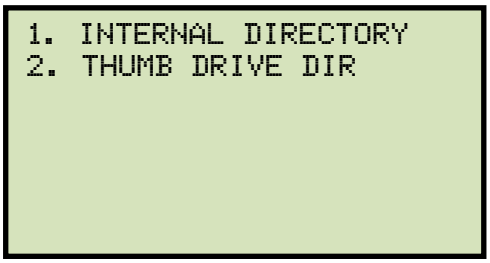
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:



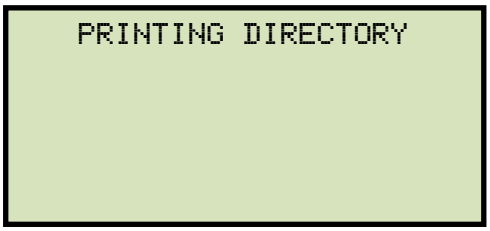
Press the **[3]** key (*RECORD DIRECTORY*).

c. The following screen will be displayed:

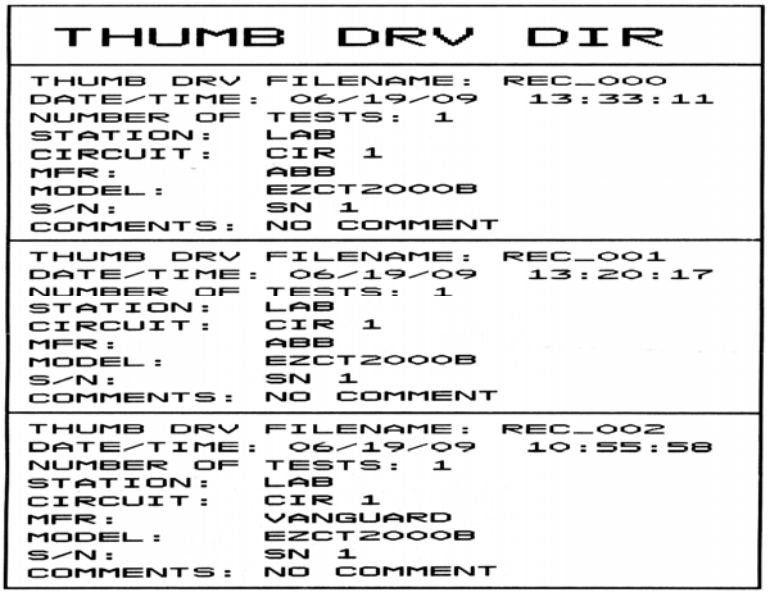


Press the **[2]** key (*THUMB DRIVE DIR*).

d. The following screen will be displayed while the directory is printed:



When printing is finished, you will be returned to the "START-UP" menu. A sample directory printout is shown in Figure 14.



THUMB DRV DIR

THUMB DRV FILENAME: REC_000
DATE/TIME: 06/19/09 13:33:11
NUMBER OF TESTS: 1
STATION: LAB
CIRCUIT: CIR 1
MFR: ABB
MODEL: EZCT2000B
S/N: SN 1
COMMENTS: NO COMMENT

THUMB DRV FILENAME: REC_001
DATE/TIME: 06/19/09 13:20:17
NUMBER OF TESTS: 1
STATION: LAB
CIRCUIT: CIR 1
MFR: ABB
MODEL: EZCT2000B
S/N: SN 1
COMMENTS: NO COMMENT

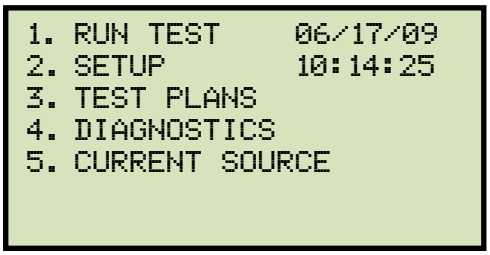
THUMB DRV FILENAME: REC_002
DATE/TIME: 06/19/09 10:55:58
NUMBER OF TESTS: 1
STATION: LAB
CIRCUIT: CIR 1
MFR: VANGUARD
MODEL: EZCT2000B
S/N: SN 1
COMMENTS: NO COMMENT

Figure 14. Typical USB Flash Drive Record Directory Printout

3.4.6. Copying Test Records to a USB Flash Drive

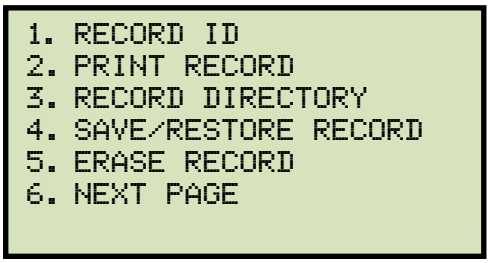
You can easily copy test records stored in the EZCT-2000B's Flash EEPROM to a connected USB Flash drive using the steps below:

a. Make sure a USB Flash drive is inserted in the EZCT-2000B's Flash drive port ("USB MEM" port). Then start from the "START-UP" menu:



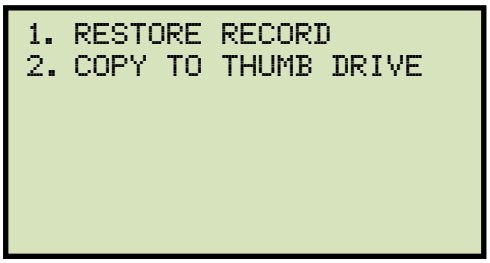
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:



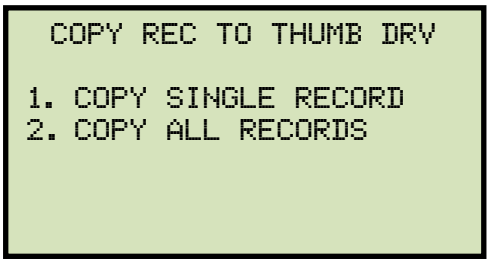
Press the **[4]** key (*SAVE/RESTORE RECORD*).

c. The following screen will be displayed:



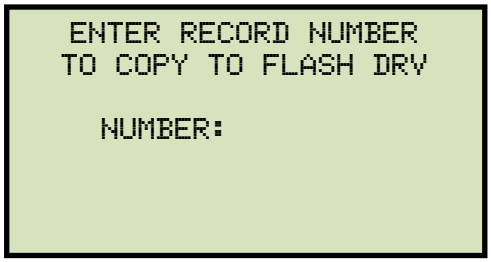
Press the **[2]** key (*COPY TO THUMB DRIVE*).

d. The following screen will be displayed:



1. *COPY SINGLE RECORD*

Press the **[1]** key (*COPY SINGLE RECORD*) if you would like to copy a single record from the EZCT-2000B to the USB Flash drive. The following screen will be displayed:

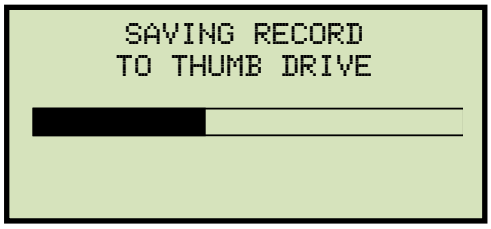


Type the record number that you would like to copy to the USB Flash drive and then press the **[ENTER]** key.

NOTE

If you do not know the record number, you can first print a test record directory using the instructions in section 3.4.4.

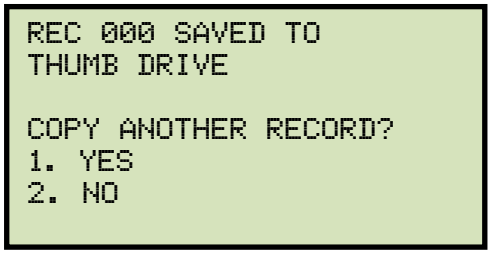
The following screen will be displayed showing the status of the copy process:



NOTES

Any existing test records on the USB Flash drive will NOT be erased. The EZCT-2000B will automatically increment the record number for newly copied test records.

After the record has been copied, the following screen will be displayed:

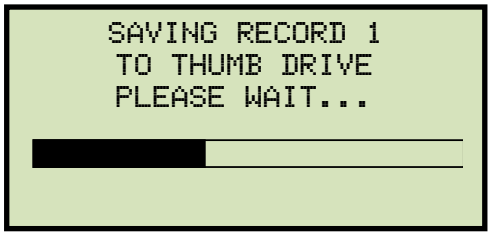


Press the **[1]** key (*YES*) if you would like to copy another record and repeat the process above.

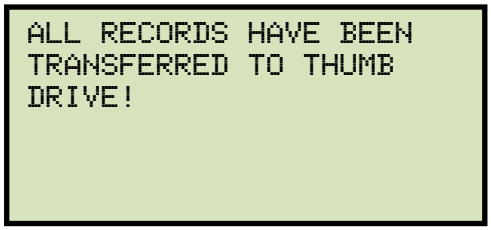
Press the **[2]** key (*NO*) to return to the "START-UP" menu.

2. *COPY ALL RECORDS*

Press the **[2]** key (COPY ALL RECORDS) if you would like to copy all the test records from the EZCT-2000B to the USB Flash drive. The following screen will be displayed:



The above progress screen will be displayed for each test record being copied. When all the test records have been copied, the following screen will be displayed:



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

3.4.7. Erasing Test Records From the Flash EEPROM

You can erase individual or all test records stored in the EZCT-2000B's Flash EEPROM. To erase a test record:

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

```
1. RUN TEST     06/17/09
2. SETUP        10:14:25
3. TEST PLANS
4. DIAGNOSTICS
5. CURRENT SOURCE
```

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

b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. RECORD DIRECTORY
4. SAVE/RESTORE RECORD
5. ERASE RECORD
6. NEXT PAGE
```

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

c. The following screen will be displayed:

```
       ERASE RECORD

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

NOTE

The above screen will be displayed only if a USB Flash drive is NOT connected to the EZCT-2000B's USB Flash drive port. If a USB Flash drive is connected, the following screen will be displayed:

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

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

```
      ERASE RECORD

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

Continue with the steps below:

1. *ERASE SINGLE REC.*

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

```
      ERASE RECORD
      NUMBER:
```

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

NOTES

- You can press the **[STOP]** key to cancel the process.
- If you do not know the record number, you can first print a test record directory using the instructions in section 3.4.4.

The following screen will be displayed momentarily:

```
     ERASING RECORD
     NUMBER: 01

    PLEASE WAIT...
```

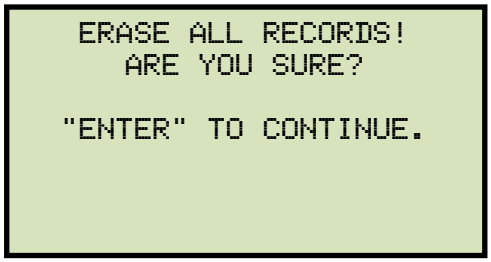
Then the following confirmation screen will be displayed:

```
RECORD NUMBER 1
 ERASED!
```

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

2. *ERASE ALL RECORDS*

Press the **[2]** key if you would like to erase all of the test records stored in the EZCT-2000B's flash EEPROM. The following confirmation screen will be displayed:



If you would like to cancel the erasure process, press the **[STOP]** key. No records will be erased and you will be returned to the "START-UP" menu.

Press the **[ENTER]** key to continue with the erasure process. The following screen will be displayed while the records are being erased:

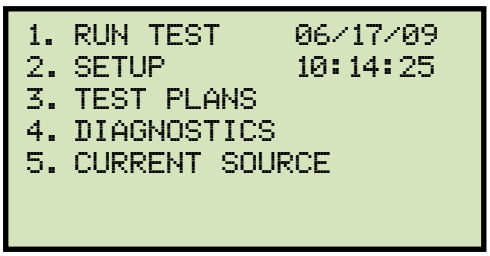
The following screen will be displayed after all of the test records have been erased:

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

3.4.8. Erasing Test Records From a USB Flash Drive

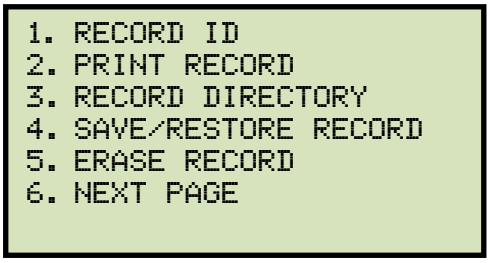
You can erase individual or all test records stored in a USB Flash drive. To erase a test record:

a. Make sure the USB Flash drive is inserted in the EZCT-2000B's USB Flash drive port ("USB MEM" port). Then start from the "START-UP" menu:



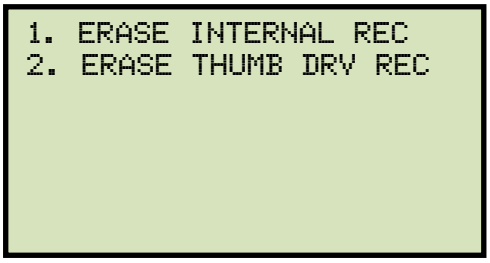
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:



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

c. The following screen will be displayed:



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

d. 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.*) if you would like to erase a single record. The following screen will be displayed:

```
    ERASE THUMB DRIVE
        REC_
```

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

NOTES

- You can press the **[STOP]** key to cancel the process.
- If you do not know the record number, you can first print a test record directory using the instructions in section 3.4.5.

The following screen will be displayed:

```
THUMB DRIVE REC_001
ERASED!
```

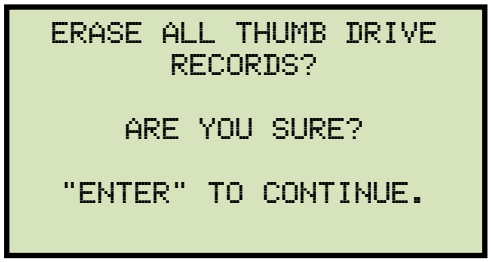
Press any key to continue. The following screen will be displayed:

```
      ERASE RECORD

1. ERASE SINGLE REC.
2. ERASE ALL RECORDS


     "STOP" TO EXIT
```

You can continue to erase additional records or press the **[STOP]** key to exit to the "START-UP" menu.

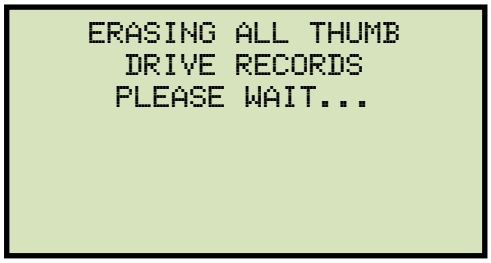
2. *ERASE ALL RECORDS*

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

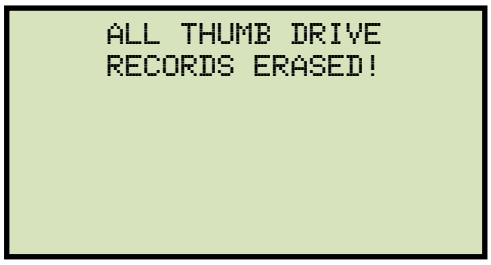


If you would like to cancel the erasure process, press the **[STOP]** key. No records will be erased and you will be returned to the "START-UP" menu.

Press the **[ENTER]** key to continue with the erasure process. The following screen will be displayed while the records are being erased:



The following screen will be displayed after all of the test records have been erased:



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

3.5 Working With Test Plans

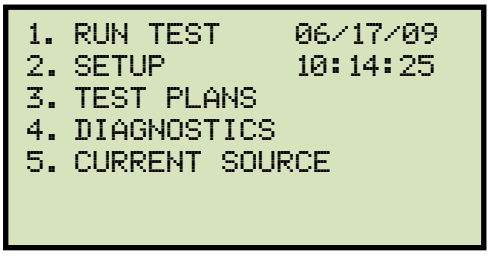
A test plan is comprised of the saturation test voltage, current range selection, CT nameplate ratios, and CT winding terminal combinations (X1 to X5) for each test, and also includes the insulation resistance test and CT load burden test definitions. Up to 10 test definitions can be stored per test plan, and up to 128 CT test plans can be stored in the EZCT-2000B's Flash EEPROM. The ability to use test plans makes CT testing an extremely simple process. To perform a test, the EZCT-2000B is connected to the CT terminals and a test plan is selected to run.

3.5.1. Extracting the Test Plan From a Test Record

A test plan can be extracted from a test record for immediate or future use. You can extract the test plan immediately after performing a test or you can extract the test plan from a restored test record (see section 3.4.1 for instructions on how to restore a test record). To extract a test plan from a test record:

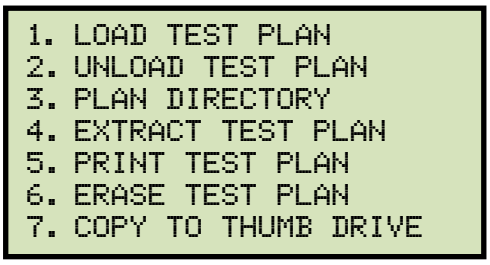
a. Either perform a test (see section 3.2) or recall a test record (see section 3.4.1) that you would like to extract the test plan from.

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



Press the **[3]** key (*TEST PLANS*).

c. The following screen will be displayed:



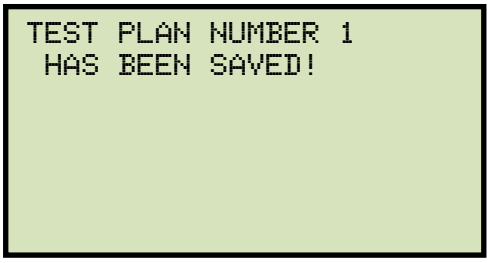
Press the **[4]** key (*EXTRACT TEST PLAN*)

NOTE

If there is no test record in the working memory, the following screen will be displayed:

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

d. The following screen will be displayed:



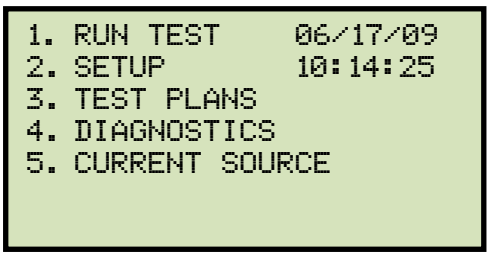
The test plan will be extracted from the test record in the working memory and will be saved to the EZCT-2000B's Flash EEPROM as a new test plan. The test plan number will be automatically incremented by the EZCT-2000B.

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

3.5.2. Printing a Directory of Test Plans Stored in the EZCT-2000B's Memory

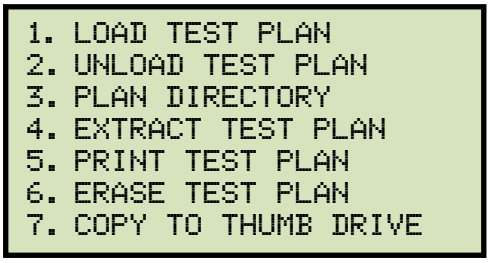
You can print a directory of all the test plans stored in the EZCT-2000B's Flash EEPROM using the steps below:

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



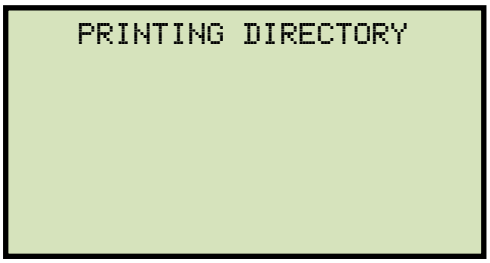
Press the **[3]** key (*TEST PLANS*).

b. The following screen will be displayed:



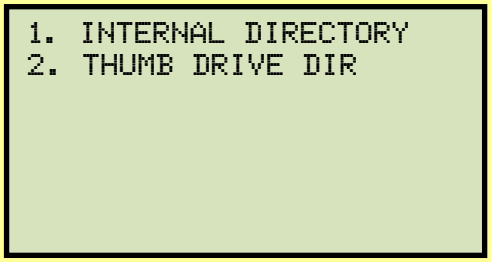
Press the **[3]** key (*PLAN DIRECTORY*).

c. The following screen will be displayed while the test plan directory is printed on the thermal printer:



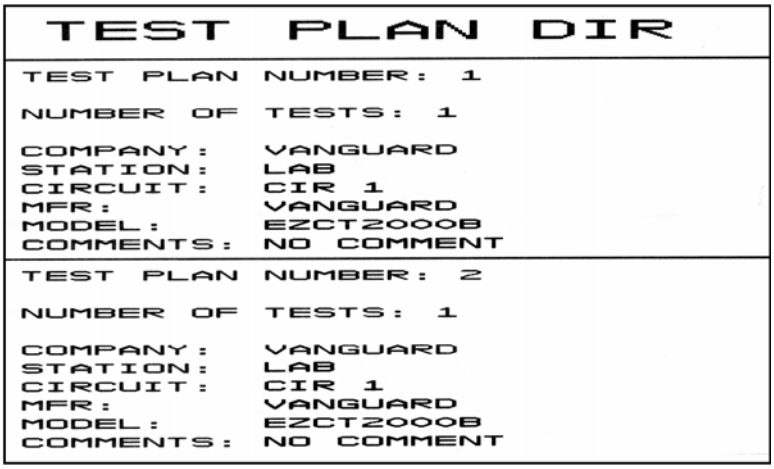
NOTE

The above screen will be displayed only if a USB Flash drive is NOT connected to the EZCT-2000B's USB Flash drive port. If a USB Flash drive is connected, the following screen will be displayed:



Press the **[1]** key (*INTERNAL DIRECTORY*). Continue with the steps below:

You will be automatically returned to the "START-UP" menu after the directory printing is finished. A typical Flash EEPROM test plan directory printout is shown in Figure 15.



```
TEST PLAN DIR

TEST PLAN NUMBER: 1

NUMBER OF TESTS: 1

COMPANY:    VANGUARD
STATION:    LAB
CIRCUIT:    CIR 1
MFR:        VANGUARD
MODEL:      EZCT2000B
COMMENTS:   NO COMMENT

TEST PLAN NUMBER: 2

NUMBER OF TESTS: 1

COMPANY:    VANGUARD
STATION:    LAB
CIRCUIT:    CIR 1
MFR:        VANGUARD
MODEL:      EZCT2000B
COMMENTS:   NO COMMENT
```

Figure 15. Typical EZCT-2000B Flash EEPROM Test Plan Directory Printout

3.5.3. Printing a Directory of Test Plans Stored in a USB Flash Drive

To print a directory of all the test plans stored in a USB Flash drive:

a. Make sure the USB Flash drive is inserted in the EZCT-2000B's USB Flash drive port ("USB MEM" port). Then start from the "START-UP" menu:

```
1. RUN TEST     06/17/09
2. SETUP        10:14:25
3. TEST PLANS
4. DIAGNOSTICS
5. CURRENT SOURCE
```

Press the **[3]** key (*TEST PLANS*).

b. The following screen will be displayed:

```
1. LOAD TEST PLAN
2. UNLOAD TEST PLAN
3. PLAN DIRECTORY
4. EXTRACT TEST PLAN
5. PRINT TEST PLAN
6. ERASE TEST PLAN
7. COPY TO THUMB DRIVE
```

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

c. The following screen will be displayed:

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

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

d. The following screen will be displayed while the test plan directory is being printed:

```
   PRINTING DIRECTORY
```

You will be returned to the "START-UP" menu once printing is finished. A typical USB Flash drive test plan directory printout is shown in Figure 16.

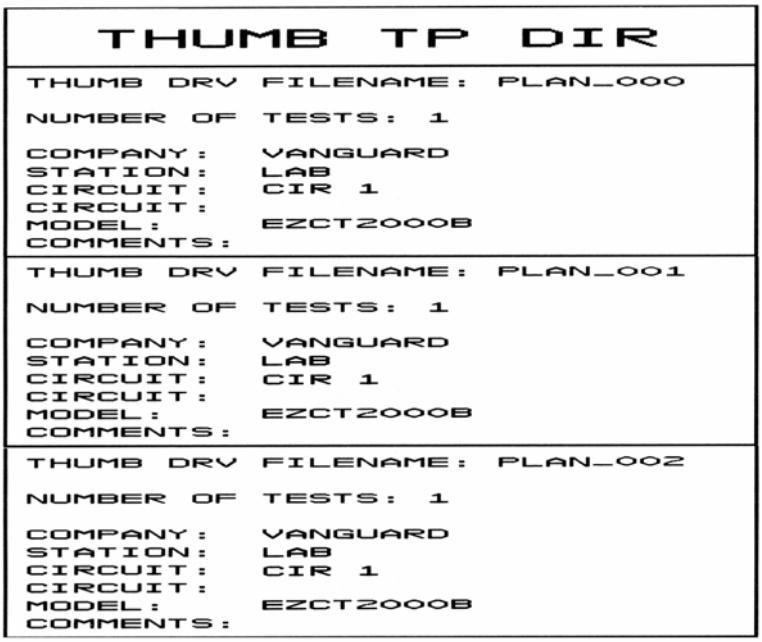
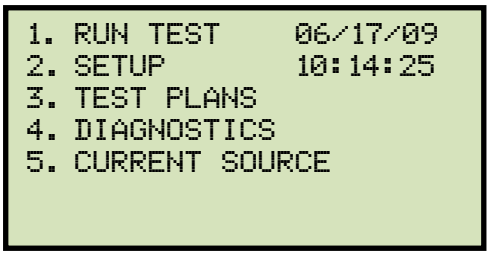


Figure 16. Typical USB Flash Drive Test Plan Directory Printout

3.5.4. Printing a Test Plan

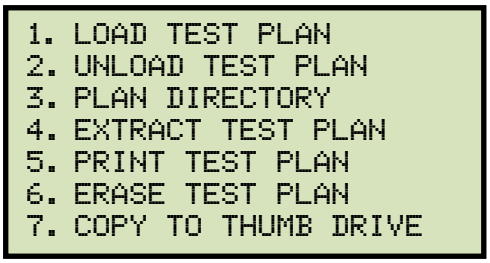
To print a test plan:

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



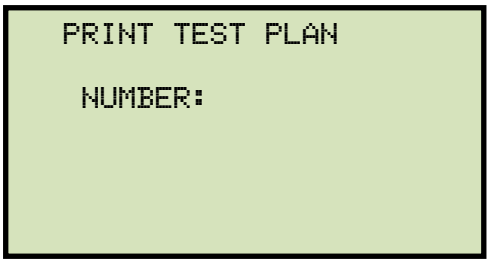
Press the **[3]** key (*TEST PLANS*).

b. The following screen will be displayed:



Press the **[5]** key (*PRINT TEST PLAN*).

c. The following screen will be displayed:



Type the test plan number that you would like to print and press the **[ENTER]** key. If you do not know the test plan number, you can first print the test plan directory using the instructions in section 3.5.2.

The test plan will be printed on the thermal printer and you will be returned to the "START-UP" menu. A typical test plan printout is shown in Figure 17. Test plan elements are described in Table 4.

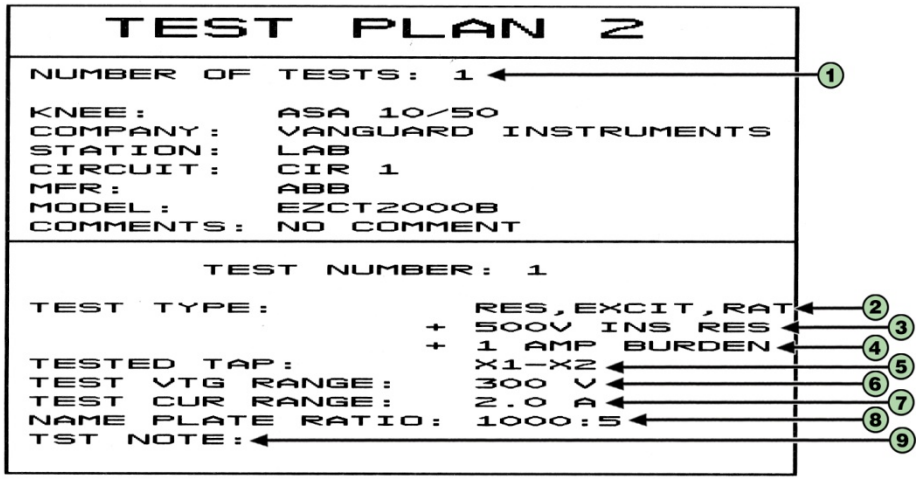


Figure 17. Typical Test Plan Printout

Table 4. Description of Test Plan Elements

Item Number	Description
1	Number of tests in test plan (1)
2	Tests to be performed (Resistance, excitation, turns ratio, insulation, and CT load burden)
3	Insulation test voltage (500 Vdc)
4	Injection current for load burden test (1 A)
5	Terminals used for excitation test (X1-X2)
6	Maximum excitation voltage (300 V)
7	Maximum excitation current (2.0 A)
8	CT nameplate ratio (1000:5)
9	Test notes (if any)

3.5.5. Erasing Test Plans From the Flash EEPROM

To erase one or all test plans from the EZCT-2000B's Flash EEPROM:

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

```
1. RUN TEST     06/17/09
2. SETUP        11:11:11
3. TEST PLANS
4. DIAGNOSTICS
5. CURRENT SOURCE
```

Press the **[3]** key (*TEST PLANS*).

b. The following screen will be displayed:

```
1. LOAD TEST PLAN
2. UNLOAD TEST PLAN
3. PLAN DIRECTORY
4. EXTRACT TEST PLAN
5. PRINT TEST PLAN
6. ERASE TEST PLAN
7. COPY TO THUMB DRIVE
```

Press the **[6]** key (*ERASE TEST PLAN*).

c. The following screen will be displayed:

```
   ERASE TEST PLAN

1. ERASE SINGLE PLAN
2. ERASE ALL PLANS
```

NOTE

The above screen will be displayed only if a USB Flash drive is NOT connected to the EZCT-2000B's USB Flash drive port. If a USB Flash drive is connected, the following screen will be displayed:

```
1. ERASE INTERNAL PLAN
2. ERASE THMB DRV PLAN
```

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

```
  ERASE TEST PLAN

1. ERASE SINGLE PLAN
2. ERASE ALL PLANS
```

Continue with the steps below:

1. *ERASE SINGLE PLAN*

   Press the **[1]** key if you would like to erase a single test plan. The following screen will be displayed:

```
  ERASE TEST PLAN

    NUMBER:
```

   Type the test plan number that you would like to erase and press the **[ENTER]** key.

NOTES

- You can press the **[STOP]** key to cancel the process.
- If you do not know the test plan number, you can print a test plan directory using the instructions in section 3.5.2.

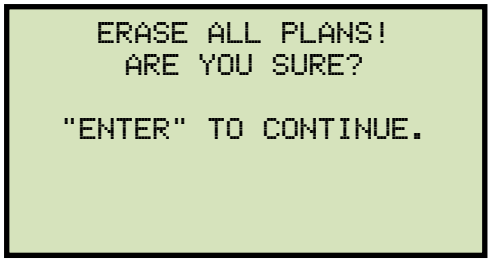
   The selected test plan will be erased and the following screen will be displayed:

```
TEST PLAN NUMBER 1
  ERASED!
```

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

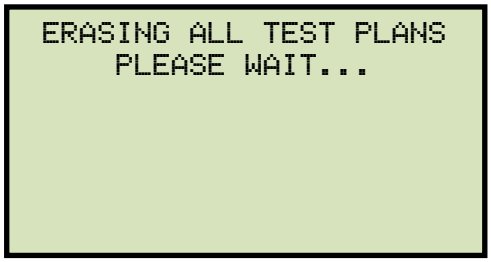
2. *ERASE ALL PLANS*

   Press the **[2]** key if you would like to erase all test plans. The following screen will be displayed:



If you would like to cancel the erasure process, press the **[STOP]** key. No test plans will be erased and you will be returned to the "START-UP" menu.

Press the **[ENTER]** key to continue with the erasure process. The following screen will be displayed while the test plans are being erased:



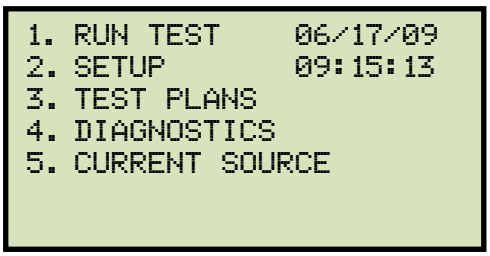
The following screen will be displayed after all of the test plans have been erased:

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

3.5.6. Erasing Test Plans From a USB Flash Drive

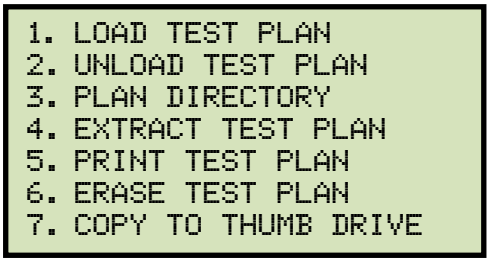
To erase one or all test plans stored on a USB Flash drive:

a. Make sure the USB Flash drive is inserted in the EZCT-2000B's USB Flash drive port ("USB MEM" port). Then start from the "START-UP" menu:



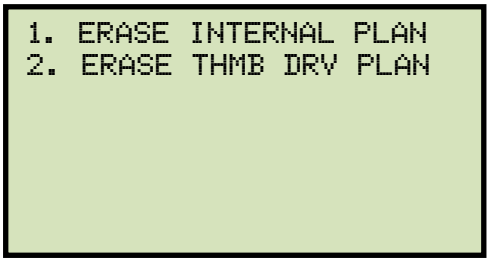
Press the **[3]** key (*TEST PLANS*).

b. The following screen will be displayed:



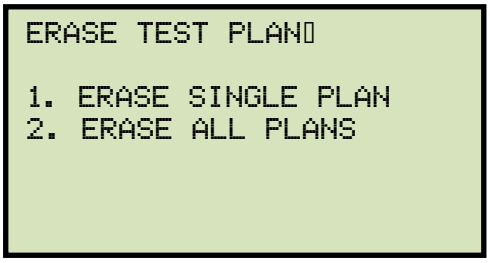
Press the **[6]** key (*ERASE TEST PLAN*).

c. The following screen will be displayed:



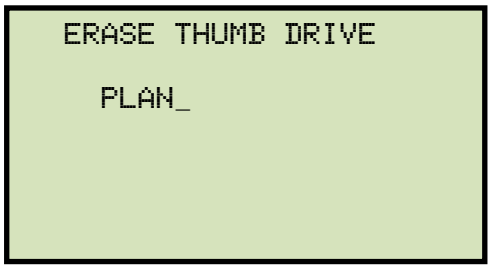
Press the **[2]** key (*ERASE THMB DRV PLAN*).

d. The following screen will be displayed:



1. *ERASE SINGLE PLAN*

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

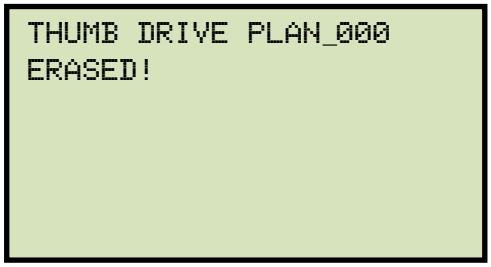


Type the test plan number that you would like to erase and press the **[ENTER]** key.

NOTES

- You can press the **[STOP]** key to cancel the process.
- If you do not know the test plan number, you can print a test plan directory using the instructions in section 3.5.3.

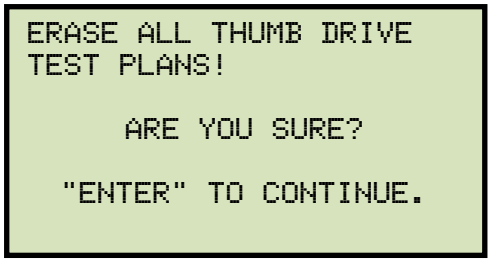
The selected test plan will be erased and the following screen will be displayed:



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

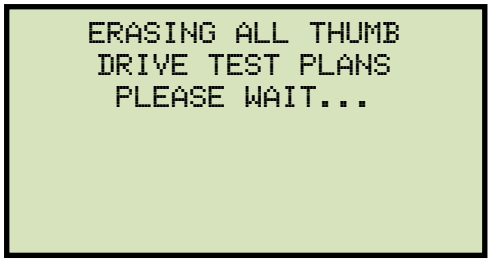
2. *ERASE ALL PLANS*

Press the [2] key (ERASE ALL PLANS) if you would like to erase all the test plans on the USB Flash drive. The following screen will be displayed:

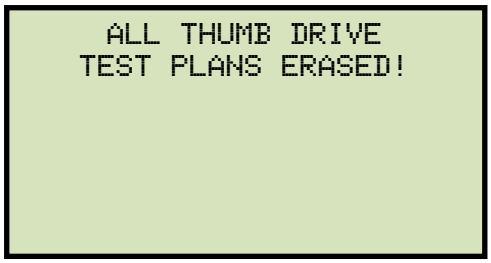


If you would like to cancel the erasure process, press the [STOP] key. No test plans will be erased and you will be returned to the "START-UP" menu.

Press the [ENTER] key to continue with the erasure process. The following screen will be displayed while the test plans are being erased:



The following screen will be displayed after all of the test plans have been erased from the USB Flash drive:



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

3.5.7. Loading a Test Plan from the EZCT-2000B's Flash EEPROM

To use a test plan for running a test, it must first be loaded into the working memory. To load a test plan from the EZCT-2000B's Flash EEPROM into the working memory:

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

```
1. RUN TEST     06/17/09
2. SETUP        10:10:10
3. TEST PLANS
4. DIAGNOSTICS
5. CURRENT SOURCE
```

Press the **[3]** key (*TEST PLANS*).

b. The following screen will be displayed:

```
1. LOAD TEST PLAN
2. UNLOAD TEST PLAN
3. PLAN DIRECTORY
4. EXTRACT TEST PLAN
5. PRINT TEST PLAN
6. ERASE TEST PLAN
7. COPY TO THUMB DRIVE
```

Press the **[1]** key (*LOAD TEST PLAN*).

c. The following screen will be displayed:

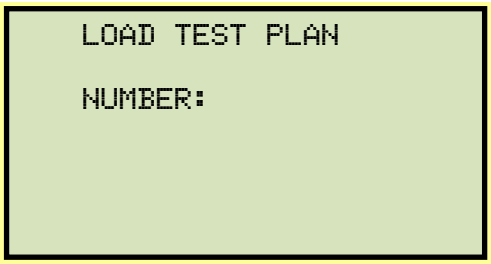
```
   LOAD TEST PLAN

   NUMBER:
```

NOTE

The above screen will be displayed only if a USB Flash drive is NOT connected to the EZCT-2000B's USB Flash drive port. If a USB Flash drive is connected, the following screen will be displayed:

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

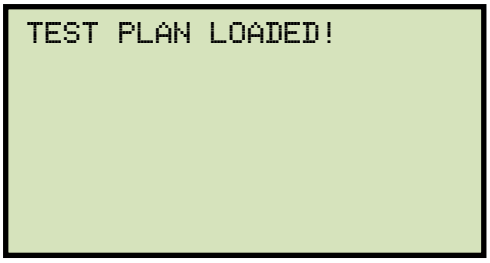
Press the **[1]** key (*INTERNAL STORAGE*). The following screen will be displayed:



Continue with the steps below:

Type the test plan number that you would like to load and press the **[ENTER]** key. If you do not know the test plan number, you can print a test plan directory using the instructions in section 3.5.2.

d. The following screen will be displayed:

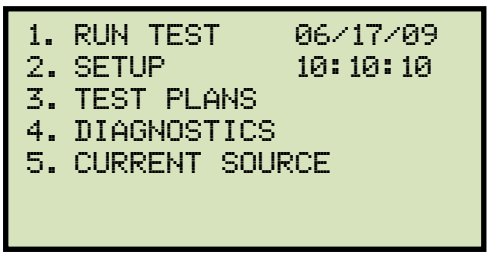


Press any key to return to the "START-UP" menu.

3.5.8. Loading a Test Plan from a USB Flash Drive

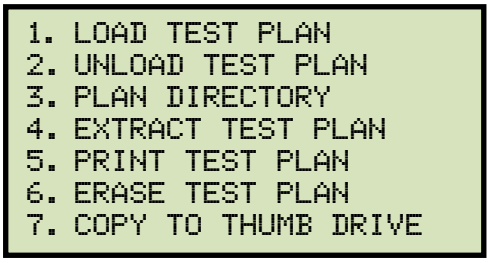
To load a test plan from a USB Flash drive:

a. Make sure the USB Flash drive is inserted in the EZCT-2000B's USB Flash drive port ("USB MEM" port). Then start from the "START-UP" menu:



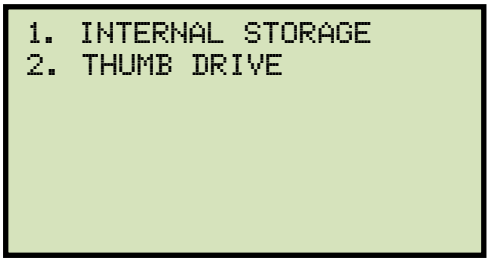
Press the **[3]** key (*TEST PLANS*).

b. The following screen will be displayed:



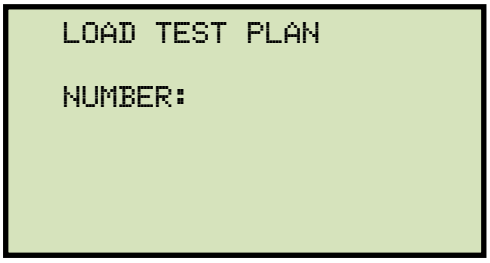
Press the **[1]** key (*LOAD TEST PLAN*).

c. The following screen will be displayed:



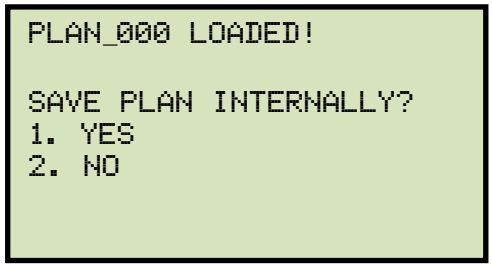
Press the **[2]** key (*THUMB DRIVE*).

d. The following screen will be displayed:



Type the test plan number that you would like to load and press the **[ENTER]** key. If you do not know the test plan number, you can print a test plan directory using the instructions in section 3.5.3.

e. The following screen will be displayed:



1. *YES*

   Press the **[1]** key if you would like the loaded test plan to be also saved in the EZCT-2000B's Flash EEPROM. Any existing test plans in the EZCT-2000B's Flash EEPROM will not be over-written. The EZCT-2000B will automatically assign a new test plan number and store the test plan in the next available memory location. The following screen will be displayed:

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

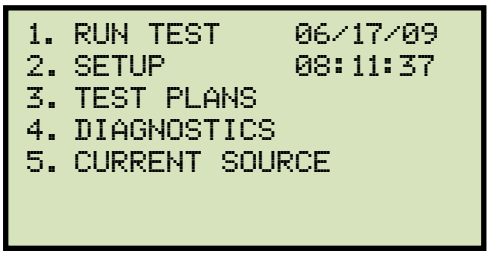
2. *NO*

   Press the **[2]** key if you do not want to save the loaded test plan in the EZCT-2000B's Flash EEPROM. It will be loaded into the working memory, and you will be returned to the "START-UP" menu.

3.5.9. Running a Test Using a Loaded Test Plan

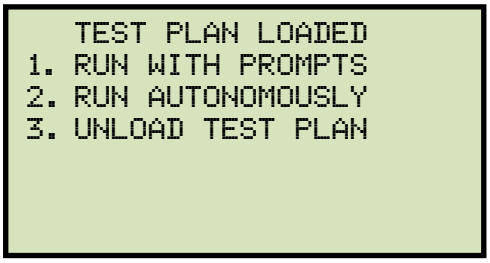
Once a test plan has been loaded into the working memory (see section 3.5.6 for directions), it can be used to run a test. To run a test using a loaded test plan:

a. Make sure a test plan has been loaded into the working memory and then start from the "START-UP" menu:



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

b. The following screen will be displayed (this screen will only be displayed if a test plan has been loaded first):

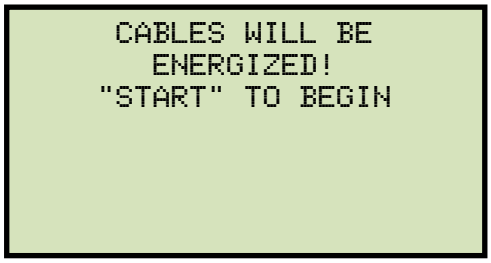


1. *RUN WITH PROMPTS*

   Press the **[1]** key to run the test with prompts. Continue to step c.

2. *RUN AUTONOMOUSLY*

   Press the **[2]** key to run the test autonomously. The following screen will be displayed:

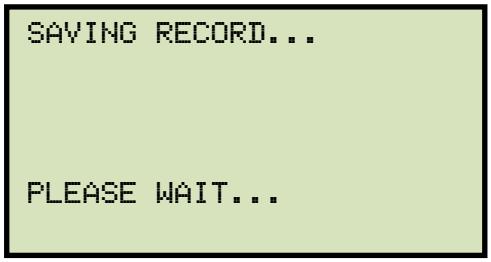


   Press the **[START]** key and the EZCT-2000B will start running the test per the test plan settings. The screen will be updated with the test status.

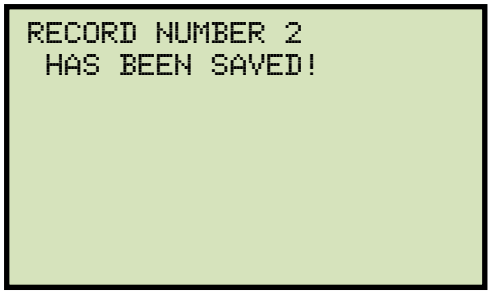
When the test has finished, the following screen will be displayed:

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

The following screen will be displayed momentarily:



Then the following confirmation screen will be displayed:

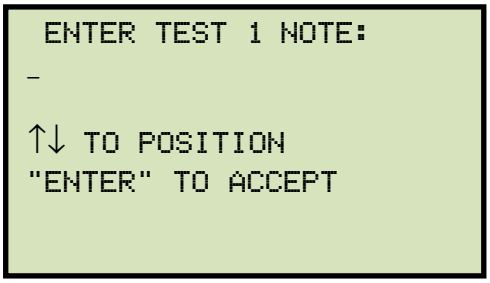


Press any key to return to the "START-UP" menu.

3. *UNLOAD TEST PLAN*

Press the **[3]** key to unload the test plan and run a test without a test plan. This will unload the test plan from the working memory and bring up the standard "RUN TEST" menu. Please see section 3.3.2, step b.

c. The following screen will be displayed:

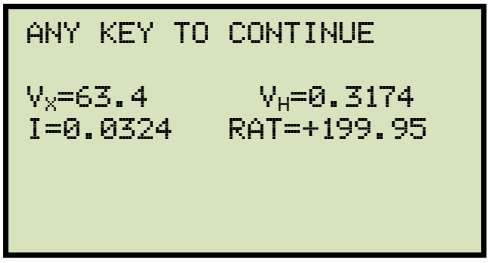


Use the alpha-numeric keys on the keypad to enter a test note and press the **[ENTER]** key.

d. The following confirmation screen will be displayed showing the test parameters:

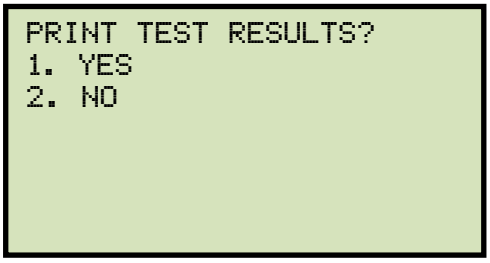
Press the **[START]** key to begin the test.

e. The EZCT-2000B will start performing the test per the test plan parameters. When the test has finished, the following screen will be displayed:



Press any key to continue.

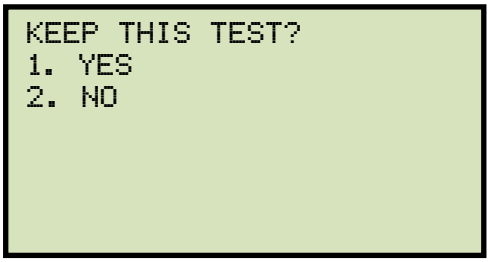
f. The following screen will be displayed:



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

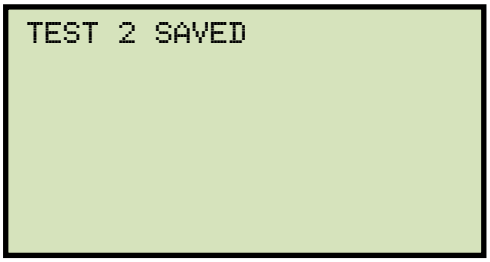
Press the **[2]** key (*NO*) if you do not want to print the test results.

g. The following screen will be displayed:



Press the **[1]** key (*YES*) to keep the test results.

h. The following screen will be displayed:

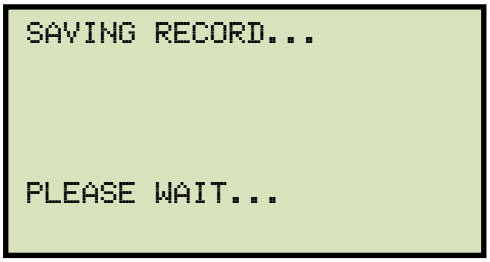


Press any key to continue.

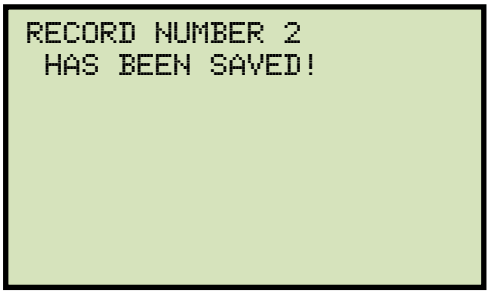
i. The following screen will be displayed:

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

The following screen will be displayed momentarily:



The following confirmation screen will then be displayed:

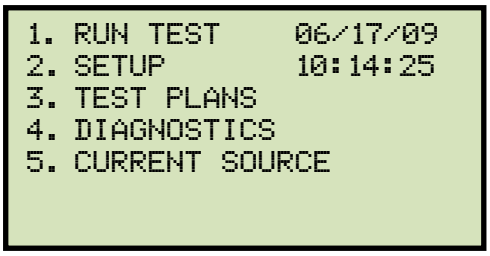


Press any key to return to the "START-UP" menu.

3.5.10. Unloading a Test Plan from the Working Memory

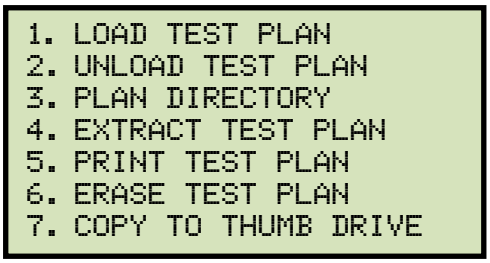
To unload the test plan from the working memory and clear all the test plan parameters:

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



Press the **[3]** key (*TEST PLANS*).

b. The following screen will be displayed:



Press the **[2]** key (*UNLOAD TEST PLAN*).

c. The following screen will be displayed:

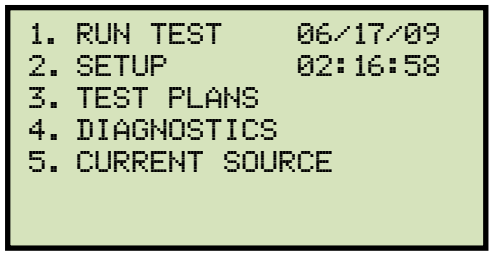
Press any key to return to the "START-UP" menu.

4.0 CHANGING SETUP PARAMETERS

4.1 Setting the Knee Point Marker

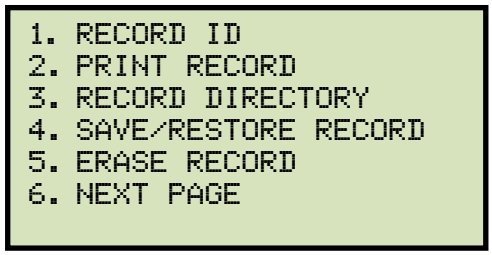
Use the steps below to change the knee point marker for the excitation graph:

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



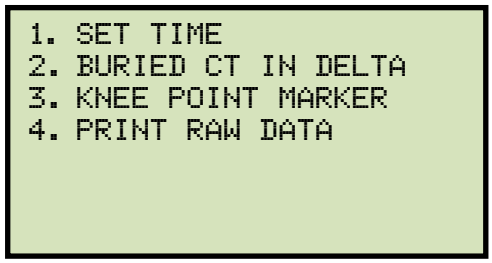
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:



Press the **[6]** key (*NEXT PAGE*).

c. The following screen will be displayed:



Press the **[3]** key (*KNEE POINT MARKER*)

d. The following screen will be displayed:

```
1. IEEE 30 DEGREE
2. IEEE 45 DEGREE
3. IEC 10%V-->50%I
```

Press either the **[1]** key (*IEEE 30 DEGREE*), the **[2]** key (*IEEE 45 DEGREE*), or the **[3]** key (*IEC 10%V-->50%I*) to select the desired knee point marker. The knee point marker will be set and you will be returned to the "START-UP" menu. A graphic report showing the knee point marker is shown in Figure 18.

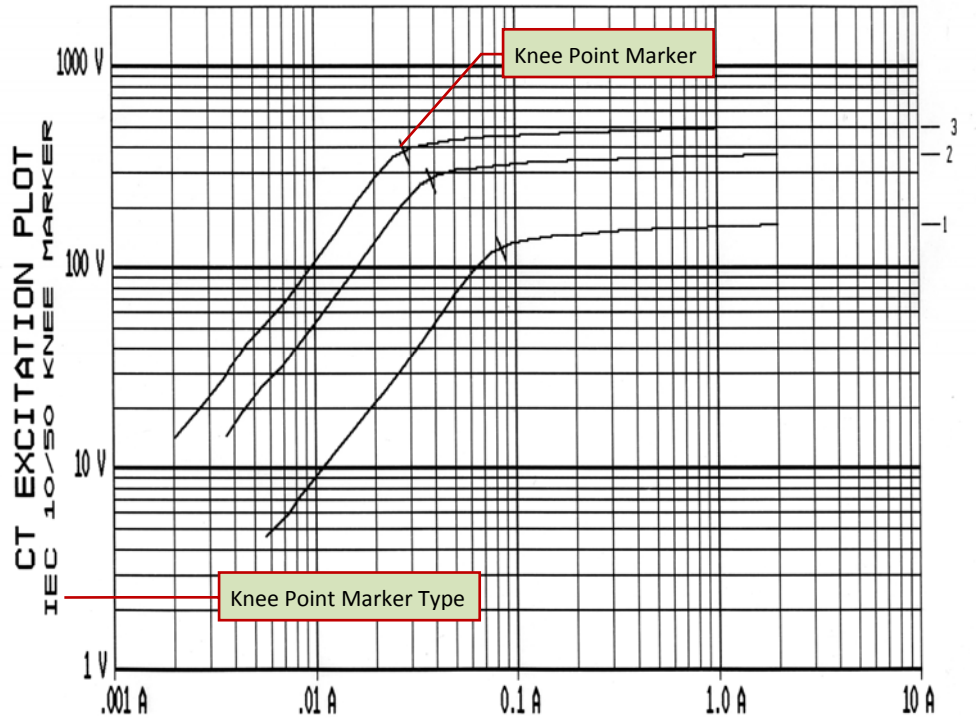


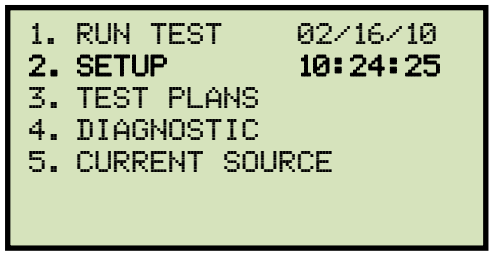
Figure 18. Graphic Report Showing Knee Point Marker

4.2 Enabling and Disabling the Buried CT in Transformer Delta Option

4.2.1. Enabling the Buried CT in Transformer Delta Option

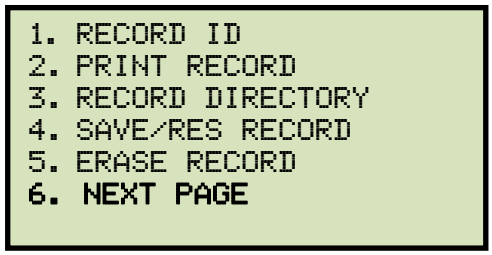
If you are measuring the turns ratio of a CT buried in the transformer Delta windings (see Figure 19 and Figure 20 and also page 92 for further information), you must first select the "Buried CT in Delta" option from the "SETUP" menu using the steps below:

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



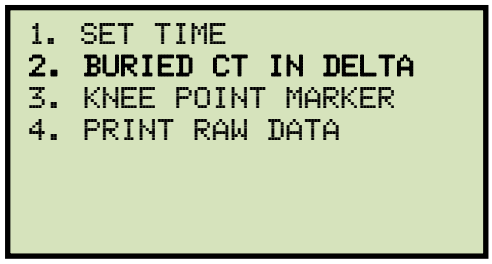
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:



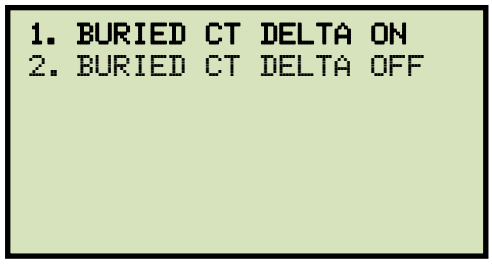
Press the **[6]** key (*NEXT PAGE*).

c. The following screen will be displayed:



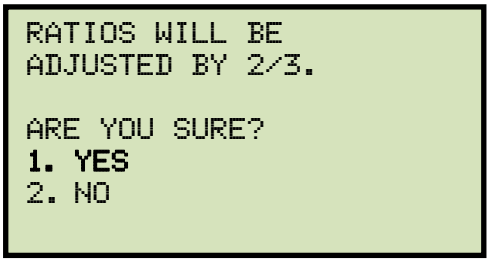
Press the **[2]** key (*BURIED CT IN DELTA*).

d. The following screen will be displayed:



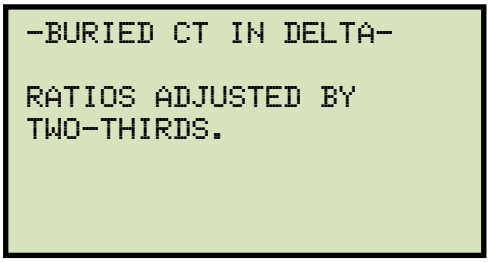
Press the **[1]** key (*BURIED CT DELTA ON*).

e. The following screen will be displayed:



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

f. The following screen will be displayed:

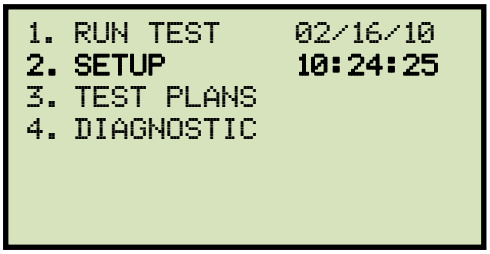


Press any key to return to the "START-UP" menu.

4.2.2. Disabling the Buried CT in Transformer Delta Option

To disable the Buried CT in Transformer Delta Option:

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

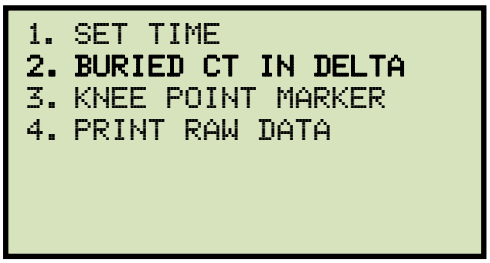


Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:

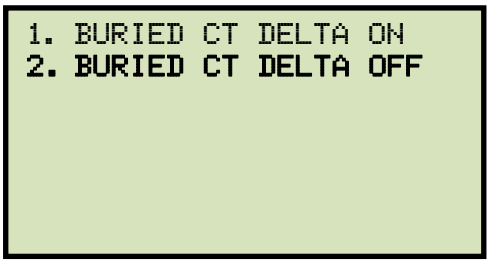
Press the **[6]** key (*NEXT PAGE*).

c. The following screen will be displayed:



Press the **[2]** key (*BURIED CT IN DELTA*).

d. The following screen will be displayed:



Press the **[2]** key (*BURIED CT DELTA OFF*).

e. The following screen will be displayed:

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

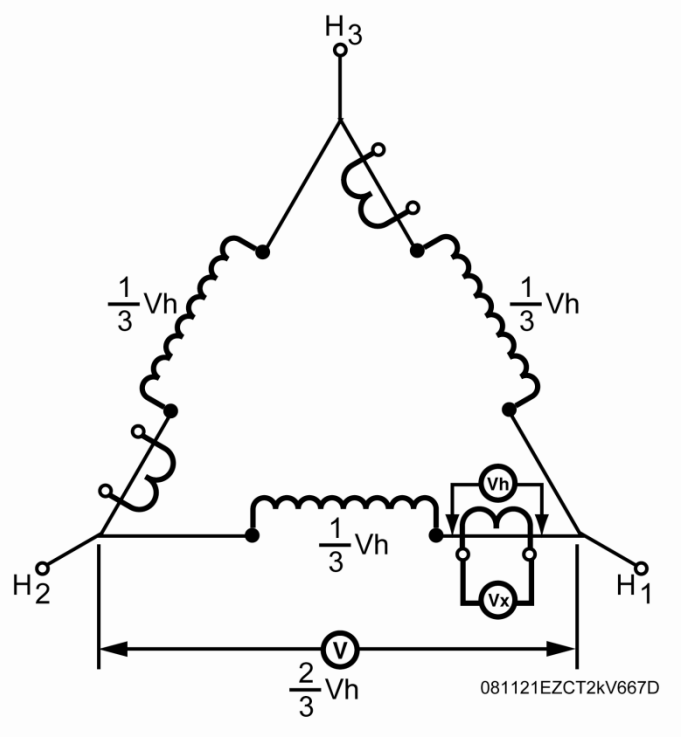


Figure 19. Buried CT in a Delta Transformer Illustration 1

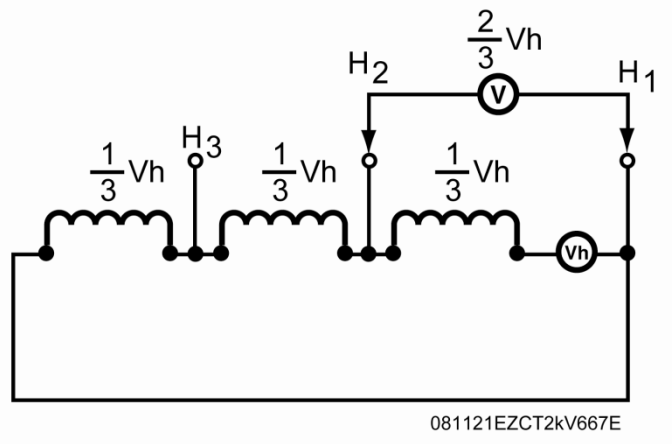


Figure 20. Buried CT in a Delta Transformer Illustration 2

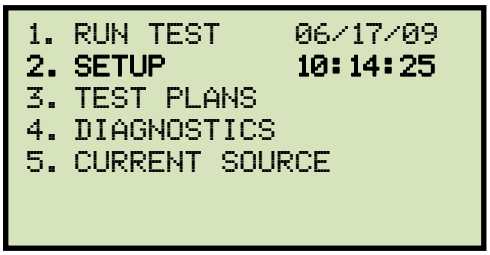
NOTES

- The CT turns ratio is ideally measured as: $\text{Ratio} = \frac{Vx}{Vh}$.
- Since the induced voltage (V) is sensed through the H1-H2 terminals of the Delta winding, this induced voltage is measured as $V = (\frac{2}{3})\ Vh$.
- The CT turns ratio is now measured as $\text{Ratio} = \frac{Vx}{V}$ or $\text{Ratio} = (\frac{3}{2})(\frac{Vx}{Vh})$. This measured turns ratio is $\frac{3}{2}$ higher than the actual turns ratio.
- The EZCT-2000B will display the correct CT turns ratio by adjusting the measured turns ratio by $\frac{2}{3}$.

4.3 Setting the Clock

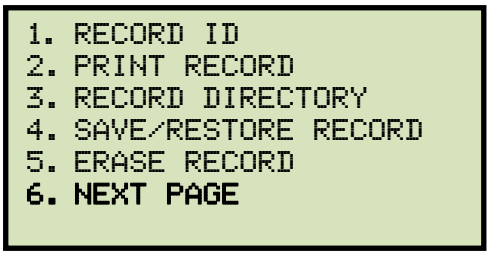
To set the EZCT-2000B's internal clock:

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



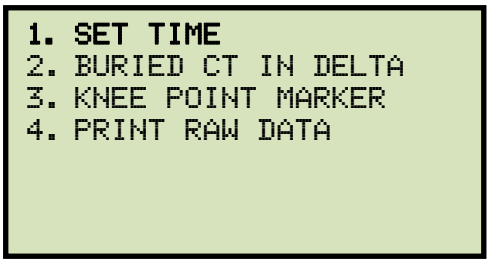
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:



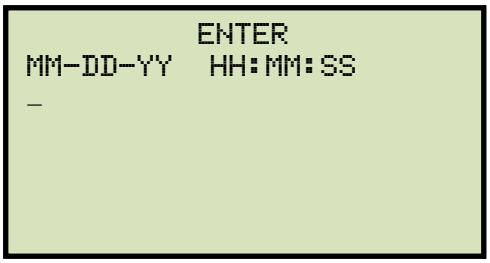
Press the **[6]** key (*NEXT PAGE*).

c. The following screen will be displayed:



Press the **[1]** key (*SET TIME*).

d. The following screen will be displayed:

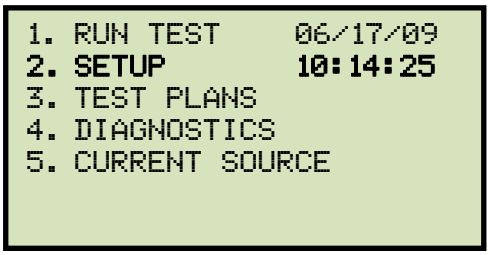


Enter the month, date, time, hours, minutes, and seconds (in 24-hour format) using the alpha-numeric keypad. When the last digit is entered, the clock will be set and you will be returned to the "START-UP" menu.

4.4 Printing Raw Memory Buffer Data

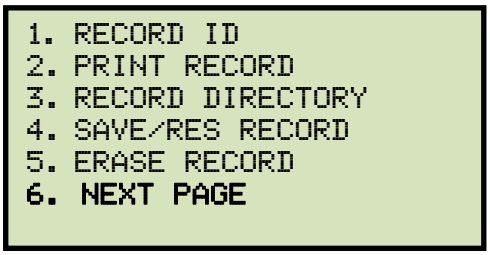
You can print the raw data from the EZCT-2000B's memory buffer for diagnostic purposes. This will print a table of current and voltage values stored in the unit's working memory. To print the raw buffer data:

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



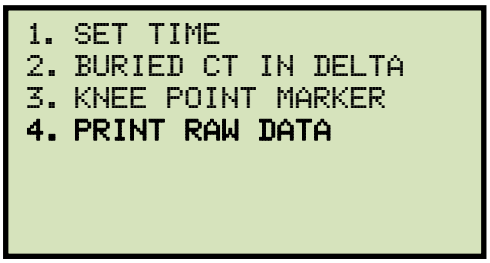
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:



Press the **[6]** key (*NEXT PAGE*).

c. The following screen will be displayed:



Press the **[4]** key (*PRINT RAW DATA*). The raw buffer data will be printed and you will be returned to the "START-UP" menu.

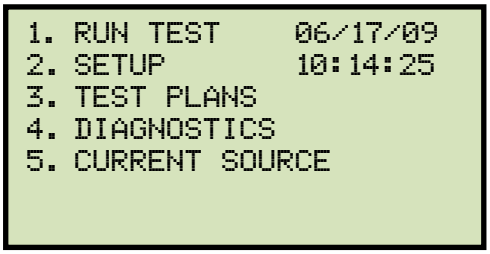
5.0 DIAGNOSTICS, VERIFICATION, AND TROUBLESHOOTING

5.1 Performing a Diagnostics Test

The Diagnostics test mode displays the output voltage at the selected X leads (V_x), the voltage sensed by the H leads (V_h), and the X voltage excitation current (I_x). These values can then be verified using an external volt meter and ampere meter.

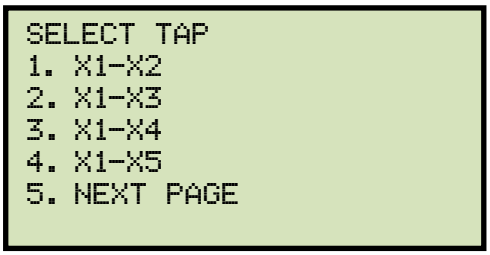
To perform a diagnostic test:

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



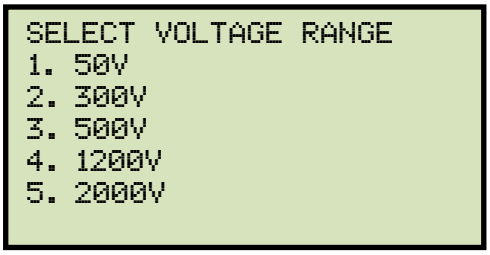
Press the **[4]** key (*DIAGNOSTICS*).

b. The following screen will be displayed:



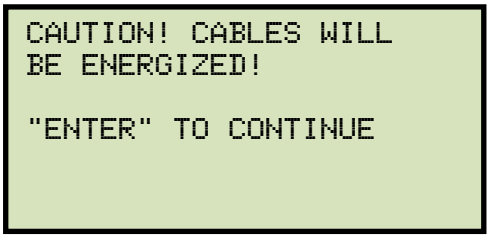
Select the tap connection by pressing the corresponding key (**[1]** – **[4]**). If the tap connection is not listed, press the **[5]** key to view the next page of options and then select the correct tap connection.

c. The following screen will be displayed:



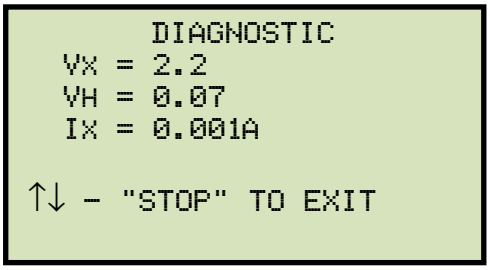
Select the maximum output voltage on the X terminals by pressing the corresponding key (**[1]** – **[5]**).

d. The following screen will be displayed:



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

e. The following screen will be displayed and the V_x, V_h, and I_x values will be continuously updated for 15 seconds:



You can press the **[PAPER ∧ Contrast]** or **[PAPER ∨ Contrast]** key to increase or decrease the V_x voltage, respectively. You can press the **[STOP]** key to end the test immediately and return to the "START-UP" menu.

The test will automatically end after 15 seconds, and you will be returned to the "START-UP" menu.

5.2 Verifying the EZCT-2000B's V_x Sense Circuit Using an External Meter

The excitation voltage (V_x) sensed by the EZCT-2000B can be verified using an external RMS volt meter. Follow the steps below to verify the EZCT-2000B's V_x sense circuit:

a. Connect the X cables to an RMS volt meter as shown in Figure 21.

b. Select the EZCT-2000B's Diagnostics mode (see section 5.1).

c. Press the **[PAPER ∧ Contrast]** key to raise the V_x voltage.

d. Verify the V_x voltage displayed on the EZCT-2000B LCD screen against the value displayed on the external volt meter.

e. Press the **[STOP]** key to end the test.

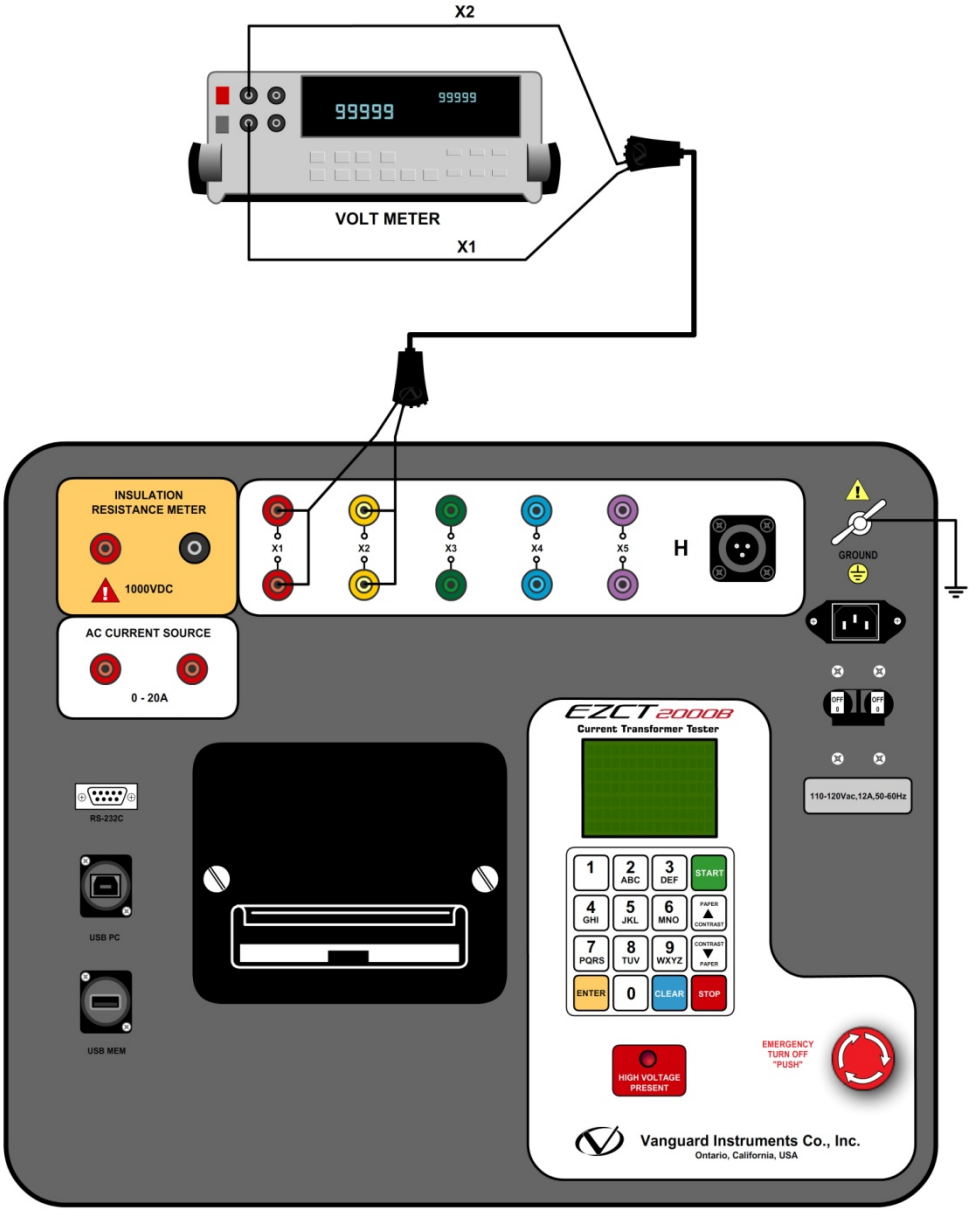


Figure 21. EZCT-2000B V_x Verification Test Connections

5.3 Verifying the EZCT-2000B's I_x Sense Circuit Using an External Meter

You can verify the excitation current (I_x) sensed by the EZCT-2000B by using an external RMS ampere meter. Follow the steps below to verify the EZCT-2000B's I_x sense circuit:

a. Connect the X cables to a power resistor and an RMS ampere meter as shown in Figure 22.

b. Select the EZCT-2000B's Diagnostics mode (see section 5.1).

c. Press the **[PAPER ∧ Contrast]** key to raise the V_x voltage.

d. Verify the I_x voltage displayed on the EZCT-2000B's LCD screen against the value displayed on the external RMS ampere meter.

e. Press the **[STOP]** key to end the test.

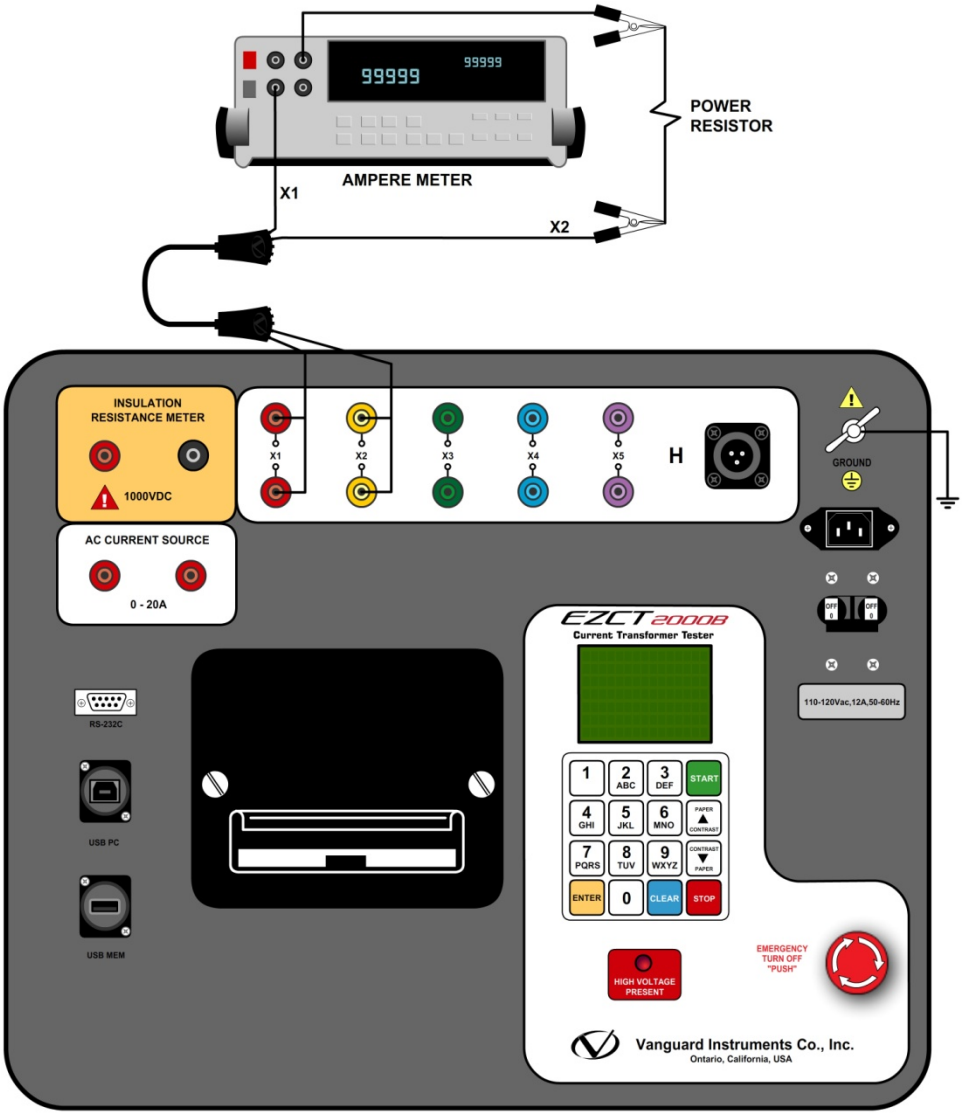


Figure 22. EZCT-2000B I_x Verification Test Connections

5.4 Quickly Verifying the EZCT-2000B's Turns Ratio Circuit

You can quickly verify the EZCT-2000B's turns ratio circuit by performing the following ratio test:

a. Connect the X1 test lead to the H1 test lead as shown in Figure 23.

b. Connect the X2 test lead to the H2 test lead as shown in Figure 23.

c. Run a turns ratio test (see section 3.3.2).

d. Observe the turns ratio test on the LCD screen. The turns ratio should be 1.000 since the excitation voltage is the same as the sensed voltage.

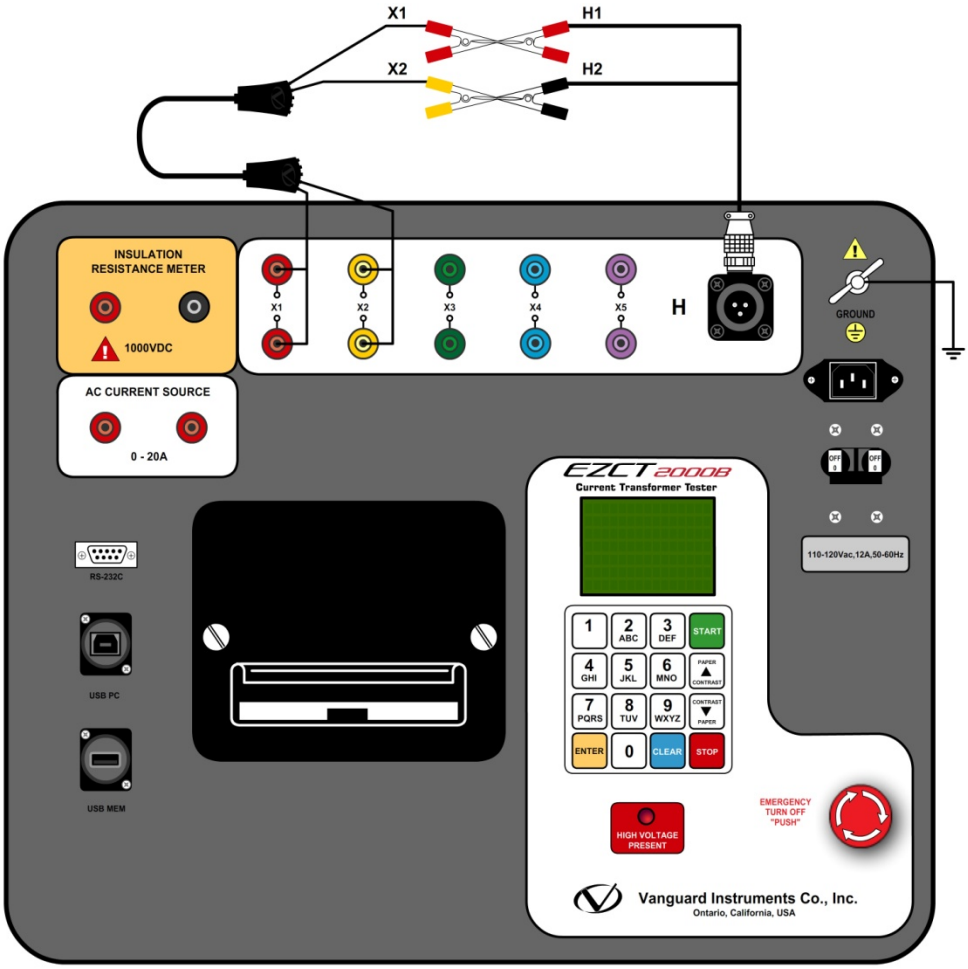


Figure 23. EZCT-2000B Turns Ratio Verification Test Connections

5.5 Troubleshooting Guide

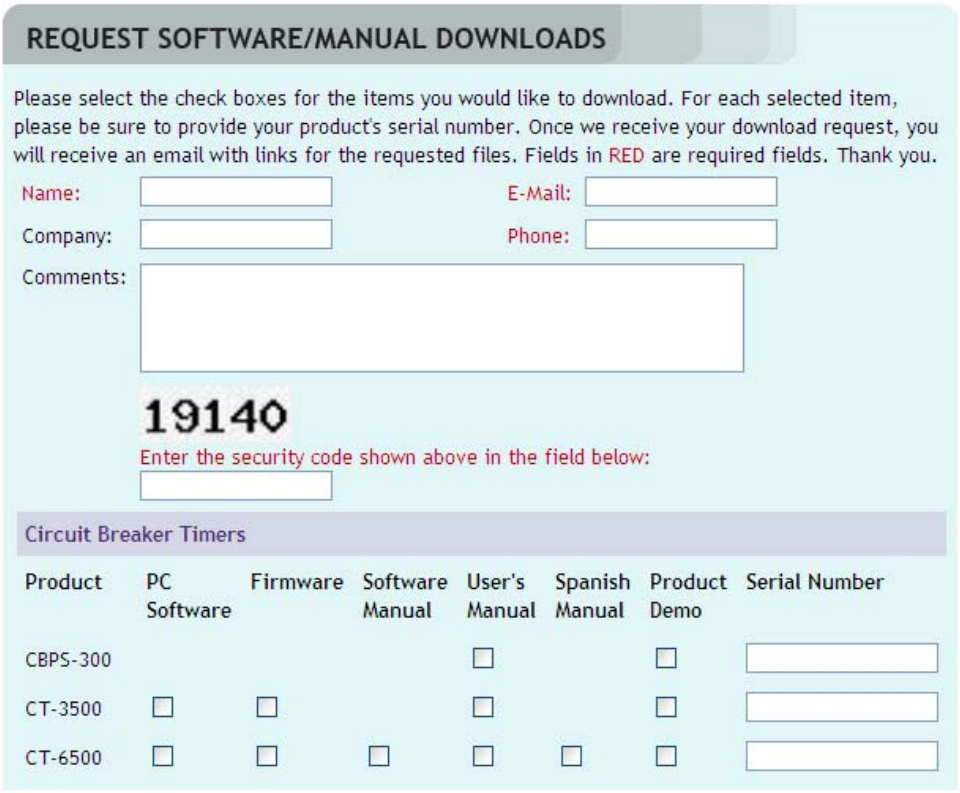
PROBLEM DESCRIPTION	Probable Cause	Suggested Solution
When running the excitation test, the V_x voltage is always zero. The excitation current can be raised during a test.	• The EZCT-2000B X cables are driving a short circuit.	• Check CT shorting screws. • Check X lead connections.
When running the excitation test, the V_x voltage can be raised but the excitation current is always zero during a test.	• The EZCT-2000B X cable is driving an opened circuit.	• Check the CT terminal connection.
CT excitation knee point voltages and turns ratio readings are incorrect.	• CT may not be completely de-magnetized. • If the user runs a dc resistance test, the CT will be magnetized. The next test the EZCT-2000B executes is an excitation test. If the excitation current did not reach at least 0.8A, the CT is not completely de-magnetized.	• Raise the excitation voltage setting in the test plan. • Re-run the excitation test. • You can quickly verify if the CT was de-magnetized by looking at the last excitation graph.
When running the excitation test, the V_x reading is erratic.	• The EZCT-2000B X cable may be opened. Each X cable has two conductors going from the clip end to the banana jacks. If one of the conductors is opened, the V_x readings will be erratic.	• Remove X cables from the EZCT-2000B and the CT terminals. • Check cable integrity using an Ohm Meter.
Saturation test is correct but turns ratio test is erroneous.	• V_H cables problem.	• Check the V_H cable connection. • Check the V_H cable integrity with an Ohmmeter
Turns ratio test of a CT mounted on a transformer bushing is incorrect.	• Transformer windings opposite side of CT windings is not shorted.	• See Figure 7.

6.0 UPGRADING FIRMWARE

The EZCT-2000B's firmware is user-upgradeable. You can download the latest firmware from the Vanguard Instruments Company web site at http://www.vanguard-instruments.com. Use the steps below to download and install the latest EZCT-2000B firmware:

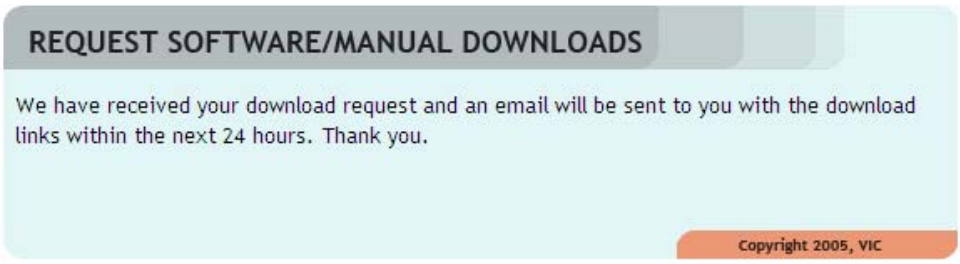
a. Visit the Vanguard web site at http://www.vanguard-instruments.com and click on the "Downloads" button:

b. You will be taken to the "Downloads" page and presented with a "Download Request Form":



Fill out all required fields (marked with red labels) and then click on the "Firmware" checkbox to the right of the "EZCT-2000B" label. Then fill out the serial number field on the right. Click on the "Submit" button once all form fields have been filled out.

c. The following confirmation page will be displayed:



d. You will also receive an email confirming the receipt of your download request. Once your request has been received, you will receive a second email, usually within 1-2 business hours, containing a download link for the firmware file. Click on this link and download the firmware file to your computer.

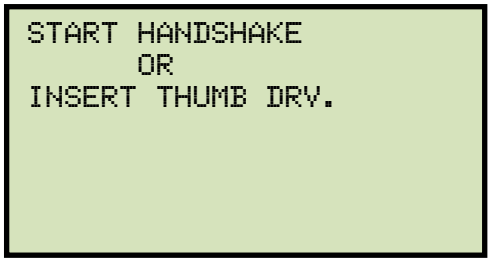
e. The downloaded file will be in ZIP compressed format. Unzip this file to an empty directory (you can use a utility like Winzip, 7Zip, Winrar, etc.). Once un-compressed, you should see a file named *EZCT2B_M.hex*. Copy this file to the root of a USB Flash drive.

f. Make sure the EZCT-2000B's power if OFF, and then insert the USB Flash drive containing the firmware file in the EZCT-2000B's Flash drive interface port ("USB MEM" port).

g. While holding down the **[STOP]** key, turn on the EZCT-2000B.

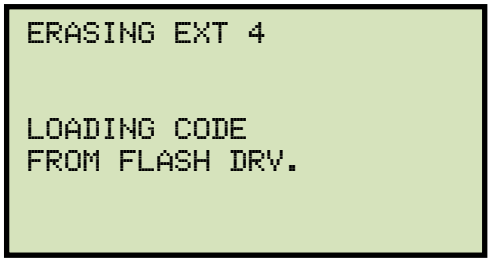
h. Continue to hold down the **[STOP]** key while the EZCT-2000B powers up.

i. After the initial logo screen, the following screen will be displayed:



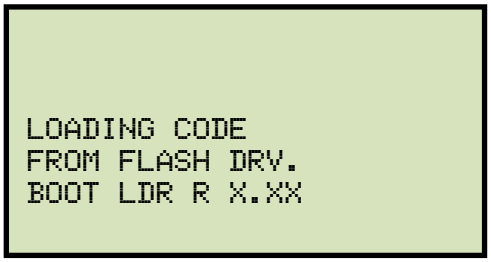
Continue to hold down the **[STOP]** key.

j. The firmware upgrade process will start and the following screen will be displayed:



You can release the **[STOP]** key at this point. The EZCT-2000B will continue the upgrade process and display the following screen:

When the firmware upgrade has finished, the following screen will be displayed:



You will hear a series of beeps as the unit re-boots. Once the unit has re-booted, the "START-UP" menu will be displayed.

7.0 Appendix A - Calculating Turns Ratio on a Shunt Reactor

The Vanguard EZCT line of products use the voltage method to measure the turns-ratio on current transformers. A typical connection for a stand-alone CT is shown in Figure 24.

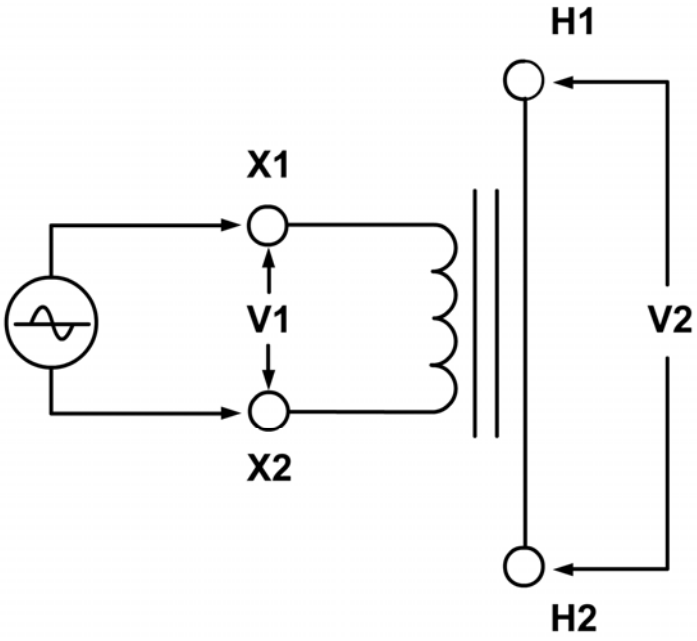


Figure 24

The EZCT applies a test voltage (V1) to the CT secondary winding. The induced voltage (V2) is sensed through the CT primary winding. In this case a single conductor is used. By definition, the turns-ratio is the voltage ratio:

$$\text{Ratio}=\frac{V1}{V2}$$

Figure 25 shows a typical connection of a CT mounted on the primary bushing of a single phase transformer. When the voltage V1 is introduced to the CT's secondary winding, there is an induced voltage (V3) on the primary winding of this single phase transformer. Since the only access to the transformer is between terminals H1-H0, The V3 voltage will be included and the turns-ratio will be:

$$\textbf{Ratio}=\frac{V1}{(V2+V3)}$$

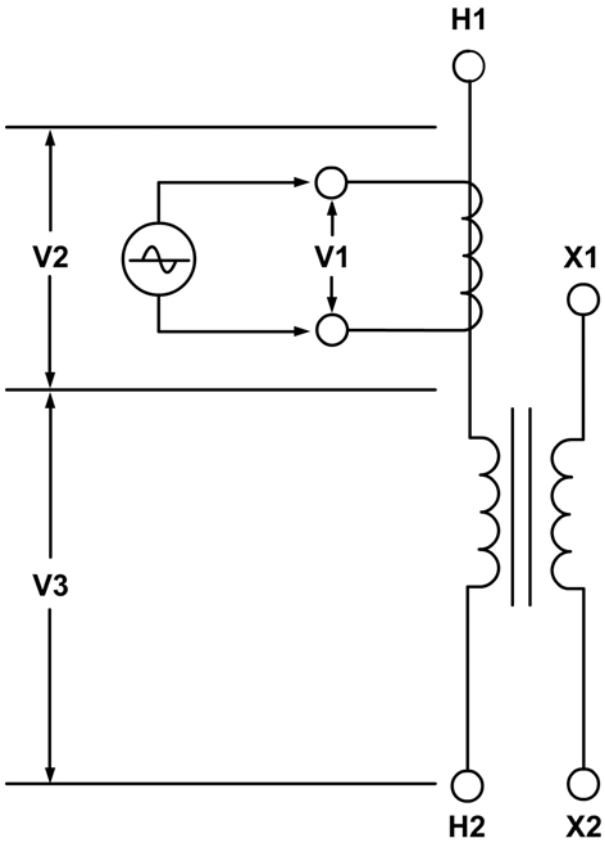


Figure 25

Ideally, we would like to eliminate the V3 voltage and only see the V2 voltage. If the induced V3 voltage on the transformer winding cannot be eliminated, the **turns-ratio measured will be wrong!**

Since this is a single phase transformer, and the transformer **secondary winding is accessible**, the user can apply a jumper to short out the transformer secondary winding as shown in Figure 26. By shorting out the transformer secondary winding, the user can eliminate most of the V3 voltage (V3=0V).

Now the turns-ratio will be:

$$\textbf{Ratio}=\frac{V1}{V2}$$

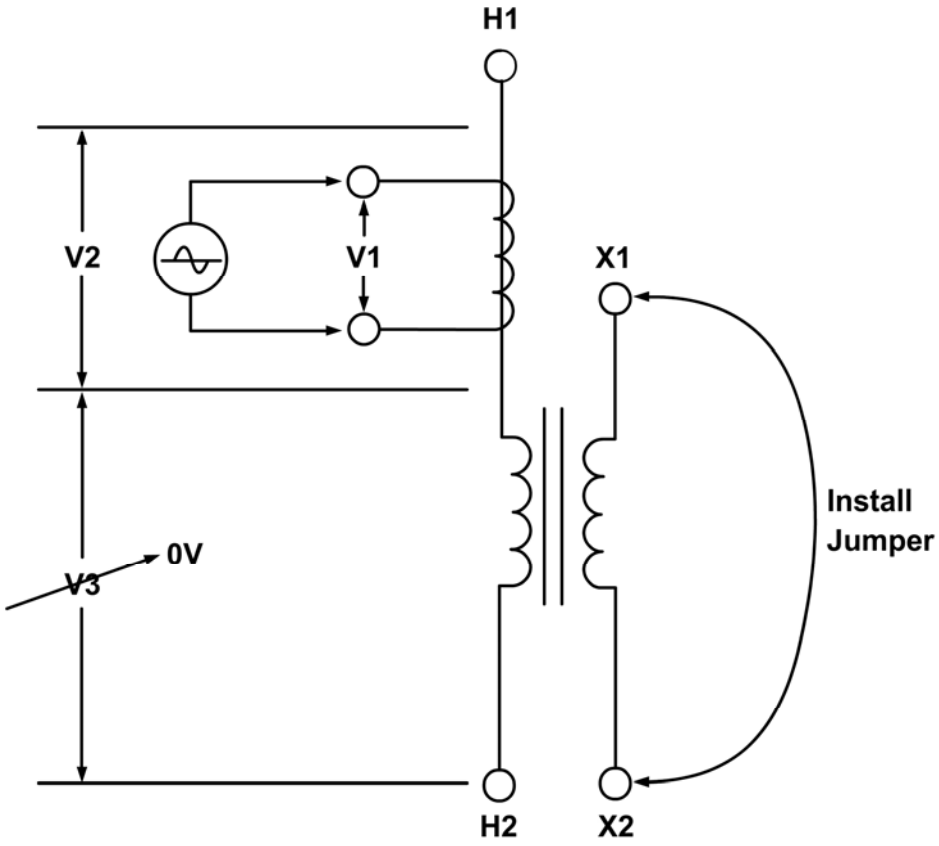


Figure 26

Figure 27 shows a **CT mounted on an auto-transformer**. This configuration is very similar to the CT mounted on a single phase transformer, the main difference being that the secondary winding is part of the primary winding.

The turns-ratio in this case will be:

$$\text{Ratio}=\frac{V1}{(V4)}=\frac{V1}{(V2+V3)}$$

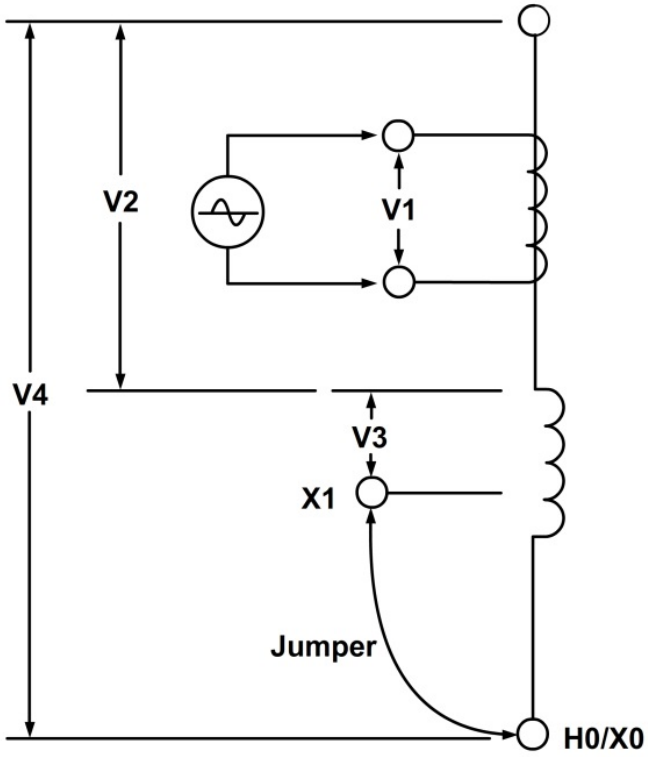


Figure 27

By shorting out the transformer's secondary winding (X1 to H0/X0); we can eliminate the voltage induced from X1 to H0/X0. The voltage V3 cannot be eliminated and will create an error in the CT turns ratio measurement. The amount of error depends on the amount of turns of the secondary windings. The alternative method to verify the CT turns ratio is shown in Figure 29 and Figure 30.

Figure 28 show a **CT mounted on a typical shunt reactor**. This configuration is very similar to the CT mounted on a single phase transformer, the main difference being the lack of the secondary winding! The turns-ratio in this case will be:

$$\text{Ratio}=\frac{V1}{(V2+V3)}$$

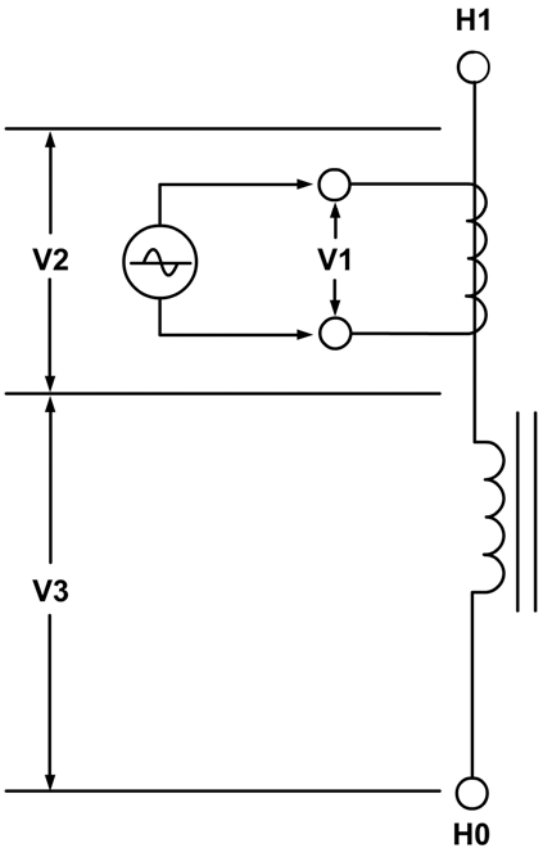


Figure 28

Since there is no secondary winding on the shunt reactor, the V3 voltage cannot be eliminated from the connection. The turns-ratio measurement from using this method will **always have some built-in error**. The amount of error depends on the size of the reactor winding and the number of turns on the CT's secondary winding. The alternative method to verify the CT turns ratio is shown in Figure 29 and Figure 30.

Figure 29 show a CT with 5 taps. The turns-ratio of the CT can be measured by treating the CT secondary winding as an auto-transformer. When using this method, the **effect of the shunt reactor winding is totally eliminated.**

The turns-ratio [(X1-X5)/(X2-X5)] measured by the EZCT or any electronic TTR will be as follows:

$$\textbf{Ratio} = \frac{V1}{V2}$$

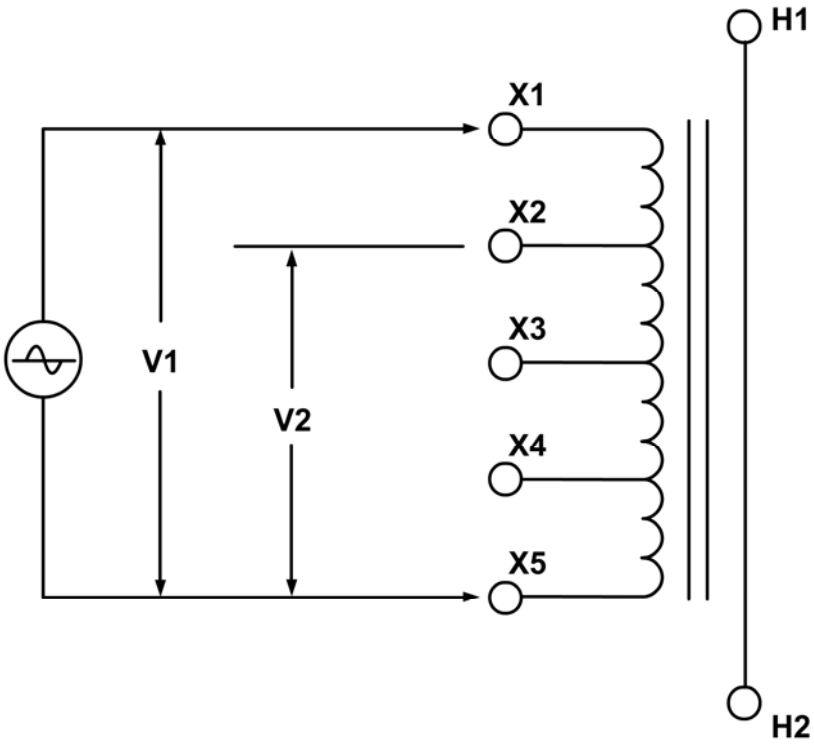


Figure 29

From the name plate of the CT show in table below, the turns-ration can be calculated as follows:

Ratio	Terminal
1200-5A	X1-X5
1000-5A	X2-X5

$$\text{Calculated Ratio} = \frac{Ratio\ (X1-X5)}{Ratio\ (X2-X5} = \frac{240}{200} = 1.20$$

A common practice for verifying the CT turns-ratio in the field is to apply an AC voltage to the CT secondary full winding (X1-X5). A volt meter can be used to verify the voltage drop across the CT terminals.

For example, if a 120Vac voltage is applied to the X1-X5 of this CT, the voltage reading across X2-X5 shall be expected as follows:

$$\frac{V(X1-X5)}{V(X2-X5)} = \frac{1200}{1000} = 1.2$$

$$\frac{120v}{V(X2-X5)} = 1.2$$

$$V\ (x2\text{-}x5) = 100V$$

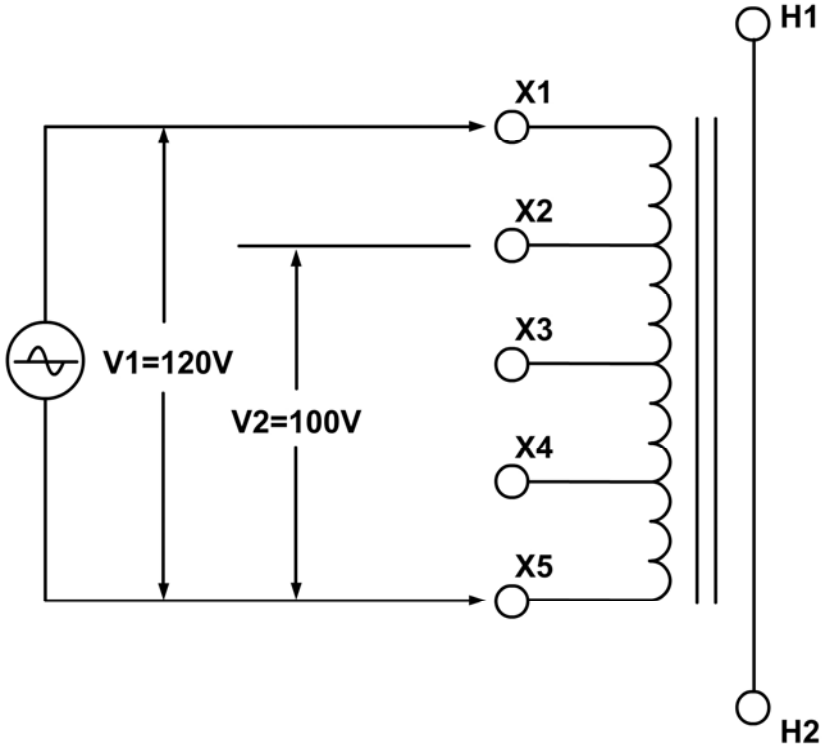
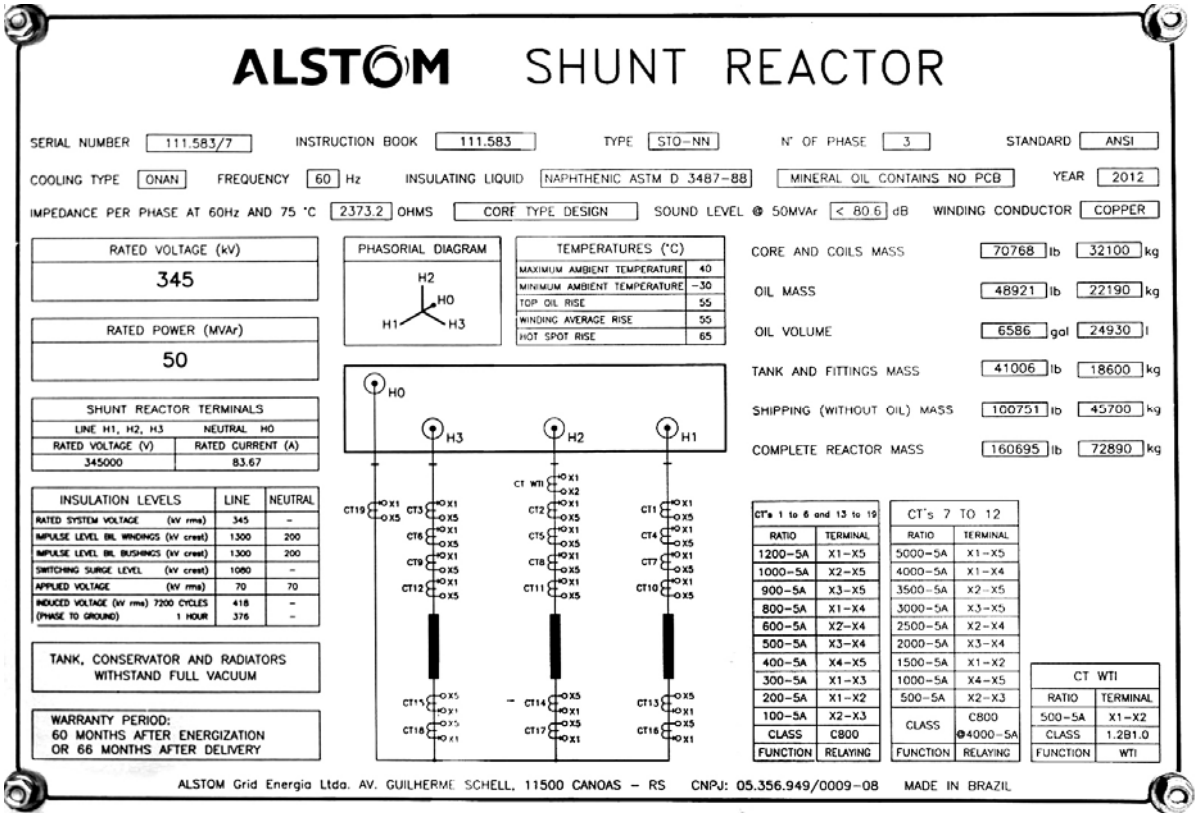


Figure 30

This method also eliminates the effect of the auto-transformer or reactor windings.



ALSTOM SHUNT REACTOR

SERIAL NUMBER 111.583/7 | INSTRUCTION BOOK 111.583 | TYPE STO-NN | N° OF PHASE 3 | STANDARD ANSI

COOLING TYPE ONAN | FREQUENCY 60 Hz | INSULATING LIQUID NAPHTHENIC ASTM D 3487-88 | MINERAL OIL CONTAINS NO PCB | YEAR 2012

IMPEDANCE PER PHASE AT 60Hz AND 75 °C 2373.2 OHMS | CORE TYPE DESIGN | SOUND LEVEL @ 50MVAr < 80.6 dB | WINDING CONDUCTOR COPPER

RATED VOLTAGE (kV)
345

RATED POWER (MVAr)
50

SHUNT REACTOR TERMINALS	
LINE H1, H2, H3	NEUTRAL H0
RATED VOLTAGE (V)	RATED CURRENT (A)
345000	83.67

INSULATION LEVELS		LINE	NEUTRAL
RATED SYSTEM VOLTAGE	(kV rms)	345	-
IMPULSE LEVEL BIL WINDINGS	(kV crest)	1300	200
IMPULSE LEVEL BIL BUSHINGS	(kV crest)	1300	200
SWITCHING SURGE LEVEL	(kV crest)	1080	-
APPLIED VOLTAGE	(kV rms)	70	70
INDUCED VOLTAGE (kV rms) 7200 CYCLES (PHASE TO GROUND)	1 HOUR	418 376	- -

TANK, CONSERVATOR AND RADIATORS WITHSTAND FULL VACUUM

WARRANTY PERIOD:
60 MONTHS AFTER ENERGIZATION
OR 66 MONTHS AFTER DELIVERY

PHASORIAL DIAGRAM

TEMPERATURES (°C)	
MAXIMUM AMBIENT TEMPERATURE	40
MINIMUM AMBIENT TEMPERATURE	-30
TOP OIL RISE	55
WINDING AVERAGE RISE	55
HOT SPOT RISE	65

CORE AND COILS MASS	70768 lb	32100	kg
OIL MASS	48921 lb	22190	kg
OIL VOLUME	6586 gal	24930	l
TANK AND FITTINGS MASS	41006 lb	18600	kg
SHIPPING (WITHOUT OIL) MASS	100751 lb	45700	kg
COMPLETE REACTOR MASS	160695 lb	72890	kg

CT's 1 to 6 and 13 to 19	
RATIO	TERMINAL
1200-5A	X1-X5
1000-5A	X2-X5
900-5A	X3-X5
800-5A	X1-X4
600-5A	X2-X4
500-5A	X3-X4
400-5A	X4-X5
300-5A	X1-X3
200-5A	X1-X2
100-5A	X2-X3
CLASS	C800
FUNCTION	RELAYING

CT's 7 TO 12	
RATIO	TERMINAL
5000-5A	X1-X5
4000-5A	X1-X4
3500-5A	X2-X5
3000-5A	X3-X5
2500-5A	X2-X4
2000-5A	X3-X4
1500-5A	X1-X2
1000-5A	X4-X5
500-5A	X2-X3
CLASS	C800 @4000-5A
FUNCTION	RELAYING

CT WTI	
RATIO	TERMINAL
500-5A	X1-X2
CLASS	1.2B1.0
FUNCTION	WTI

ALSTOM Grid Energia Ltda. AV. GUILHERME SCHELL, 11500 CANOAS - RS CNPJ: 05.356.949/0009-08 MADE IN BRAZIL

Figure 31

Figure 32

Vanguard Instruments Company, Inc.

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

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

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