

EZCT S2A™

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

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SAFETY SUMMARY

FOLLOW EXACT OPERATING PROCEDURES

Any deviation from the procedures described in this User's Manual may create one or more safety hazards, may damage the EZCT S2A, or cause errors in the test results. Vanguard Instruments Company, Inc. assumes no liability for unsafe or improper use of the EZCT S2A.

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 S2A can produce a voltage up to 1,500 Vac that can cause severe injury and/or equipment damage. Due to this reason, the EZCT S2A shall be used only by **trained operators**.

The EZCT S2A's X output terminals are rated to 1,500 Vac working voltage. Any voltage above 1,500 Vac will damage the input circuitry.

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 S2A.

Always ground the EZCT S2A 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 S2A 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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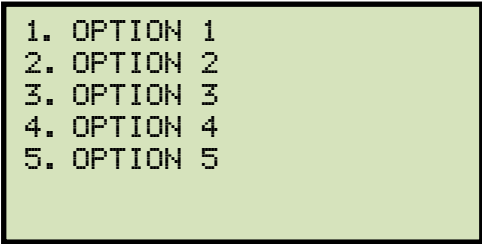
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CONVENTIONS USED IN THIS DOCUMENT

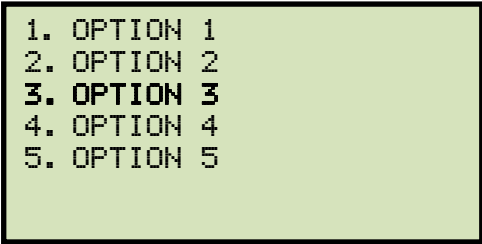
This document uses the following conventions:

- A key or switch on the EZCT S2A is indicated as **[KEY]** and **[SWITCH]**.
- 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.
- EZCT S2A LCD screen output is shown as:



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

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



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

- Warning messages are indicated as:



WARNING

Warning message

- Important notes are indicated as:



NOTE

Note details

1.0 INTRODUCTION

1.1 General Description and Features

The EZCT S2A is Vanguard's third-generation, microprocessor-based, current transformer test set. The EZCT S2A can perform the current transformer (CT) excitation, CT current-ratio, and winding polarity tests automatically. The EZCT S2A automatically raises and lowers the excitation test voltage without any operator intervention. With up to 1500 Vac excitation test voltage available, the EZCT S2A can easily perform excitation tests on very large CT's.

Excitation Test

The CT excitation test is performed using the ANSI/IEEE C57.13.1, IEC 60044-1 test method. The test voltage range for the CT excitation test (50 Vac, 250 Vac, 500 Vac, or 1500 Vac) can be selected, and then the test voltage is raised and lowered automatically by the EZCT S2A. The test voltage and current data are collected and stored in the unit's internal memory. Up to 10 CT excitation and current-ratio tests can be stored in one test record. IEEE-30, IEEE-45, ANSI/IEC 60044-1 (10/50) knee point voltages are also calculated and printed on the test report. Once the test is completed, test results can be printed and excitation curves can be plotted on the built-in 4.5-inch wide thermal printer.

CT Ratio and Polarity Tests

The EZCT S2A determines the CT current-ratio using the ANSI/IEEE C57.12.90 measurement method. A test voltage is applied to the CT's secondary terminals and the induced voltage is measured through the CT's H1 and H2 terminals. The CT current-ratio and polarity are displayed on the screen and stored in memory. The current-ratio measuring range is 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.

User Interface and Display

The EZCT S2A features a back-lit LCD screen (240 x 128 dot graphic) that is viewable in both bright sunlight and low-light levels. A rugged, alpha-numeric, membrane keypad is used to control the unit.

Built-in Thermal Printer

A built-in 4.5-inch wide thermal printer can print the current transformer test report and plot the excitation curves.

Test Record Header Information

The test record header information can include the company name, substation name, circuit ID, manufacturer, CT serial number, operator's name, and test record comments. In addition to the test record header, a 20-character test description for each test in the record can also be entered.

Internal Test Record Storage Capacity

The EZCT S2A can store up to 140 test records in Flash EEPROM. Each test record may contain up to 10 excitation curves, current-ratio readings, and winding polarity readings. Test records can be recalled and printed on the built-in thermal printer.

Internal Test Plan Storage Capacity

The EZCT S2A can store up to 128 CT test plans in Flash EEPROM. A test plan defines the excitation test voltage and current selection, CT nameplate ratio, and CT winding terminal connection instructions for each test. Up to 10 test definitions can be stored in each test plan. The use of a test plan greatly simplifies the CT testing process since it also provides instructions for making the proper CT cable connections. Test plans can be created on the EZCT S2A itself or created on a PC and downloaded to the EZCT S2A via the unit's built-in RS-232C or USB port.

External Data Storage

The EZCT S2A features a standard USB Flash drive interface that makes it very convenient to store and transfer test records and test plans. By plugging in a USB Flash drive, you can quickly transfer your test records and test plans between a computer and the EZCT S2A without the need to connect the unit to the computer.

Computer Interface

The EZCT S2A can be used as a stand-alone unit or can be computer-controlled via the built-in RS-232C or USB interfaces. A Windows® XP/Vista-based Current Transformer Analysis software application is provided with each EZCT S2A. This software can be used to retrieve test records from the EZCT S2A, create test plans, download test plans to the EZCT S2A, and can also be used to run CT tests from the PC. Tabulated test records can be exported in Microsoft® Excel format.

1.2 Furnished Accessories

The EZCT S2A comes furnished with the following:

- 1 Power Cord
- 2 20-foot X Cable Sets
- 1 35-foot H Cable Set
- One RS-232C serial cable
- One USB cable
- Ground Cables
- Cable carrying duffel bag

1.3 Technical Specifications

Table 1. EZCT S2A Technical Specifications

TYPE	Portable current transformer test set
PHYSICAL SPECIFICATIONS	16.8"W x 12.6"H x 12"D (42.7 cm x 32 cm x 26.9 cm); Weight: 55 lbs (25 kg)
INPUT POWER	100 – 120 Vac or 200 – 240 Vac (factory pre-set), 50 Hz/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 – 250 Vac @ 10A max 0 – 500 Vac @ 5A max, 0 – 1500 Vac @ 1.2A max
VOLTAGE READING RANGE	0 – 2,200 Vac; Accuracy: $\pm 1.0\%$ of reading, ± 1 volt
CURRENT READING RANGE	0 – 10A; Accuracy: $\pm 1.0\%$ of reading, $\pm 0.02A$
CURRENT-RATIO RANGE	0.8 – 999: 0.1%, 1000 – 1999: 0.3%, 2000 – 5000: 1%
PHASE ANGLE MEASUREMENT	0 - 360 degrees; Accuracy: ± 1.0 degree
DISPLAY	Back-lit LCD Screen (240 x 128 dot graphic; 114mm x 64mm); viewable in bright sunlight and low-light levels
PRINTER	Built-in 4.5-inch wide thermal printer
COMPUTER INTERFACES	One RS-232C port (115k baud), one USB port
EXTERNAL DATA STORAGE	One USB Flash drive interface port (Flash drive not included)
PC SOFTWARE	Windows [®] XP/Vista-based CT Analysis software is included with purchase price
INTERNAL TEST RECORD STORAGE	Stores 140 test records. Each test record may contain up to 10 sets of excitation, resistance and ratio data
INTERNAL TEST PLAN STORAGE	Stores 128 test plans. Each test plan can store 10 excitation test voltage and current settings
SAFETY	Designed to meet UL 61010A-1 and CAN/CSA C22.2 No. 1010.1-92 standards
ENVIRONMENT	Operating: -10° to 50° C (15°F to +122° F); Storage: -30° C to 70° C (-22°F to +158° F)
HUMIDITY (MAX)	90% RH @ 40° C (104° F) non-condensing
ALTITUDE (MAX)	2000m (6562 ft) to fully safety specifications
CABLES	Two 20-foot X cable sets, One 35-foot H cable set, power cord, One cable-carrying duffel bag
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 S2A Controls and Indicators

The EZCT S2A'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 S2A. 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.

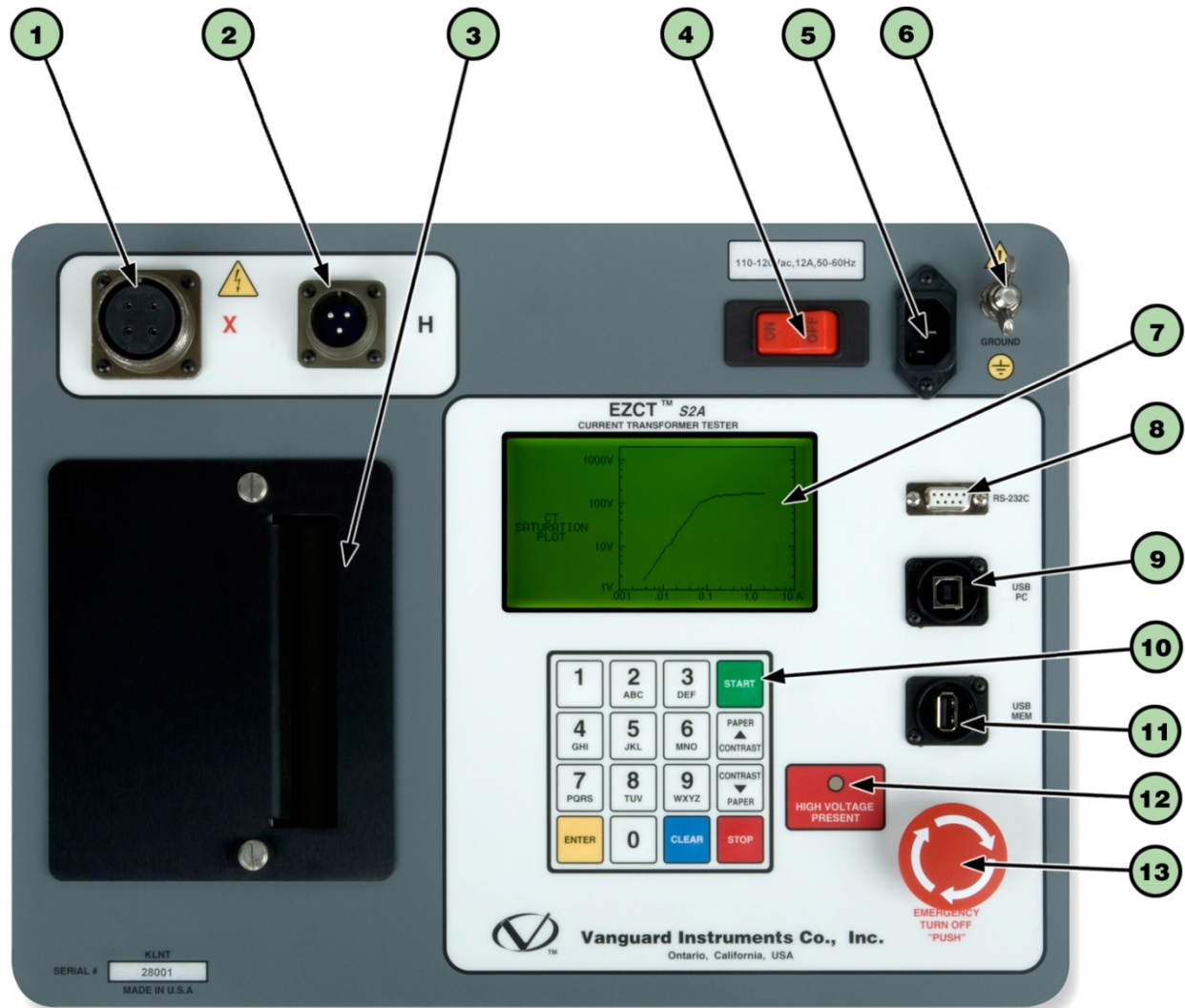


Figure 1. EZCT S2A Controls and Indicators

Table 2. Functional Descriptions of EZCT S2A Controls and Indicators

Item Number	Panel Markings	Functional Description
1	X	Current transformer excitation voltage connector. The EZCT S2A's X output terminal is rated to 1500 Vac working voltage. Any voltage above 1500 Vac will damage the input circuitry.
2	H	Current transformer primary input test cable connector.
3		Built-in 4.5-inch wide thermal printer.
4	110-120 Vac, 12A, 50-60Hz	Power switch with built-in circuit breaker.
5		Power receptacle.
6	GROUND	Ground terminal.
7		Back-lit LCD Screen (240 x 128 dot graphic; 114mm x 64mm).
8	RS-232C	RS-232C PC interface. Baud rate is set for 115KB, 8 data bits, 2 stop bits.
9	USB PC	USB PC interface.
10		Rugged alpha-numeric keypad.
11	USB MEM	USB Flash drive interface port
12	HIGH VOLTAGE PRESENT	Test voltage presence indicator.
13	EMERGENCY TURN OFF "PUSH"	Emergency turn off switch.

2.0 PRE-TEST SETUP

2.1 Operating Voltages

The EZCT S2A'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 v 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 v Contrast]** key.

2.4 Printer Paper

The EZCT S2A'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 S2A features one USB and one RS-232C PC interface port. A Windows-based “Current Transformer Analysis” software application is supplied with the EZCT S2A. For further information, please see the Software User’s Manual.

3.0 OPERATING PROCEDURES

3.1 EZCT S2A Cable Connections

Always connect the EZCT S2A to the substation ground before connecting any test cables. 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. Transformer bushing CT connections for Delta and Y transformers are shown in Figure 3 and Figure 4, respectively.

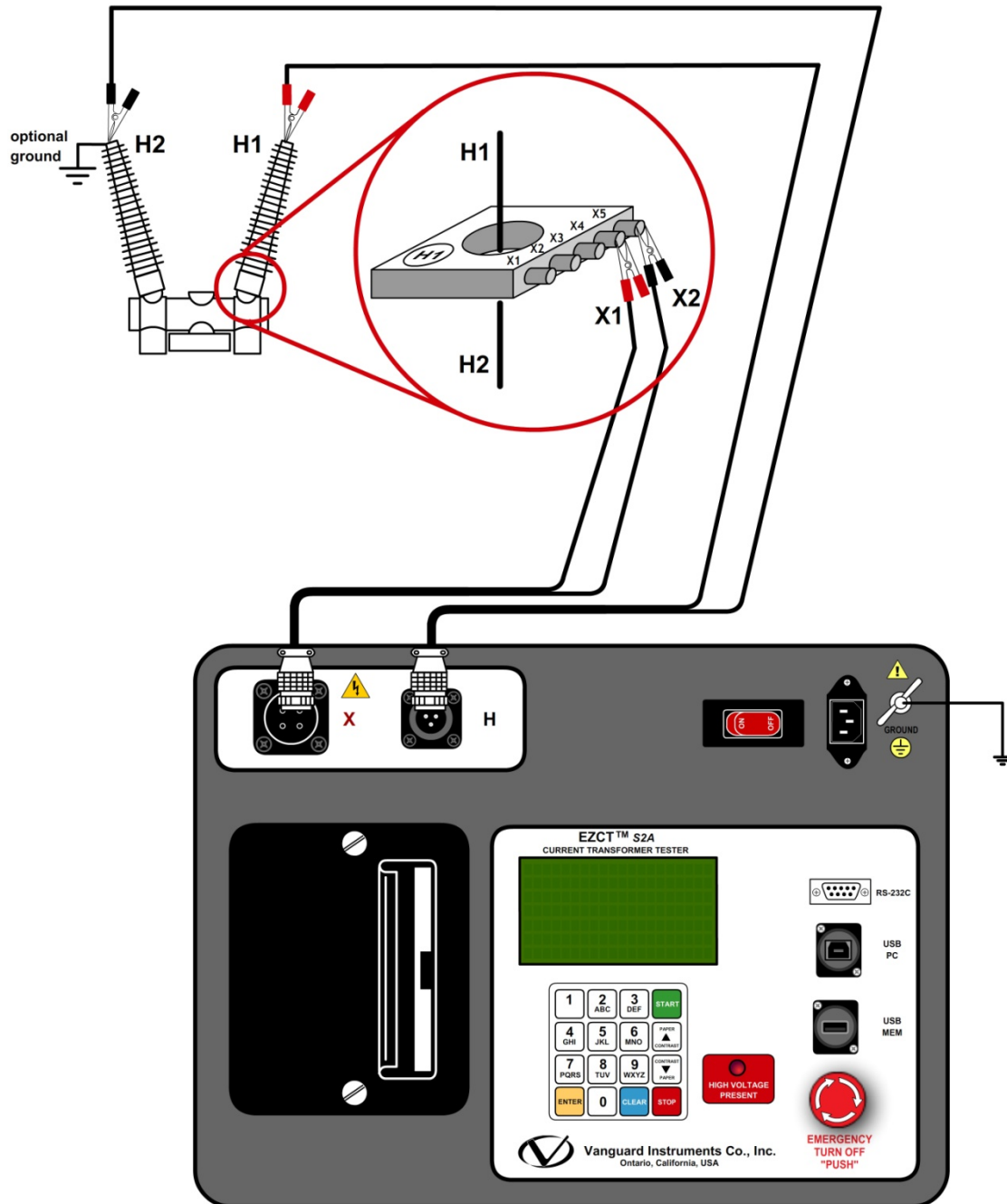


Figure 2. Typical EZCT S2A Excitation and Ratio Test Cable Connection

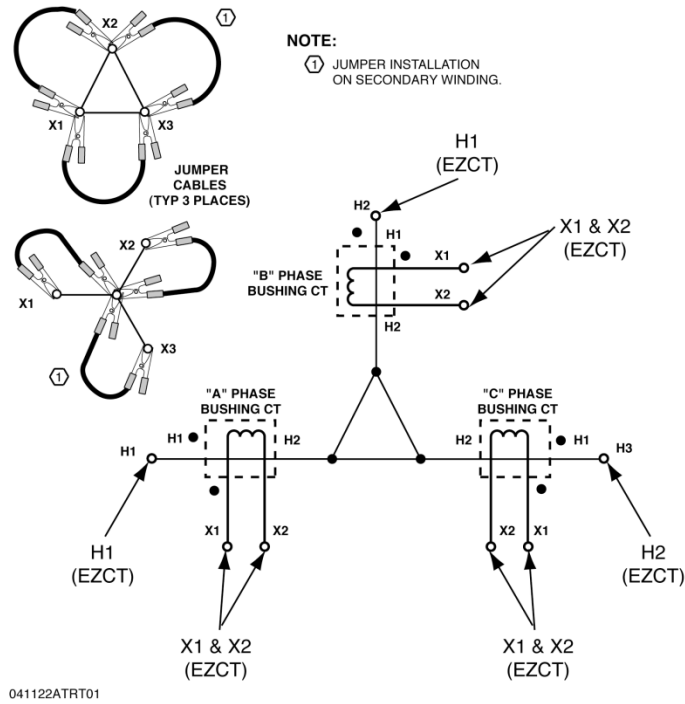


Figure 3. Bushing CT Connection on Delta Transformer

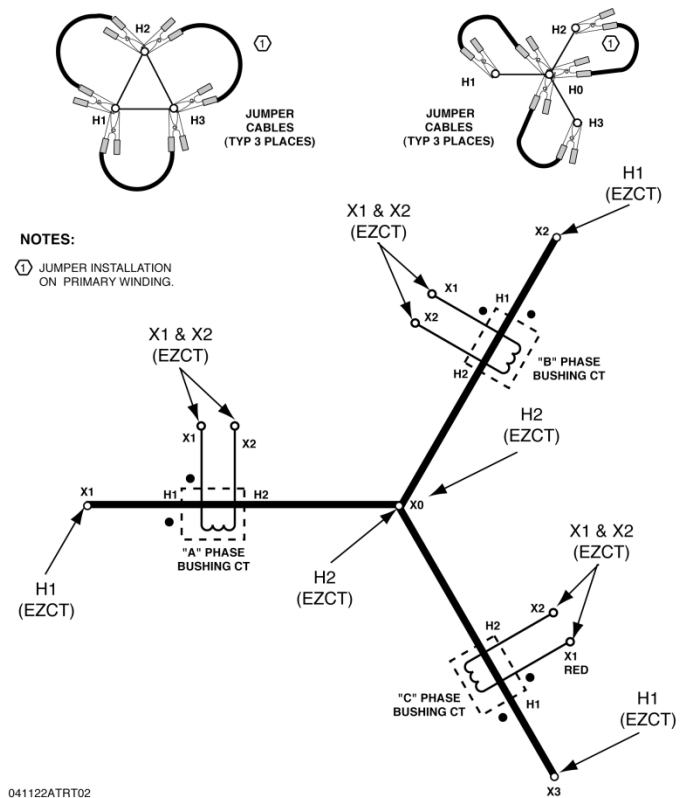


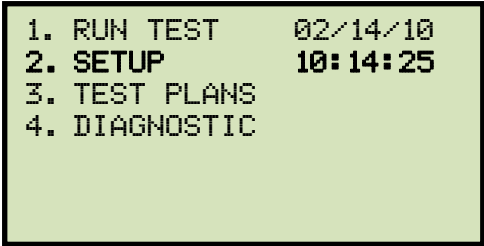
Figure 4. Bushing CT Connection on Y Transformer

3.2 Performing Tests

3.2.1. 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:

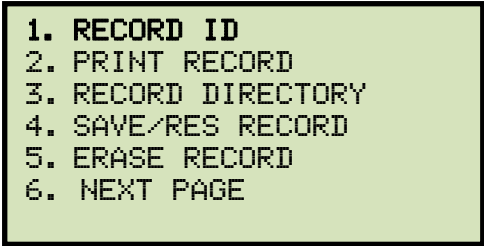
- a. When the unit is turned on and the firmware has been loaded, you will be presented with the "START-UP" menu as shown below:



```
1. RUN TEST      02/14/10
2. SETUP         10:14:25
3. TEST PLANS
4. DIAGNOSTIC
```

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

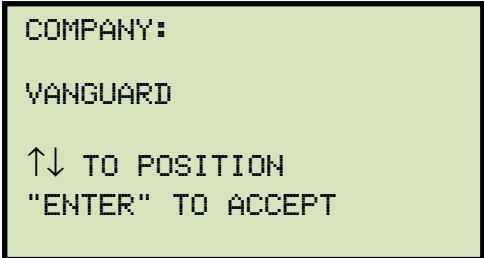
- b. The following screen will be displayed:



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

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

- c. The following screen will be displayed:



```
COMPANY:

VANGUARD

↑↓ TO POSITION
"ENTER" TO ACCEPT
```

Type the company name using the alpha-numeric keypad.

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

- d. The following screen will be displayed:

```
STATION:  
  
LAB  
  
↑↓ TO POSITION  
"ENTER" TO ACCEPT
```

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

- e. The following screen will be displayed:

```
CIRCUIT:  
  
CIRCUIT 1  
  
↑↓ TO POSITION  
"ENTER" TO ACCEPT
```

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

- f. The following screen will be displayed:

```
MANUFACTURER:  
  
ABB  
  
↑↓ TO POSITION  
"ENTER" TO ACCEPT
```

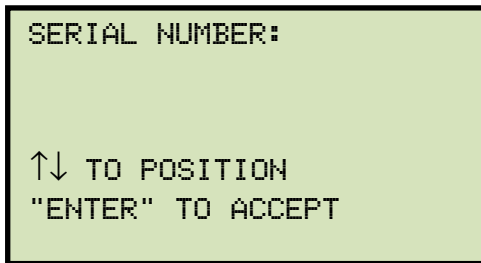
Type the manufacturer name using the alpha-numeric keypad and then press the **[ENTER]** key.

- g. The following screen will be displayed:

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

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

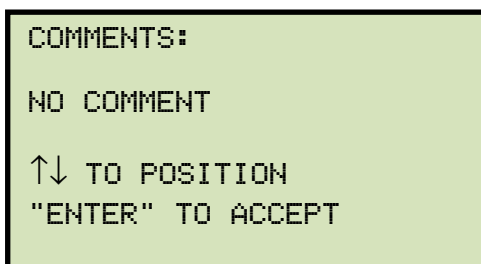
- h. The following screen will be displayed:

A screenshot of a terminal screen with a light green background and a black border. The text is in a monospaced font. It displays 'SERIAL NUMBER:' at the top, followed by a blank line. Below that is '↑↓ TO POSITION' and '“ENTER” TO ACCEPT' at the bottom.

```
SERIAL NUMBER:  
  
↑↓ TO POSITION  
“ENTER” TO ACCEPT
```

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

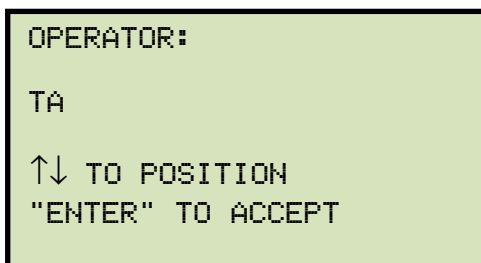
- i. The following screen will be displayed:

A screenshot of a terminal screen with a light green background and a black border. The text is in a monospaced font. It displays 'COMMENTS:' at the top, followed by a blank line. Below that is 'NO COMMENT', followed by another blank line. At the bottom are '↑↓ TO POSITION' and '“ENTER” TO ACCEPT'.

```
COMMENTS:  
  
NO COMMENT  
  
↑↓ TO POSITION  
“ENTER” TO ACCEPT
```

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

- j. The following screen will be displayed:

A screenshot of a terminal screen with a light green background and a black border. The text is in a monospaced font. It displays 'OPERATOR:' at the top, followed by a blank line. Below that is 'TA', followed by another blank line. At the bottom are '↑↓ TO POSITION' and '“ENTER” TO ACCEPT'.

```
OPERATOR:  
  
TA  
  
↑↓ TO POSITION  
“ENTER” TO ACCEPT
```

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

3.2.2. Performing Excitation and Ratio Tests

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

- a. When the EZCT S2A 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:

```
1. RUN TEST      02/14/10
2. SETUP         10:24:25
3. TEST PLANS
4. DIAGNOSTIC
```

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

- b. The following screen will be displayed:

```
1. EXCITATION & RATIO
2. EXCITATION ONLY
3. RATIO ONLY
```

Select the test type by pressing the corresponding key (**[1]** - **[3]**)

- c. The following screen will be displayed:

```
SELECT TAP:
1. X1-X2
2. X1-X3
3. X1-X4
4. X1-X5
5. NEXT PAGE
```

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. The following screen will be displayed:

```
HOOK CABLES TO CT:
X1 CABLE TO CT-X1
X2 CABLE TO CT-X2
"ENTER" TO CONTINUE
```



The cable connection information displayed depends on your selection in step c.

NOTE

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

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

```
SELECT VOLTAGE RANGE:
1. 50V
2. 250V
3. 500V
4. 1500V
```

Select the test voltage range by pressing the corresponding key (**[1]** - **[4]**).

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

```
SET TEST CURRENT:
1. 0.2A
2. 0.5A
3. 1A
4. 2A
5. 5A
6. 10A
```

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



Most CT's will saturate before the excitation current reaches 1A. To reduce stress on CT's, a maximum test current of 1A is recommended.

NOTE

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

```
XFMR NAME PLATE RAT.
1. YES
2. NO
```

1. YES

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

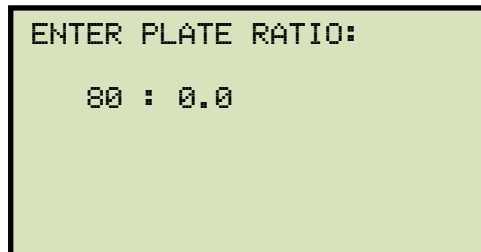


```
ENTER PLATE RATIO:
0 :
```

Type the first number using the keypad.

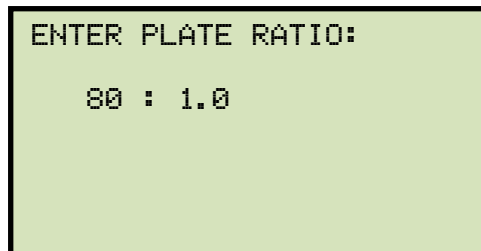
You can press the **[CLEAR]** key to restart a field entry if necessary.

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



```
ENTER PLATE RATIO:
80 : 0.0
```

Type the second number using the keypad. The screen will be updated as shown:



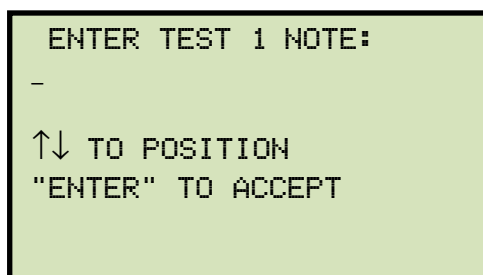
```
ENTER PLATE RATIO:
80 : 1.0
```

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

2. *NO*

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

h. The following screen will be displayed:



```
ENTER TEST 1 NOTE:
-
↑↓ TO POSITION
"ENTER" TO ACCEPT
```

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 v Contrast]** key to move to the previous character. Press the **[ENTER]** key when you are done typing the note.

- i. The following screen will be displayed:

```
TEST 1 PARAMETERS:
1500V      1.0A      X1-X2

"START" TO BEGIN
```

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

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

```
CABLES ENERGIZED!
1500V      1.0A      X1-X2
  I = 0.6810 AMPS
  V = 61.0      VAC
```



NOTE

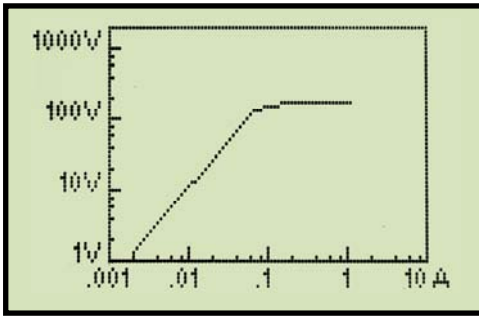
The "HIGH VOLTAGE PRESENT" light will be illuminated to indicate that high voltage is present.

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

```
RATIO TEST

VX = 39.9   VH = 0.4984
I = 0.1324  RAT=+80.058
```

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



Press any key on the keypad to continue.

- l. 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 S2A tabulated test report printout is shown in Figure 5. A typical graphic report is shown in Figure 6.

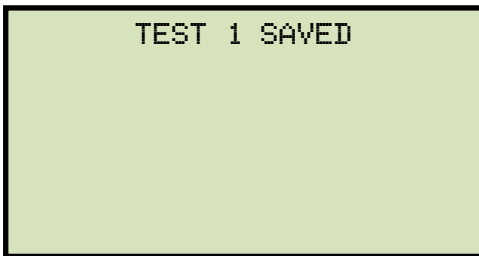
Press the **[2]** key (*NO*) if you do not want to print the test results.

- m. The following screen will be displayed:

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

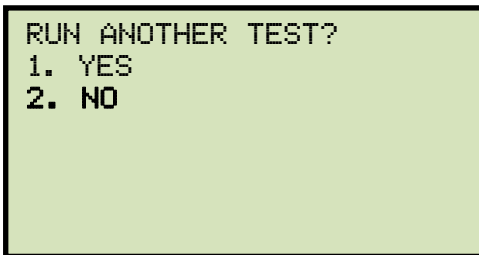
Press the **[1]** key (*YES*) to keep the test results.

- n. The following screen will be displayed:

A screenshot of a green screen with a black border. The text "TEST 1 SAVED" is displayed in the upper center in a black, monospaced font.

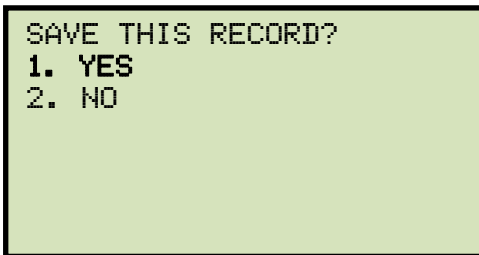
Press any key to continue.

- o. The following screen will be displayed:

A screenshot of a green screen with a black border. The text "RUN ANOTHER TEST?" is at the top. Below it are two options: "1. YES" and "2. NO", both in a black, monospaced font.

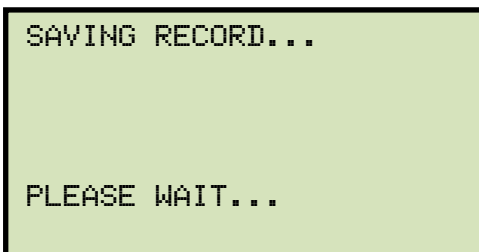
Press the **[2]** key (*NO*).

- p. The following screen will be displayed:

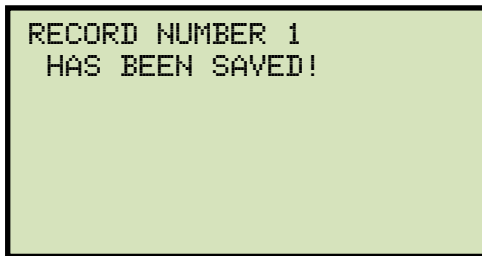
A screenshot of a green screen with a black border. The text "SAVE THIS RECORD?" is at the top. Below it are two options: "1. YES" and "2. NO", both in a black, monospaced font.

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

The following screen will be displayed momentarily:

A screenshot of a green screen with a black border. The text "SAVING RECORD..." is at the top, and "PLEASE WAIT..." is at the bottom, both in a black, monospaced font.

- q. The following confirmation screen will then be displayed:



The test record number is automatically assigned to each test record stored in the EZCT S2A's Flash EEPROM.

NOTE

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

CT EXCITATION TEST RESULTS			
DATE: 12/01/09		TIME: 09:01:00	
COMPANY: VANGUARD			
STATION: LAB			
CIRCUIT:			
MFR:			
MODEL:			
S/N:			
COMMENTS:			
OPERATOR:			
TESTED TAP: X1-X2			
TST NOTE:			
CT DATA POINTS			
#	CUR (A)	VTG (V)	Z (OHMS)
# 1	0.0400	8.0	200.0
# 2	0.0512	11.2	219.5
# 3	0.0574	13.0	227.2
# 4	0.0706	17.4	246.5
# 5	0.0866	22.9	264.7
# 6	0.1080	31.2	289.3
# 7	0.1292	39.4	305.0
# 8	0.1586	49.8	314.0
# 9	0.1946	59.3	304.6
#10	0.2470	66.7	270.1
#11	0.2928	70.2	239.9
#12	0.3704	73.8	199.1
#13	0.4454	75.8	170.2
#14	0.5422	77.8	143.6
#15	0.6654	79.8	119.9
#16	0.8172	81.5	99.8
#17	1.0088	83.4	82.7
TABULATED GRAPH POINTS			
	CUR (A)	VTG (V)	Z (OHMS)
	0.0010	0.2	200.0
	0.0020	0.4	200.0
	0.0040	0.8	200.0
	0.0050	1.0	200.0
	0.0080	1.6	200.0
	0.0100	2.0	200.0
	0.0200	4.0	200.0
	0.0400	8.0	200.0
	0.0500	10.9	217.6
	0.0800	20.6	258.0
	0.1000	28.1	281.2
	0.2000	60.0	300.2
	0.4000	74.6	186.4
	0.5000	77.0	153.9
	0.8000	81.3	101.7
	1.0000	83.3	83.3
ASA 10/50 V _{kp} : 67.2 VOLTS			
ASA 10/50 I _{kp} : 0.2538 AMPS			
IEEE 30° V _{kp} : 60.8 VOLTS			
IEEE 30° I _{kp} : 0.2004 AMPS			
IEEE 45° V _{kp} : 49.0 VOLTS			
IEEE 45° I _{kp} : 0.1564 AMPS			
NAME PLATE RATIO: 80:1			
MEASURED RATIO: 80.058			
PERCENT ERROR: 0.08 %			
POLARITY: - IN PHASE			
PHASE ANGLE: 0.02°			
EXCITATION VTG: 39.9 VOLTS			
EXCITATION CUR: 0.1324 AMPS			

Figure 5. Typical EZCT S2A Tabulated Report Printout

Table 3. Descriptions of Tabulated Test Results Elements

Item Number	Description
1	Test record header information.
2	The 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	ASA 10/50 knee point voltage and excitation current (This is equivalent to the IEC 10/50 and ANSI 10/50 knee point voltage and excitation current)
9	IEEE 30° knee point voltage and excitation current.
10	IEEE 45° knee point voltage and excitation current.
11	CT nameplate turns ratio.
12	Measured turns ratio.
13	Turns ratio percentage error.
14	Polarity of the CT.
15	Measured phase angle.
16	Excitation voltage used in CT turns ratio test.
17	Excitation current in turns ratio test.

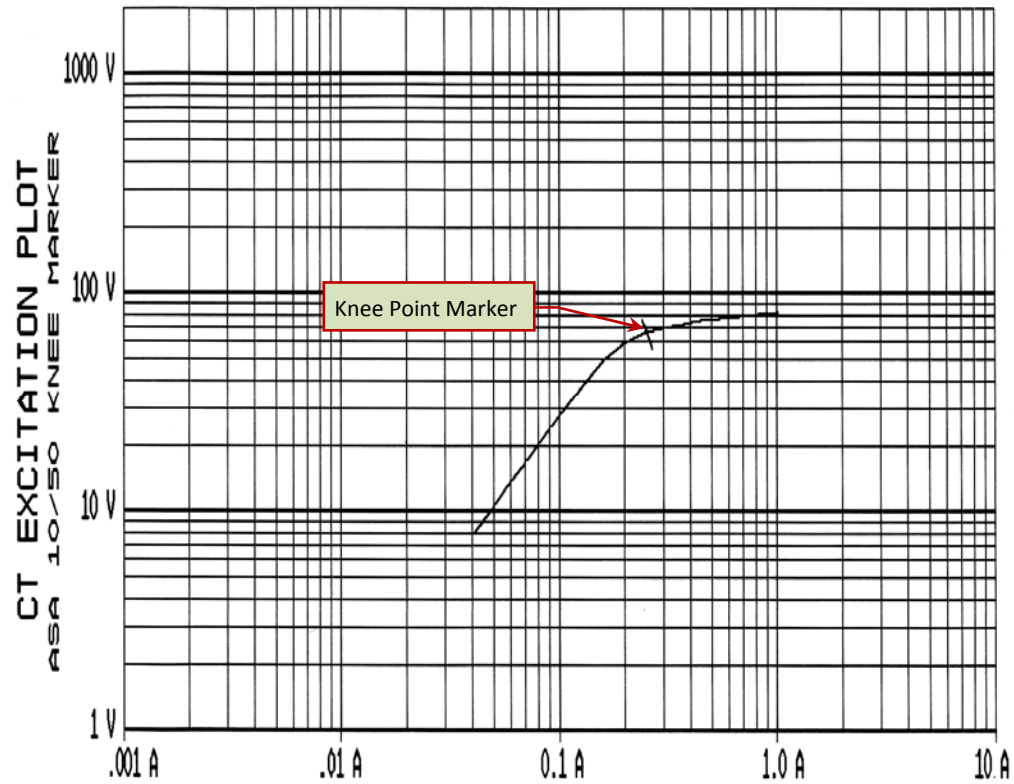


Figure 6. Typical EZCT S2A Graphic Report

3.3 Working With Test Records

3.3.1. Restoring and Printing a Test Record From Flash EEPROM

You can restore a test record from the EZCT S2A'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      02/16/10
2. SETUP        10:24:25
3. TEST PLANS
4. DIAGNOSTIC
```

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

- b. The following screen will be displayed:

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

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

- c. The following screen will be displayed:

```
RESTORE RECORD

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



If you have a USB Flash drive inserted in the EZCT S2A's "USB MEM" port, the following screen will be displayed instead of the above screen:

NOTE

```
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.

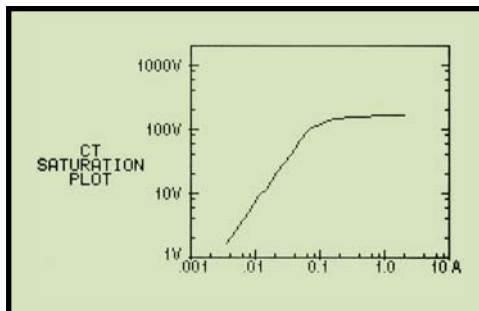
1. *ENTER RECORD NUMBER*

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 test record's graph will be displayed as shown below:



Press any key to continue.

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:

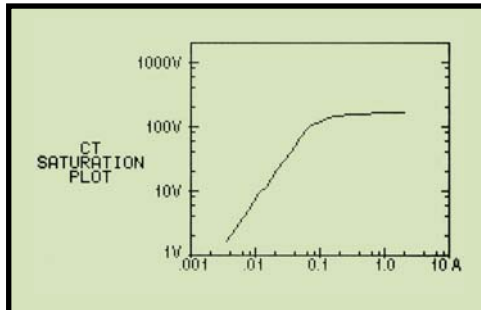
```
RECORD DIRECTORY

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

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

```
#1      02/14/10   10:10
5 TESTS
SHA 586
CIR 1
MITSUBISHI ELECTRIC
```

When you have located the test record that you would like to restore, press the **[ENTER]** key. The test record's graph will be displayed as shown below:



Press any key to continue.

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:

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

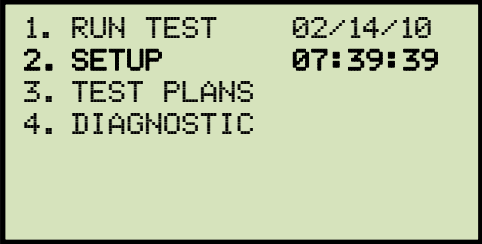
Press the **[1]** key to print the tabulated data and graphics results on the thermal printer. The test record will be restored to the working memory and will be printed on the thermal printer, and then you will be returned to the "START-UP" menu.

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.

3.3.2. 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 S2A's working memory using the steps below:


- a. Make sure the USB Flash drive containing the test record(s) is inserted in the EZCT S2A's USB Flash drive port ("USB MEM" port). Then start from the "START-UP" menu:



```
1. RUN TEST      02/14/10
2. SETUP        07:39:39
3. TEST PLANS
4. DIAGNOSTIC
```

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


- b. The following screen will be displayed:



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

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

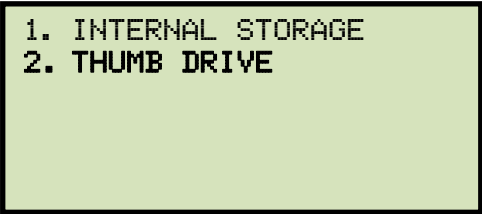
- c. The following screen will be displayed:



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

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

- d. The following screen will be displayed:



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

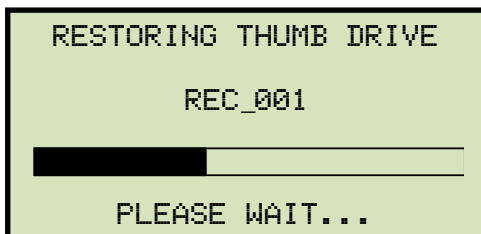
Press the **[2]** key (*THUMB DRIVE*).

- e. The following screen will be displayed:

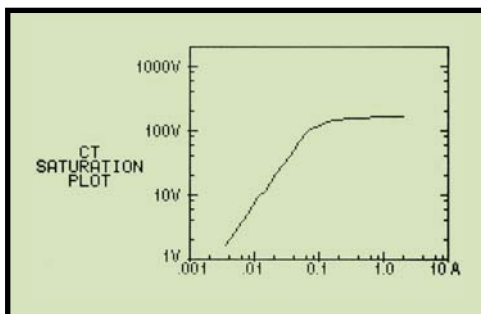


Type the record number that you would like to restore and press the **[ENTER]** key. If you do not know the record number, you can print a test record directory. Please see section 3.3.4 for details

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

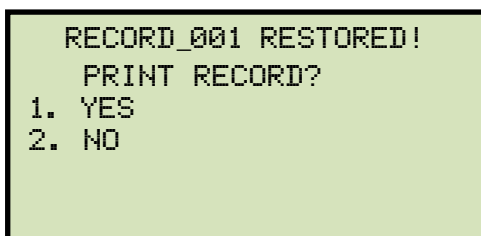


Once the record has been restored, the record's graph will be displayed as shown below:



Press any key to continue.

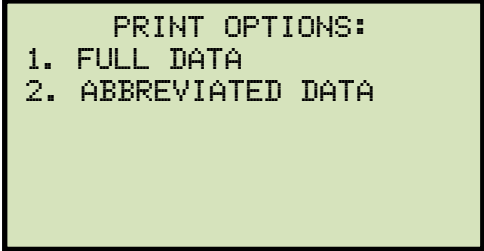
- g. The following screen will be displayed:



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 h.

- h. The following screen will be displayed:



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

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.

3.3.3. Printing a Restored Test Record

You can print a test record at the time that it is restored from the Flash EEPROM (see section 3.3.1), 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      02/14/10
2. SETUP        07:39:39
3. TEST PLANS
4. DIAGNOSTIC
```

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

- b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. RECORD DIRECTORY
4. SAVE/RES 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
```



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

NOTE

```
NO SHOTS TO PRINT!
```

Press any key to return to the "START-UP" menu. Please see section 3.3.1 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.

3.3.4. Printing a Directory of Test Records Stored in the EZCT S2A's Memory

You can print a directory of all the test records stored in the EZCT S2A's Flash EEPROM using the steps below:

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

```
1. RUN TEST      02/16/10
2. SETUP        10:24:25
3. TEST PLANS
4. DIAGNOSTIC
```

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

- b. The following screen will be displayed:

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

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

- c. The following screen will be displayed:

```
PRINT DIRECTORY
1. FULL DIRECTORY
2. SHORT DIRECTORY
```

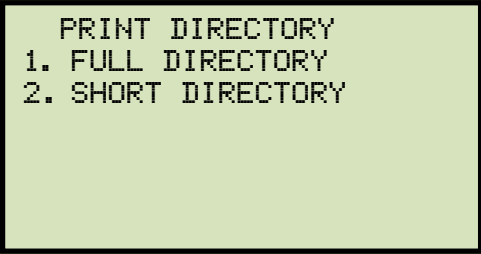


NOTE

The above screen will be displayed only if a USB Flash drive is NOT connected to the EZCT S2A's USB Flash drive port. If a USB Flash drive is connected, the following screen will be displayed:

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

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



```
PRINT DIRECTORY
1. FULL DIRECTORY
2. SHORT DIRECTORY
```

Continue with the steps below:

Press the **[1]** key to print a full directory listing of all the test records stored in the EZCT S2A'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 7.

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 S2A'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: 09/24/09 13:59:14 NUMBER OF TESTS: 1 STATION: LAB CIRCUIT: MFR: MODEL: S2A S/N: COMMENTS:	
RECORD NUMBER: 6 DATE/TIME: 07/10/09 10:55:57 NUMBER OF TESTS: 3 STATION: CAMANCHE PUMP PLT CIRCUIT: VFD-001, RELAY CTs MFR: MODEL: S/N: COMMENTS:	
RECORD NUMBER: 5 DATE/TIME: 03/09/09 13:16:48 NUMBER OF TESTS: 9 STATION: SHASTA SWITCHYARD CIRCUIT: SHA 586 MFR: MITSUBISHI ELECTRIC MODEL: D100739H09M S/N: COMMENTS:	
RECORD NUMBER: 4 DATE/TIME: 01/24/09 15:27:09 NUMBER OF TESTS: 4 STATION: test 1 CIRCUIT: test 1 MFR: MODEL: S/N: COMMENTS:	
RECORD NUMBER: 3 DATE/TIME: 01/24/09 15:25:02 NUMBER OF TESTS: 4 STATION: test 1 CIRCUIT: test 1 MFR: MODEL: S/N: COMMENTS:	
RECORD NUMBER: 2 DATE/TIME: 01/21/09 10:37:06 NUMBER OF TESTS: 10 STATION: CA-CUP, MSB3 CIRCUIT: MAIN CT-T MFR: SQ-D MODEL: S/N: COMMENTS:	
RECORD NUMBER: 1 DATE/TIME: 01/21/09 09:12:57 NUMBER OF TESTS: 1 STATION: CIRCUIT: MFR: MODEL: S/N: COMMENTS:	

Figure 7. Typical Internal Test Record Directory Printout

3.3.5. Erasing Test Records From the Flash EEPROM

You can erase individual or all test records stored in the EZCT S2A's Flash EEPROM. To erase a test record:

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

```
1. RUN TEST      02/16/10
2. SETUP        10:24:25
3. TEST PLANS
4. DIAGNOSTIC
```

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

- b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. RECORD DIRECTORY
4. SAVE/RES 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 S2A'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 (*ERASE SINGLE REC.*) 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 3.3.4.

The following screen will be displayed momentarily:

```
ERASING RECORD  
NUMBER: 01  
  
PLEASE WAIT...
```

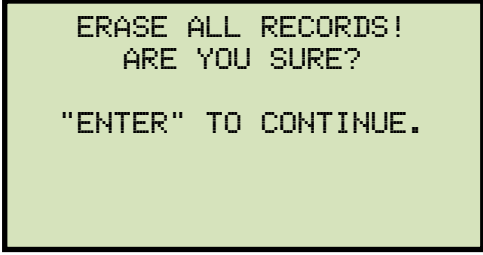
Then the following confirmation screen will be displayed:

```
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 S2A's flash EEPROM. The following confirmation screen will be displayed:




ERASE ALL RECORDS!
ARE YOU SURE?

"ENTER" TO CONTINUE.

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:



ERASING RECORDS
PLEASE WAIT...

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



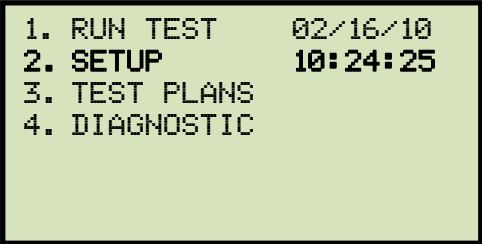
RECORDS ERASED

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

3.3.6. 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:

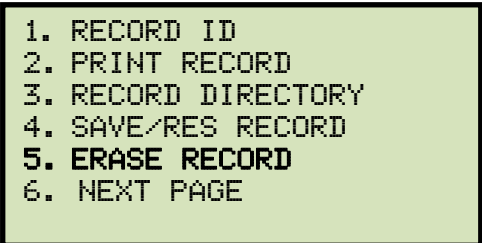
- a. Make sure the USB Flash drive is inserted in the EZCT S2A's USB Flash drive port ("USB MEM" port). Then start from the "START-UP" menu:



```
1. RUN TEST      02/16/10
2. SETUP        10:24:25
3. TEST PLANS
4. DIAGNOSTIC
```

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

- b. The following screen will be displayed:



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

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

- c. The following screen will be displayed:



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

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

d. The following screen will be displayed:

```
ERASE RECORD  
  
1. ERASE SINGLE 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 **Error!**
Reference source not found..

The following screen will be displayed:

```
THUMB DRIVE REC_001  
ERASED!
```

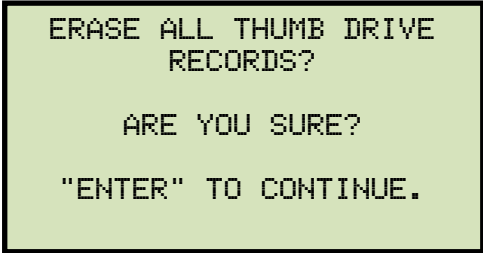
Press any key to continue. The following screen will be displayed:

```
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

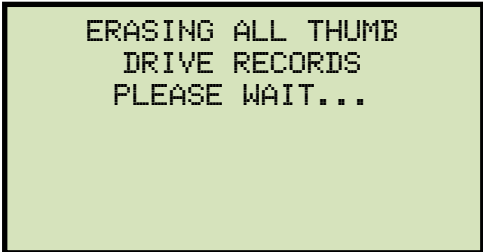
Press the **[2]** key (*ERASE ALL RECORDS*) if you would like to erase all of the test records stored in the USB Flash drive. The following confirmation screen will be displayed:



```
ERASE ALL THUMB DRIVE  
RECORDS?  
  
ARE YOU SURE?  
  
"ENTER" TO CONTINUE.
```

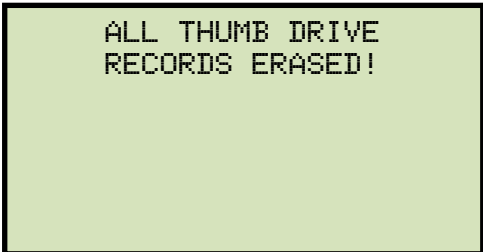
If you would like to cancel the erasure process, press the **[STOP]** key. No records will be erased and you will be returned to the "START-UP" menu.

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



```
ERASING ALL THUMB  
DRIVE RECORDS  
PLEASE WAIT...
```

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



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

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

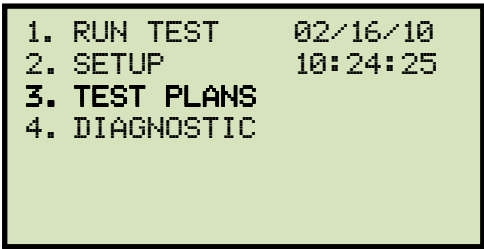
3.4 Working With Test Plans

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. Up to 10 test definitions can be stored per test plan, and up to 128 CT test plans can be stored in the EZCT S2A's Flash EEPROM. The ability to use test plans makes CT testing an extremely simple process. To perform a test, the EZCT S2A is connected to the CT terminals and a test plan is selected to run.

3.4.1. 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 3.3.1 for instructions on how to restore a test record). To extract a test plan from a test record:

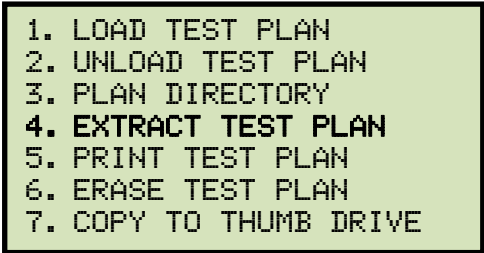
- a. Either perform a test (see section 3.2) or restore a test record (see section 3.3.1) that you would like to extract the test plan from.
- b. Start from the "START-UP" menu:



```
1. RUN TEST      02/16/10
2. SETUP        10:24:25
3. TEST PLANS
4. DIAGNOSTIC
```

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

- c. 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
```



- Option 7 (*COPY TO THUMB DRIVE*) will be listed only if a USB Flash drive is connected to the EZCT S2A's "USB MEM" port.

NOTES

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

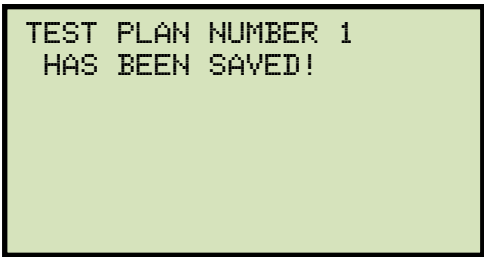


NO RECORD LOADED!

Press any key to return to the "START-UP" menu. You must first restore a test record to the working memory before a test plan can be extracted. Please see section 3.3.1

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

- d. The following screen will be displayed:



TEST PLAN NUMBER 1
HAS BEEN SAVED!

The test plan will be extracted from the test record in the working memory and will be saved to the EZCT S2A's Flash EEPROM as a new test plan. The test plan number will be automatically incremented by the EZCT S2A.

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

3.4.2. Printing a Directory of Test Plans Stored in the EZCT S2A's Memory

You can print a directory of all the test plans stored in the EZCT S2A's Flash EEPROM using the steps below:

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

```
1. RUN TEST      02/16/10
2. SETUP         10:24:25
3. TEST PLANS
4. DIAGNOSTIC
```

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 while the test plan directory is printed on the thermal printer:

```
PRINTING DIRECTORY
```



NOTE

The above screen will be displayed only if a USB Flash drive is NOT connected to the EZCT S2A's USB Flash drive port. If a USB Flash drive is connected, the following screen will be displayed:

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

Press the **[1]** key (*INTERNAL DIRECTORY*). 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 8 below.

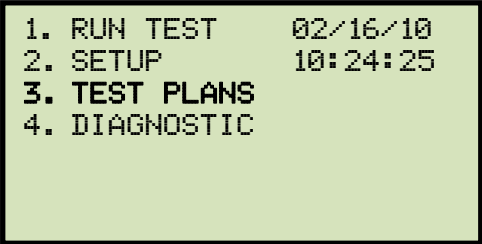
TEST PLAN DIR	
TEST PLAN NUMBER: 1	
NUMBER OF TESTS: 2	
COMPANY:	
STATION:	
CIRCUIT:	
MFR:	
MODEL:	
COMMENTS:	
TEST PLAN NUMBER: 2	
NUMBER OF TESTS: 1	
COMPANY:	
STATION:	
CIRCUIT:	
MFR:	
MODEL:	
COMMENTS:	
TEST PLAN NUMBER: 3	
NUMBER OF TESTS: 9	
COMPANY:	APPARATUS TESTING AN
STATION:	SHASTA SWITCHYARD
CIRCUIT:	SHA 586
MFR:	MITSUBISHI ELECTRIC
MODEL:	D100739H09M
COMMENTS:	
TEST PLAN NUMBER: 4	
NUMBER OF TESTS: 10	
COMPANY:	APPARATUS TESTING &
STATION:	CA-CUP, MSB3
CIRCUIT:	MAIN CT-T
MFR:	SG-D
MODEL:	
COMMENTS:	
TEST PLAN NUMBER: 5	
NUMBER OF TESTS: 3	
COMPANY:	ate
STATION:	test
CIRCUIT:	test
MFR:	
MODEL:	
COMMENTS:	
TEST PLAN NUMBER: 6	
NUMBER OF TESTS: 3	
COMPANY:	ATE
STATION:	
CIRCUIT:	Test-3
MFR:	
MODEL:	
COMMENTS:	
TEST PLAN NUMBER: 7	
NUMBER OF TESTS: 1	
COMPANY:	VANGUARD
STATION:	LAB
CIRCUIT:	
MFR:	
MODEL:	
COMMENTS:	

Figure 8. Typical EZCT S2A Flash EEPROM Test Plan Directory Printout

3.4.3. 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:

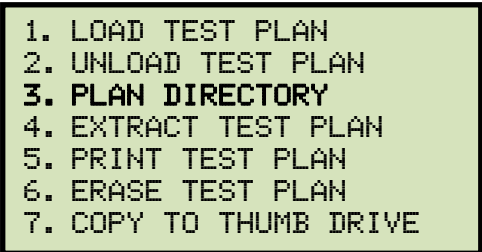
- a. Make sure the USB Flash drive is inserted in the EZCT S2A's Flash drive port ("USB MEM" port). Then start from the "START-UP" menu:



```
1. RUN TEST      02/16/10
2. SETUP        10:24:25
3. TEST PLANS
4. DIAGNOSTIC
```

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

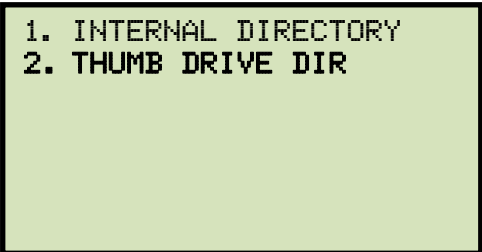
- b. The following screen will be displayed:



```
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 9.

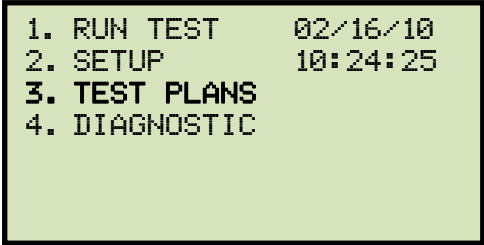
THUMB TP DIR	
THUMB DRV FILENAME: PLAN_000	
NUMBER OF TESTS: 1	
COMPANY: VANGUARD	
STATION: LAB	
CIRCUIT: CIR 1	
MODEL: EZCT S2A	
COMMENTS:	
THUMB DRV FILENAME: PLAN_001	
NUMBER OF TESTS: 1	
COMPANY: VANGUARD	
STATION: LAB	
CIRCUIT: CIR 1	
MODEL: EZCT S2A	
COMMENTS:	
THUMB DRV FILENAME: PLAN_002	
NUMBER OF TESTS: 1	
COMPANY: VANGUARD	
STATION: LAB	
CIRCUIT: CIR 1	
MODEL: EZCT S2A	
COMMENTS:	

Figure 9. Typical USB Flash Drive Test Plan Directory Printout

3.4.4. Printing a Test Plan

To print a test plan:

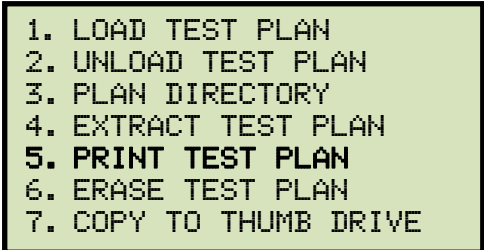
- a. Start from the "START-UP" menu:



```
1. RUN TEST      02/16/10
2. SETUP        10:24:25
3. TEST PLANS
4. DIAGNOSTIC
```

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

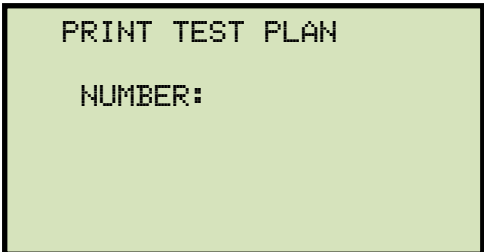
- b. The following screen will be displayed:



```
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 **[5]** key (*PRINT TEST PLAN*).

- c. The following screen will be displayed:



```
PRINT TEST PLAN

NUMBER:
```

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 3.4.2.

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 10. Test plan elements are described in Table 4.

TEST PLAN 4	
NUMBER OF TESTS: 2 ← ①	
KNEE: IEEE 300 COMPANY: APPARATUS TESTING & STATION: CA-CUP, MSB3 CIRCUIT: MAIN CT-T MFR: SQ-D MODEL: COMMENTS:	
TEST NUMBER: 1	
TEST TYPE:	EXCIT, RAT ← ②
TESTED TAP:	X2-X3 ← ③
TEST VTG RANGE:	300 V ← ④
TEST CUR RANGE:	2.0 A ← ⑤
NAME PLATE RATIO:	100:5 ← ⑥
TST NOTE:	← ⑦
TEST NUMBER: 2	
TEST TYPE:	EXCIT, RAT
TESTED TAP:	X1-X2
TEST VTG RANGE:	300 V
TEST CUR RANGE:	2.0 A
NAME PLATE RATIO:	200:5
TST NOTE:	

Figure 10. Typical Test Plan Printout

Table 4. Description of Test Plan Elements

Item Number	Description
1	Number of tests in test plan (2)
2	Tests to be performed (Excitation and Turns Ratio)
3	Terminals used for excitation test (X2-X3)
4	Maximum excitation voltage (300 V)
5	Maximum excitation current (2.0 A)
6	CT nameplate ratio (100:5)
7	Test notes (if any)

3.4.5. Erasing Test Plans From the Flash EEPROM

To erase one or all test plans from the EZCT S2A's Flash EEPROM:

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

```
1. RUN TEST      02/16/10
2. SETUP        10:24:25
3. TEST PLANS
4. DIAGNOSTIC
```

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 S2A'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 3.4.2.

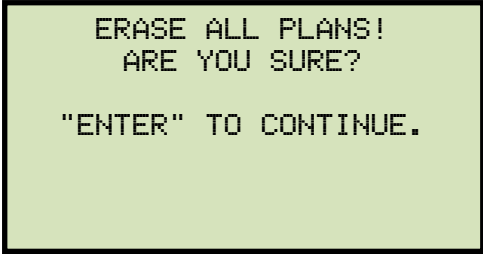
The selected test plan will be erased and the following screen will be displayed:

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

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

2. *ERASE ALL PLANS*

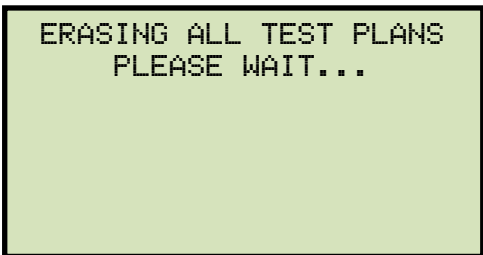
Press the **[2]** key if you would like to erase all test plans. The following screen will be displayed:



```
ERASE ALL PLANS!  
ARE YOU SURE?  
  
"ENTER" TO CONTINUE.
```

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:



```
ERASING ALL TEST PLANS  
PLEASE WAIT...
```

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



```
PLANS ERASED!
```

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

3.4.6. 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 S2A's USB Flash drive port ("USB MEM" port). Then start from the "START-UP" menu:

```
1. RUN TEST      02/16/10
2. SETUP         10:24:25
3. TEST PLANS
4. DIAGNOSTIC
```

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:

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

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

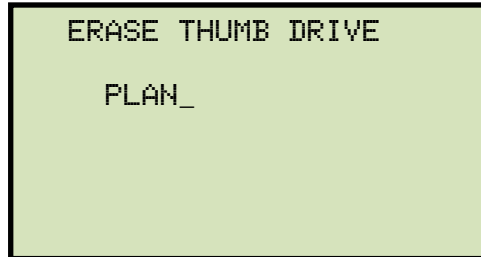
- d. The following screen will be displayed:

```
ERASE TEST PLAN

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

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:



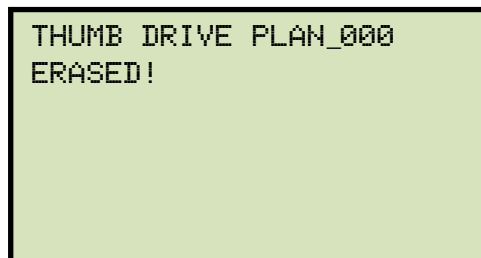
Type the test plan number that you would like to erase and press the **[ENTER]** key.



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 3.4.3.

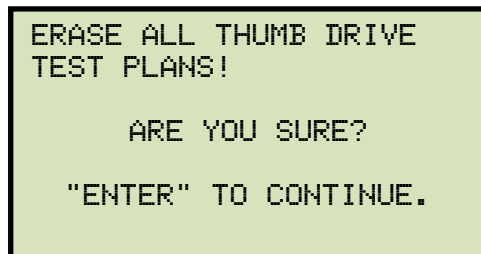
The selected test plan will be erased and the following screen will be displayed:



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

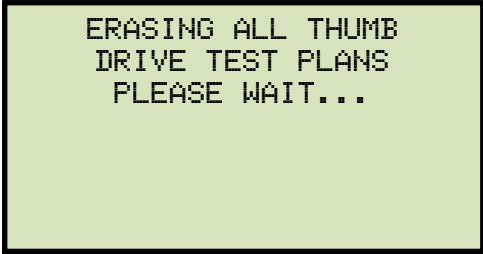
2. ERASE ALL PLANS

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:



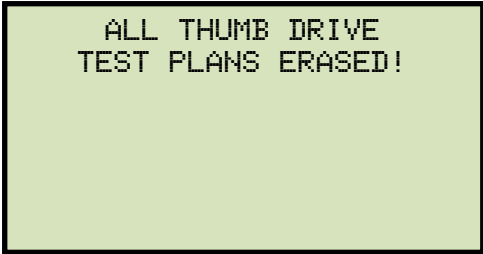
If you would like to cancel the erasure process, press the **[STOP]** key. No test plans will be erased and you will be returned to the "START-UP" menu.

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



ERASING ALL THUMB
DRIVE TEST PLANS
PLEASE WAIT...

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



ALL THUMB DRIVE
TEST PLANS ERASED!

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

3.4.7. Loading a Test Plan from the EZCT S2A'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 S2A's Flash EEPROM into the working memory:

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

```
1. RUN TEST      02/16/10
2. SETUP        10:24:25
3. TEST PLANS
4. DIAGNOSTIC
```

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:
```

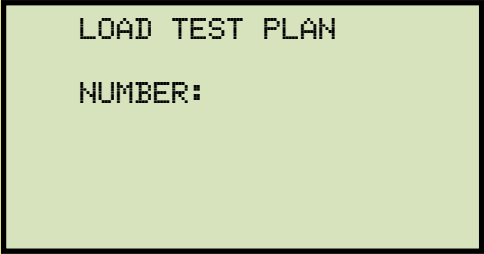


NOTE

The above screen will be displayed only if a USB Flash drive is NOT connected to the EZCT S2A'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:

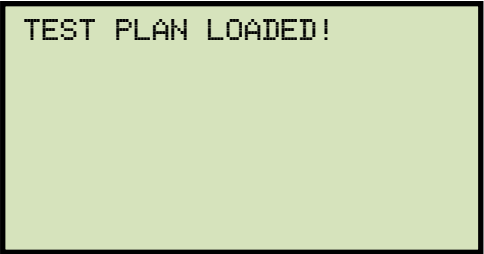


```
LOAD TEST PLAN
NUMBER:
```

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 3.4.2.

- d. The following screen will be displayed:



```
TEST PLAN LOADED!
```

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

3.4.8. 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 S2A's USB Flash drive port ("USB MEM" port). Then start from the "START-UP" menu:

```
1. RUN TEST      02/16/10
2. SETUP        10:24:25
3. TEST PLANS
4. DIAGNOSTIC
```

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:

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

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

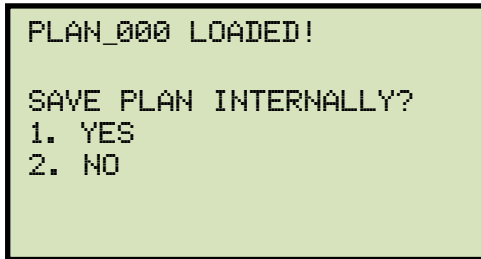
- d. The following screen will be displayed:

```
LOAD TEST PLAN

NUMBER:
```

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 3.4.3.

- e. The following screen will be displayed:



```
PLAN_000 LOADED!  
  
SAVE PLAN INTERNALLY?  
1. YES  
2. NO
```

1. *YES*

Press the **[1]** key if you would like the loaded test plan to be also saved in the EZCT S2A's Flash EEPROM. Any existing test plans in the EZCT S2A's Flash EEPROM will not be over-written. The EZCT S2A 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:



```
TEST PLAN XXX SAVED!
```

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

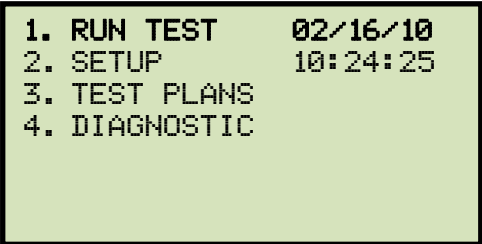
2. *NO*

Press the **[2]** key if you do not want to save the loaded test plan in the EZCT S2A's Flash EEPROM. It will be loaded into the working memory, and you will be returned to the "START-UP" menu.

3.4.9. Running a Test Using a Loaded Test Plan

Once a test plan has been loaded into the working memory (see sections 3.4.7 and 3.4.8 for directions), it can be used to run a test. To run a test using a loaded test plan:

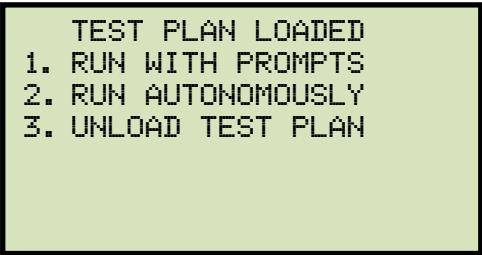
- a. Make sure a test plan has been loaded into the working memory and then start from the "START-UP" menu:



```
1. RUN TEST      02/16/10
2. SETUP        10:24:25
3. TEST PLANS
4. DIAGNOSTIC
```

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):



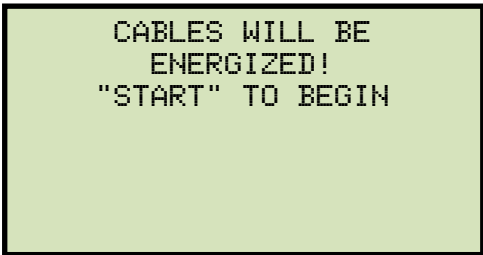
```
TEST PLAN LOADED
1. RUN WITH PROMPTS
2. RUN AUTONOMOUSLY
3. UNLOAD TEST PLAN
```

1. *RUN WITH PROMPTS*

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

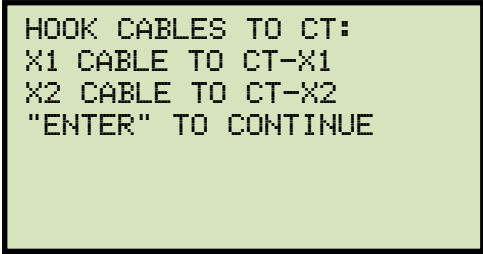
2. *RUN AUTONOMOUSLY*

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



```
CABLES WILL BE
ENERGIZED!
"START" TO BEGIN
```


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



```
HOOK CABLES TO CT:  
X1 CABLE TO CT-X1  
X2 CABLE TO CT-X2  
"ENTER" TO CONTINUE
```

Press the **[ENTER]** key and the EZCT S2A will start running the test per the test plan settings. The screen will be updated with the test status.

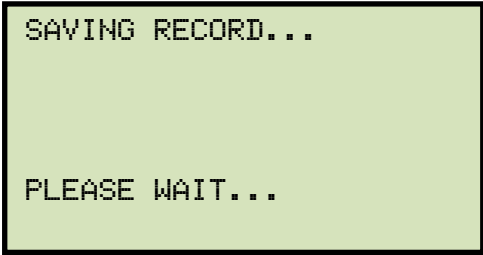
When the test has finished, the following screen will be displayed:



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

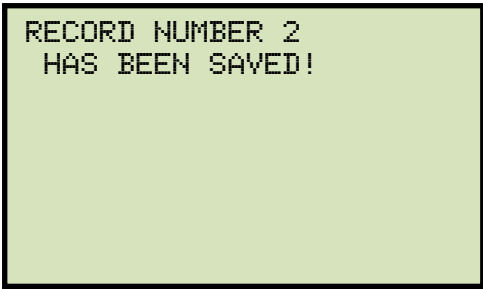
Press the **[1]** key (YES) to save the record.

The following screen will be displayed momentarily:



```
SAVING RECORD...  
  
PLEASE WAIT...
```

Then the following confirmation screen will be displayed:



```
RECORD NUMBER 2  
HAS BEEN SAVED!
```

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 3.2.2, step b.

- c. The following screen will be displayed:

```
HOOK CABLES TO CT:  
X1 CABLE TO CT-X1  
X2 CABLE TO CT-X2  
"ENTER" TO CONTINUE
```

Press the **[ENTER]** key.

- d. The following screen will be displayed:

```
ENTER TEST 1 NOTE:  
-  
  
↑↓ TO POSITION  
"ENTER" TO ACCEPT
```

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

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

```
TEST 1 PARAMETERS:  
1500V      1.0A      X1-X2  
  
  
"START" TO BEGIN
```

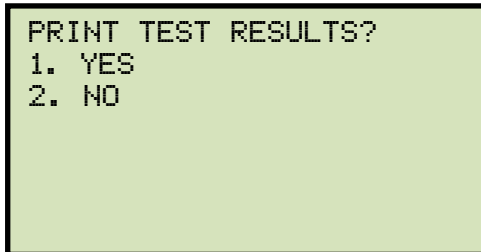
Press the **[START]** key to begin the test.

- f. The EZCT S2A will start performing the test per the test plan parameters. When the test has finished, the following screen will be displayed:

```
ANY KEY TO CONTINUE  
  
VX=77.6      VH=0.3876  
I=0.0522     RAT=+200.08
```

Press any key to continue.

- g. The following screen will be displayed:

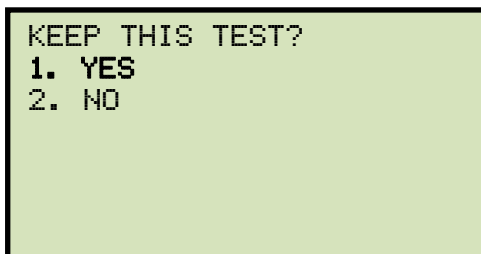


```
PRINT TEST RESULTS?  
1. YES  
2. NO
```

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

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

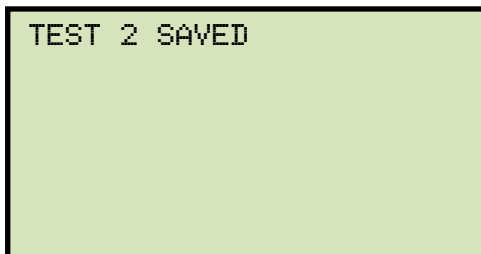
- h. The following screen will be displayed:



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

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

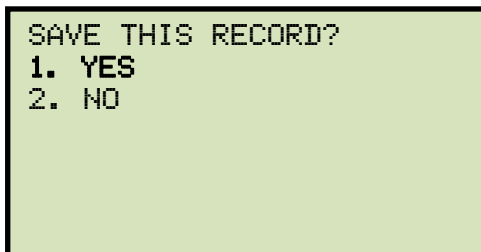
- i. The following screen will be displayed:



```
TEST 2 SAVED
```

Press any key to continue.

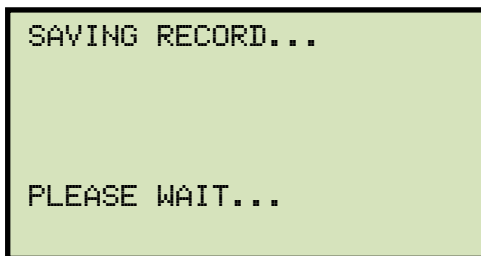
- j. The following screen will be displayed:



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

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

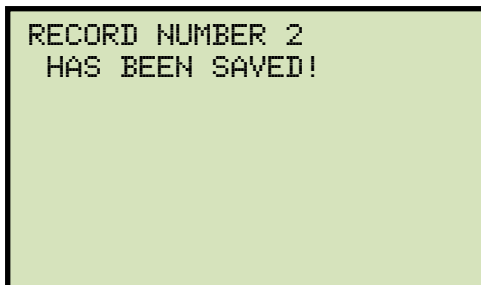
The following screen will be displayed momentarily:



SAVING RECORD...

PLEASE WAIT...

The following confirmation screen will then be displayed:



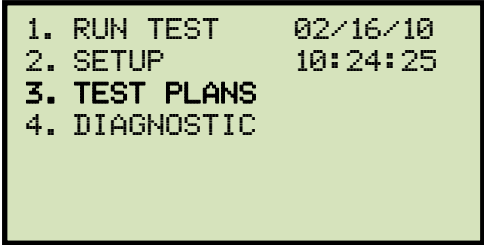
RECORD NUMBER 2
HAS BEEN SAVED!

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

3.4.10. Unloading a Test Plan from the Working Memory

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

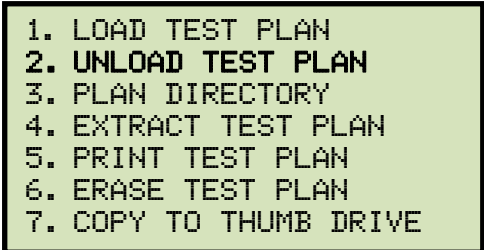
- a. Start from the "START-UP" menu:



```
1. RUN TEST      02/16/10
2. SETUP        10:24:25
3. TEST PLANS
4. DIAGNOSTIC
```

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

- c. The following screen will be displayed:



```
TEST PLAN UNLOADED!
```

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:

```
1. RUN TEST      02/16/10
2. SETUP        10:24:25
3. TEST PLANS
4. DIAGNOSTIC
```

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

- b. The following screen will be displayed:

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

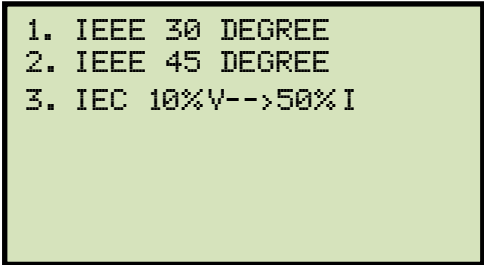
Press the **[6]** key (*NEXT PAGE*).

- c. The following screen will be displayed:

```
1. SET TIME
2. BURIED CT IN DELTA
3. KNEE POINT MARKER
4. PRINT RAW DATA
```

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

d. The following screen will be displayed:

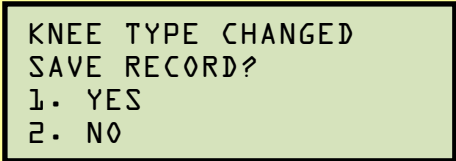


```
1. IEEE 30 DEGREE
2. IEEE 45 DEGREE
3. IEC 10%V-->50%I
```

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 11.

**NOTE**

If a test record is loaded in the current working memory, the following screen will be displayed:



```
KNEE TYPE CHANGED
SAVE RECORD?
1. YES
2. NO
```

Press the **[1]** key (*YES*) to save the test record with the updated knee point marker setting.

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

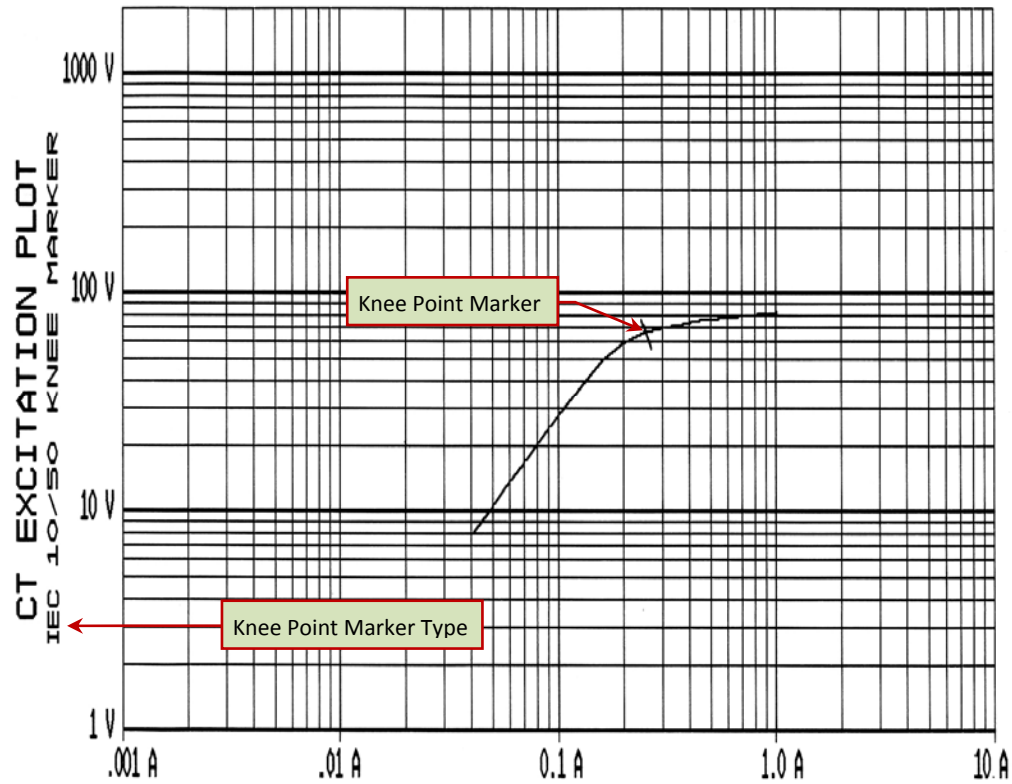


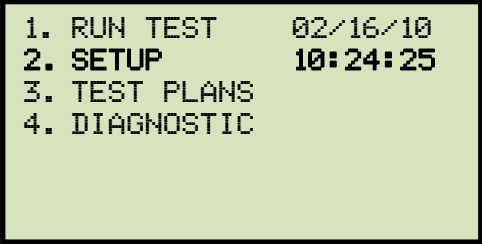
Figure 11. Graphic Report Showing Knee Point Marker

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 12 and Figure 13 for further information), you must first enable the “Buried CT in Delta” option from the “SETUP” menu using the steps below:


- a. Start from the “START-UP” menu:



```
1. RUN TEST      02/16/10
2. SETUP        10:24:25
3. TEST PLANS
4. DIAGNOSTIC
```

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

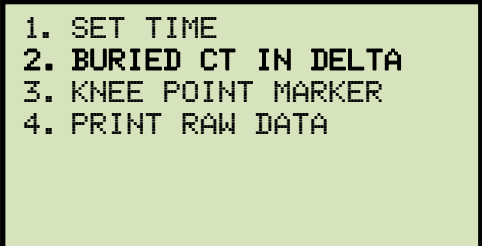
- b. The following screen will be displayed:



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

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

- c. The following screen will be displayed:



```
1. SET TIME
2. BURIED CT IN DELTA
3. KNEE POINT MARKER
4. PRINT RAW DATA
```

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

- d. The following screen will be displayed:



```
1. BURIED CT DELTA ON
2. BURIED CT DELTA OFF
```

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

- e. The following screen will be displayed:

```
RATIOS WILL BE  
ADJUSTED BY 2/3.  
  
ARE YOU SURE?  
1. YES  
2. NO
```

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

- f. The following screen will be displayed:

```
-BURIED CT IN DELTA-  
  
RATIOS ADJUSTED BY  
TWO-THIRDS.
```

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:

```
1. RUN TEST      02/16/10  
2. SETUP        10:24:25  
3. TEST PLANS  
4. DIAGNOSTIC
```

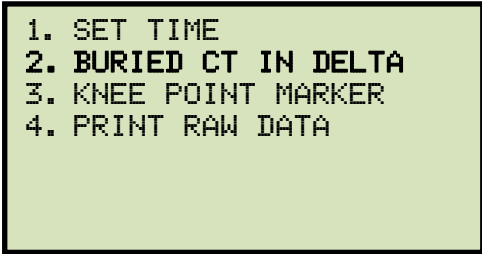
Press the **[2]** key (SETUP).

- b. The following screen will be displayed:

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

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

- c. The following screen will be displayed:



```
1. SET TIME
2. BURIED CT IN DELTA
3. KNEE POINT MARKER
4. PRINT RAW DATA
```

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

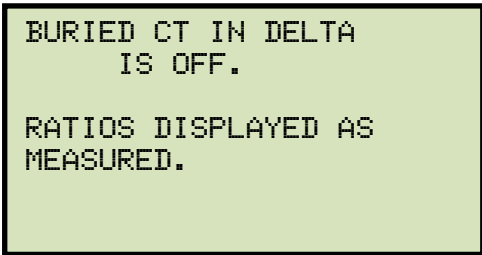
- d. The following screen will be displayed:



```
1. BURIED CT DELTA ON
2. BURIED CT DELTA OFF
```

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

- e. The following screen will be displayed:



```
BURIED CT IN DELTA
  IS OFF.

RATIOS DISPLAYED AS
MEASURED.
```

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

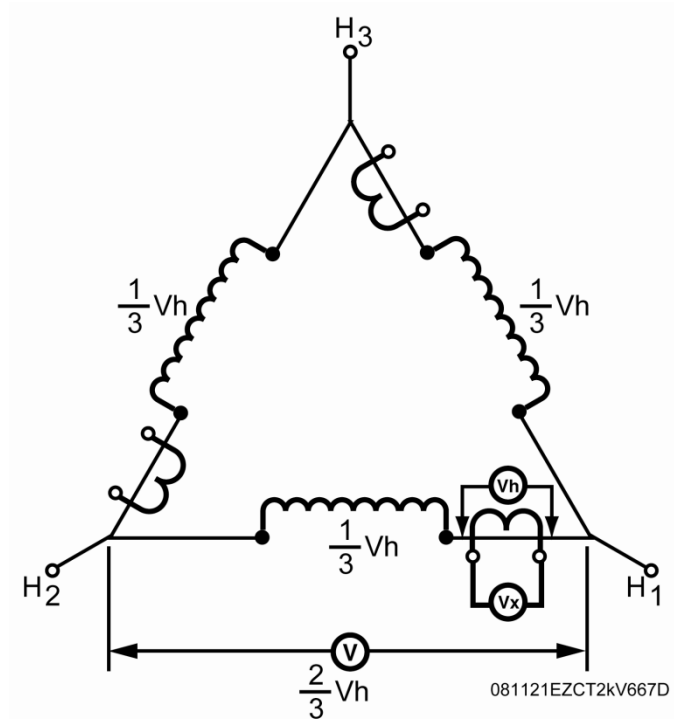


Figure 12. Buried CT in a Delta Transformer Illustration 1

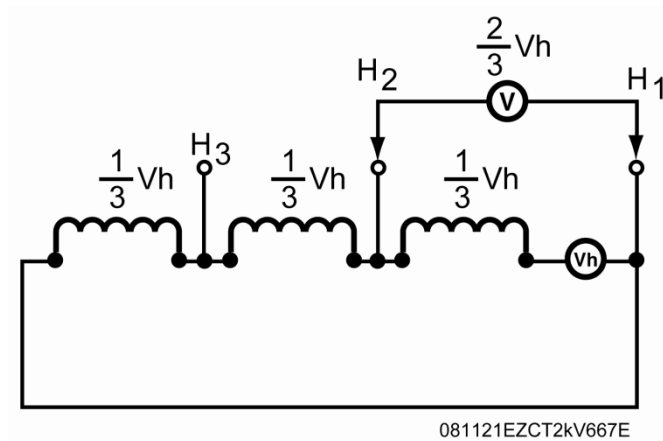


Figure 13. Buried CT in a Delta Transformer Illustration 2

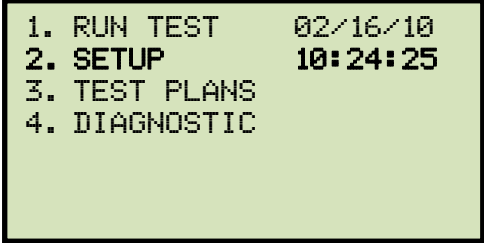
**NOTES**

- The CT turns ratio is ideally measured as: $\text{Ratio} = \frac{V_x}{V_h}$.
- Since the induced voltage (V) is sensed through the H1-H2 terminals of the Delta winding, this induced voltage is measured as $V = (\frac{2}{3}) V_h$.
- The CT turns ratio is now measured as $\text{Ratio} = \frac{V_x}{V}$ or $\text{Ratio} = (\frac{3}{2}) (\frac{V_x}{V_h})$. This measured turns ratio is $\frac{3}{2}$ higher than the actual turns ratio.
- The EZCT S2A 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 S2A's internal clock:


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



```
1. RUN TEST      02/16/10
2. SETUP        10:24:25
3. TEST PLANS
4. DIAGNOSTIC
```

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

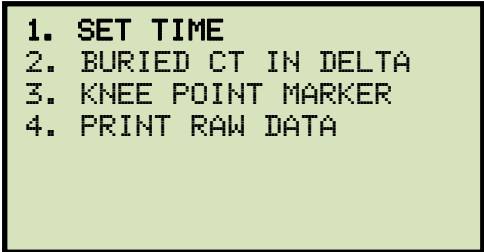
- b. The following screen will be displayed:



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

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

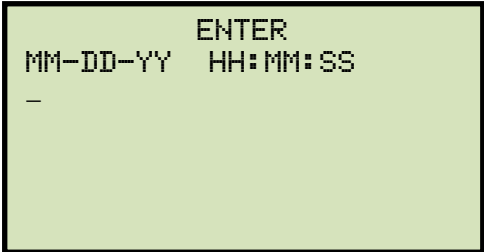
- c. The following screen will be displayed:



```
1. SET TIME
2. BURIED CT IN DELTA
3. KNEE POINT MARKER
4. PRINT RAW DATA
```

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

- d. The following screen will be displayed:



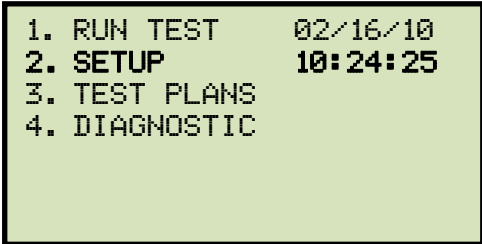
```
ENTER
MM-DD-YY  HH:MM:SS
_
```

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 S2A's memory buffer for diagnostic purposes. This will print a table of current and voltage values from the last test performed as well as all stored test records. To print the raw buffer data:

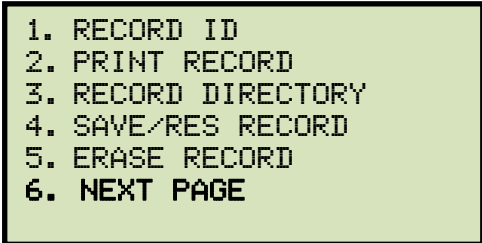
- a. Start from the "START-UP" menu:



```
1. RUN TEST      02/16/10
2. SETUP        10:24:25
3. TEST PLANS
4. DIAGNOSTIC
```

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

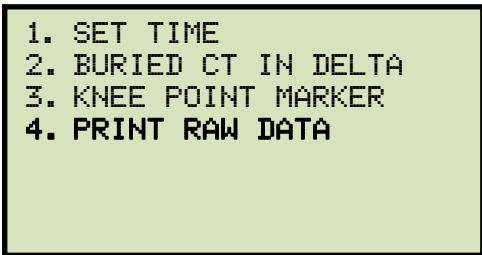
- b. The following screen will be displayed:



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

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

- c. The following screen will be displayed:



```
1. SET TIME
2. BURIED CT IN DELTA
3. KNEE POINT MARKER
4. PRINT RAW DATA
```

Press the **[4]** key (*PRINT RAW DATA*). The raw buffer data will be printed and you will be returned to the "START-UP" menu. A sample printout is shown in Figure 14.



You can press the **[STOP]** key at any time to abort the printing process.

NOTE


```

SINGLE TEST BUFFER
I      U
1.0142 261.8
0.8634 260.3
0.7022 259.8
0.5414 259.3
0.4462 258.8
0.3634 249.3
0.3062 246.3
0.2386 240.1
0.2082 239.6
0.1662 239.1
0.1350 239.1
0.1054 239.1
0.0866 201.8
0.0698 189.1
0.0570 160.0
0.0468 131.8
0.0380 101.1
0.0308 75.5
0.0250 56.3
0.0206 43.3
0.0166 32.2
0.0142 26.1
0.0110 19.1
0.0088 14.4
0.0074 11.1
0.0060 8.8
0.0054 7.5
0.0040 5.5
0.0026 3.3
0.0022 2.2
0.0000 0.0
0.0000 0.0

TEST RECORD BUFFER
TEST NUMBER 1
I      U
1.0058 262.3
0.8288 260.3
0.7146 259.8
0.5590 259.3
0.4578 259.3
0.3750 259.3
0.3146 247.3
0.2424 240.1
0.2118 239.6
0.1584 239.1
0.1378 239.1
0.1068 239.1
0.0880 201.8
0.0718 187.1
0.0572 161.1
0.0468 131.1
0.0380 101.1
0.0312 76.3
0.0254 58.3
0.0210 44.3
0.0168 32.2
0.0140 26.1
0.0112 19.1
0.0090 14.4
0.0074 11.1
0.0060 8.8
0.0056 7.5
0.0042 5.5
0.0026 3.3
0.0022 2.2
0.0000 0.0
0.0000 0.0

TEST NUMBER 2
I      U
1.0142 261.8
0.8634 260.3
0.7022 259.8
0.5414 259.3
0.4462 258.8
0.3634 249.3
0.3062 246.3
0.2386 240.1
0.2082 239.6
0.1662 239.1
0.1350 239.1
0.1054 239.1
0.0866 201.8
0.0698 189.1
0.0570 160.0
0.0468 131.8
0.0380 101.1
0.0308 75.5
0.0250 56.3
0.0206 43.3
0.0166 32.2
0.0142 26.1
0.0110 19.1
0.0088 14.4
0.0074 11.1
0.0060 8.8
0.0054 7.5
0.0040 5.5
0.0026 3.3
0.0022 2.2
0.0000 0.0
0.0000 0.0

```

Figure 14. Sample Raw Data Printout

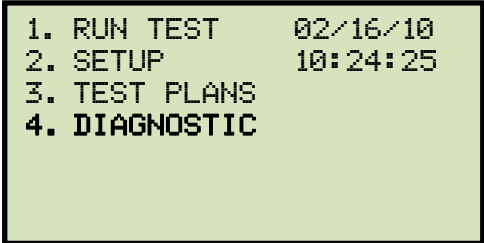
5.0 DIAGNOSTICS, VERIFICATION, AND TROUBLESHOOTING

5.1 Performing a Diagnostics Test

The Diagnostics test mode displays the output voltage at the 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. The Diagnostic Test mode uses the X1-X2 taps.

To perform a diagnostic test:


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



```
1. RUN TEST      02/16/10
2. SETUP        10:24:25
3. TEST PLANS
4. DIAGNOSTIC
```

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

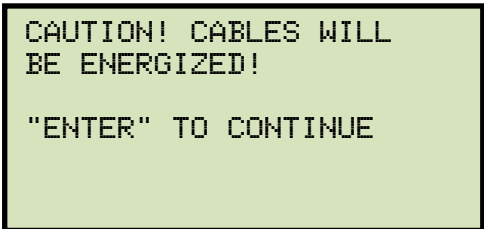
- b. The following screen will be displayed:



```
SELECT VOLTAGE RANGE
1. 50V
2. 250V
3. 500V
4. 1500V
```

Select the maximum output voltage on the X terminals by pressing the corresponding key (**[1]** – **[4]**).

- c. The following screen will be displayed:

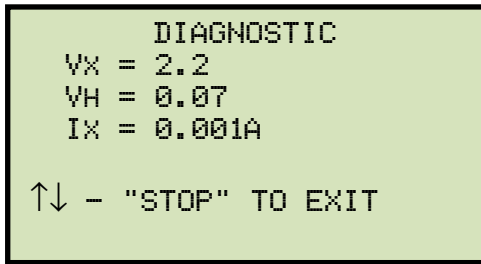


```
CAUTION! CABLES WILL
BE ENERGIZED!

"ENTER" TO CONTINUE
```

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

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



```
DIAGNOSTIC
VX = 2.2
VH = 0.07
IX = 0.001A

↑↓ - "STOP" TO EXIT
```

You can press the **[PAPER ^ Contrast]** or **[PAPER v 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 S2A's V_x Sense Circuit Using an External Meter

The excitation voltage (V_x) sensed by the EZCT S2A can be verified using an external RMS volt meter. Follow the steps below to verify the EZCT S2A's V_x sense circuit:

- Connect the X cables to an RMS volt meter as shown in Figure 15.
- Select the EZCT S2A's Diagnostics mode (see section 5.1).
- Press the **[PAPER ^ Contrast]** key to raise the V_x voltage.
- Verify the V_x voltage displayed on the EZCT S2A LCD screen against the value displayed on the external volt meter.
- Press the **[STOP]** key to end the test.

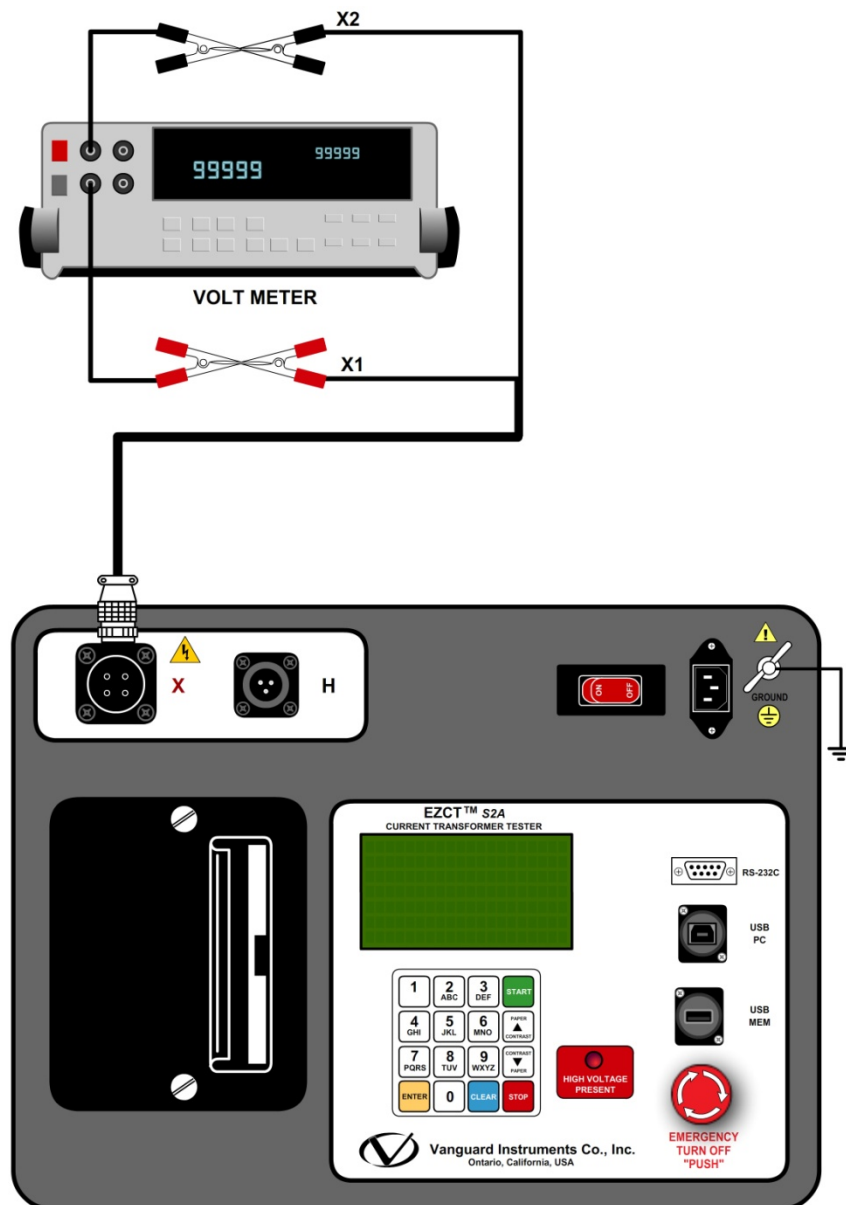


Figure 15. EZCT S2A V_x Verification Test Connections

5.3 Verifying the EZCT S2A's I_x Sense Circuit Using an External Meter

You can verify the excitation current (I_x) sensed by the EZCT S2A by using an external RMS ampere meter. Follow the steps below to verify the EZCT S2A's I_x sense circuit:

- Connect the X cables to a power resistor and an RMS ampere meter as shown in Figure 16.
- Select the EZCT S2A's Diagnostics mode (see section 5.1).
- Press the **[PAPER ^ Contrast]** key to raise the V_x voltage.
- Verify the I_x voltage displayed on the EZCT S2A's LCD screen against the value displayed on the external RMS ampere meter.
- Press the **[STOP]** key to end the test.

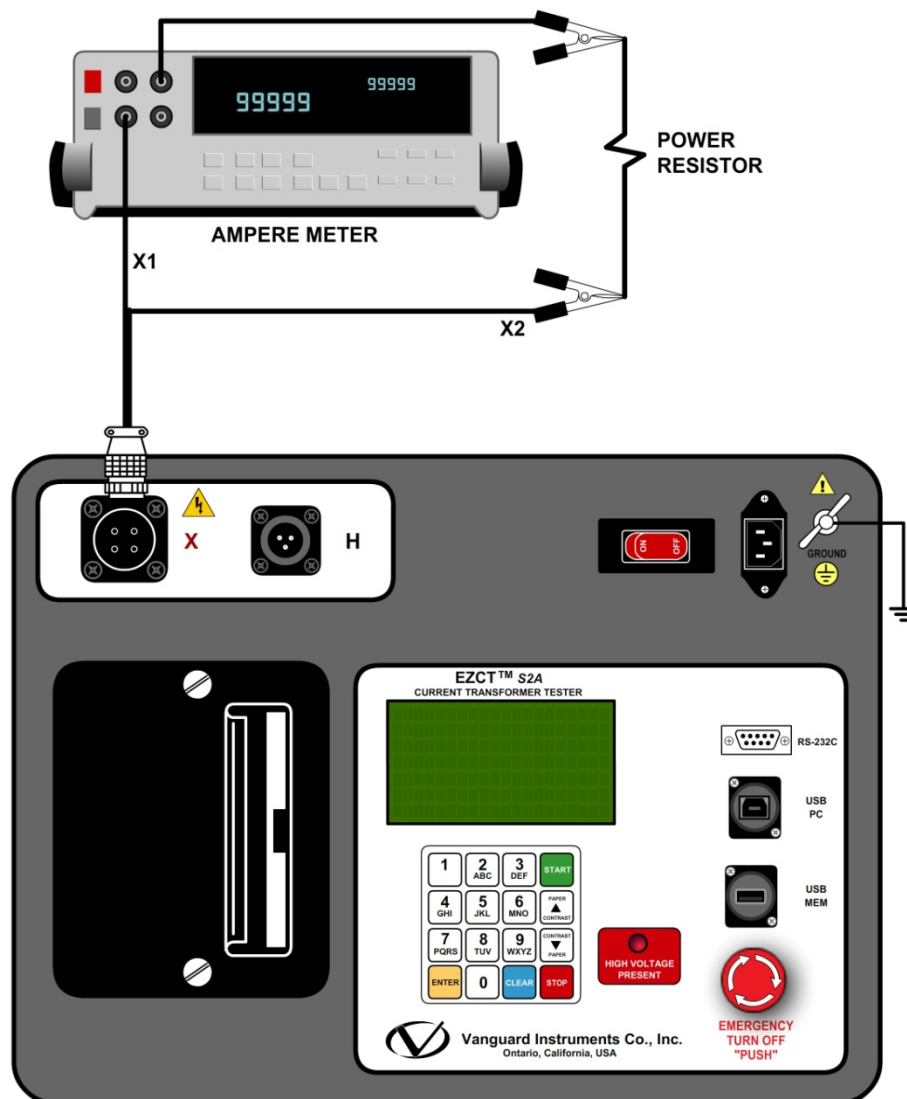


Figure 16. EZCT S2A I_x Verification Test Connections

5.4 Quickly Verifying the EZCT S2A's Turns Ratio Circuit

You can quickly verify the EZCT S2A's turns ratio circuit by performing the following ratio test:

- Connect the X1 test lead to the H1 test lead as shown in Figure 17.
- Connect the X2 test lead to the H2 test lead as shown in Figure 17.
- Run a turns ratio test (see section 3.2.2).
- 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.

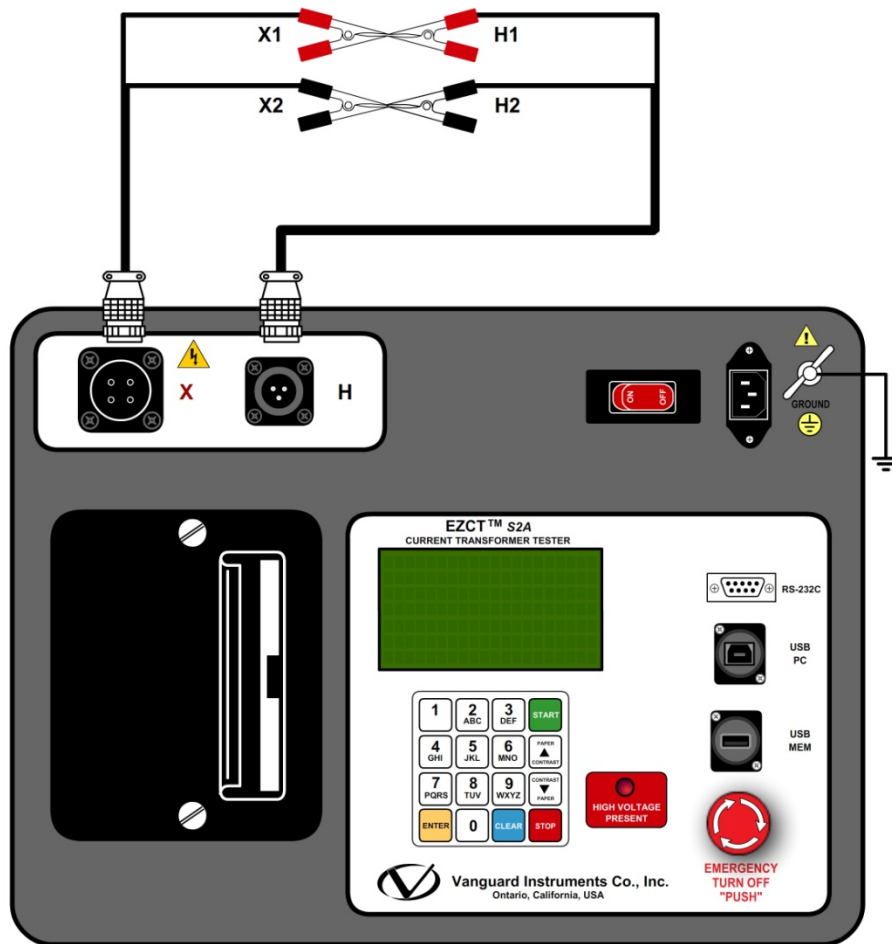


Figure 17. EZCT S2A Turns Ratio Verification Test Connections

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.	<ul style="list-style-type: none"> The EZCT S2A X cables are driving a short circuit. 	<ul style="list-style-type: none"> 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.	<ul style="list-style-type: none"> The EZCT S2A X cable is driving an opened circuit. 	<ul style="list-style-type: none"> Check the CT terminal connection.
Cannot reach the CT knee point voltage (the current did not reach at least 1A)	<ul style="list-style-type: none"> The test voltage selected for the test was too low. You can quickly verify if the CT was demagnetized by looking at the last excitation graph. 	<ul style="list-style-type: none"> Select a higher test voltage for the test.
When running the excitation test, the V_x reading is erratic.	<ul style="list-style-type: none"> The EZCT S2A X cable may be opened. Each X cable has two conductors going from the clip end to the X connector on the front panel. If one of the conductors is opened, the V_x readings will be erratic. 	<ul style="list-style-type: none"> Remove X cables from the EZCT S2A and the CT terminals. Check cable integrity using an Ohm Meter.
The turns ratio reading is incorrect.	<ul style="list-style-type: none"> No H cable connection. No excitation voltage 	<ul style="list-style-type: none"> Check the H cable connection. Check the X cable connection.
Saturation test is correct but turns ratio test is erroneous.	<ul style="list-style-type: none"> V_H cables problem. 	<ul style="list-style-type: none"> 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.	<ul style="list-style-type: none"> Transformer windings opposite side of CT windings may not be shorted. 	<ul style="list-style-type: none"> See Figure 4.

6.0 UPGRADING FIRMWARE

The EZCT S2A'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 S2A firmware:

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



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

REQUEST SOFTWARE/MANUAL DOWNLOADS

Please select the check boxes for the items you would like to download. For each selected item, please be sure to provide your product's serial number. Once we receive your download request, you will receive an email with links for the requested files. Fields in **RED** are required fields. Thank you.

Name:
E-Mail:

Company:
Phone:

Comments:

19140

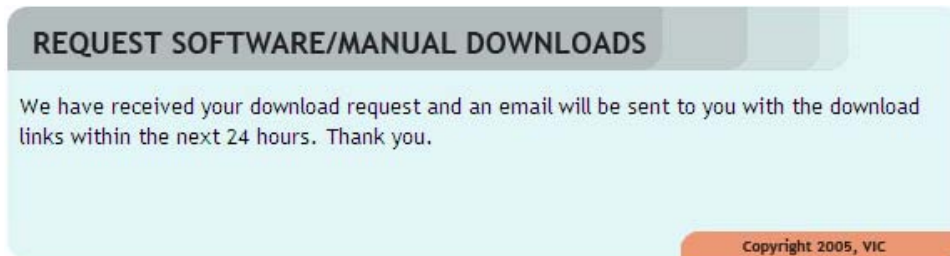
Enter the security code shown above in the field below:

Circuit Breaker Timers

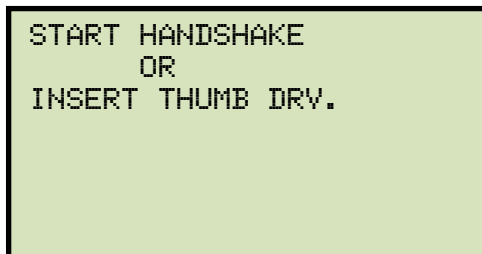
Product	PC Software	Firmware	Software Manual	User's Manual	Spanish Manual	Product Demo	Serial Number
CBPS-300				<input type="checkbox"/>		<input type="checkbox"/>	<input style="width: 100px;" type="text"/>
CT-3500	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	<input style="width: 100px;" type="text"/>
CT-6500	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input style="width: 100px;" type="text"/>

Fill out all required fields (marked with red labels) and then click on the "Firmware" checkbox to the right of the "EZCT-S2A" 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:

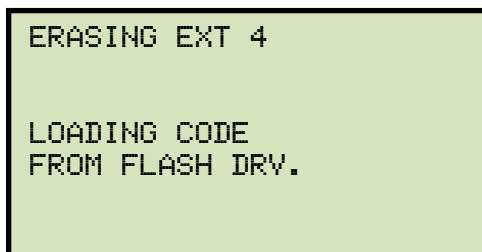


- d. You will also receive an email confirming the receipt of your download request. Once your request has been received, you will receive a second email, usually within 1-2 business hours, containing a download link for the firmware file. Click on this link and download the firmware file to your computer.
- 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 *EZCTS2AM.hex*. Copy this file to the root of a USB Flash drive.
- f. Make sure the EZCT S2A's power is OFF, and then insert the USB Flash drive containing the firmware file in the EZCT S2A's Flash drive interface port ("USB MEM" port).
- g. While holding down the **[STOP]** key, turn on the EZCT S2A.
- h. Continue to hold down the **[STOP]** key while the EZCT S2A powers up.
- i. After the initial logo screen, the following screen will be displayed:

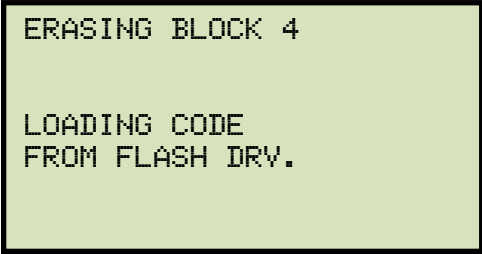


Continue to hold down the **[STOP]** key.

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



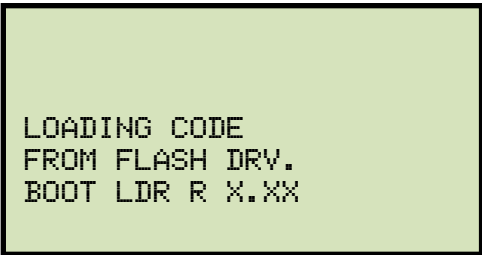
You can release the **[STOP]** key at this point. The EZCT S2A will continue the upgrade process and display the following screen:



ERASING BLOCK 4

LOADING CODE
FROM FLASH DRV.

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



LOADING CODE
FROM FLASH DRV.
BOOT LDR R X.XX

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 18.

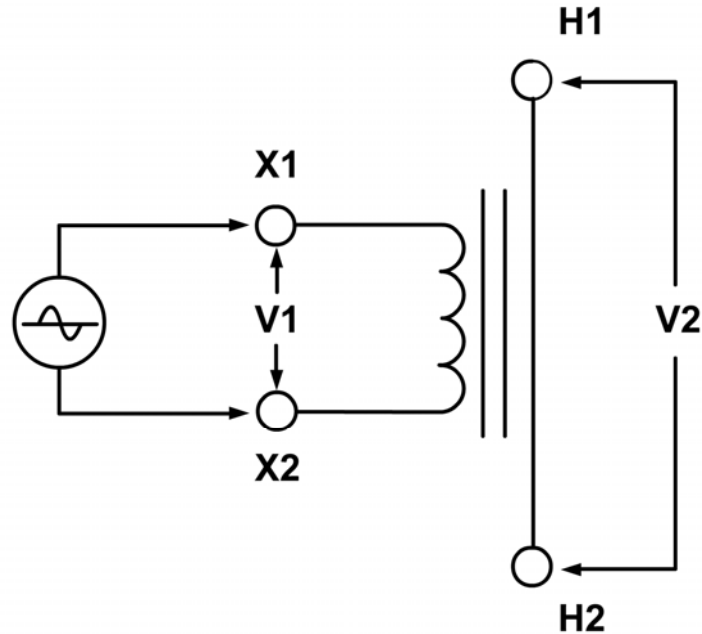


Figure 18

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 19 shows a typical connection of a CT mounted on the primary bushing of a single phase transformer. When the voltage V_1 is introduced to the CT's secondary winding, there is an induced voltage (V_3) on the primary winding of this single phase transformer. Since the only access to the transformer is between terminals H1-H0, The V_3 voltage will be included and the turns-ratio will be:

$$\text{Ratio} = \frac{V_1}{(V_2 + V_3)}$$

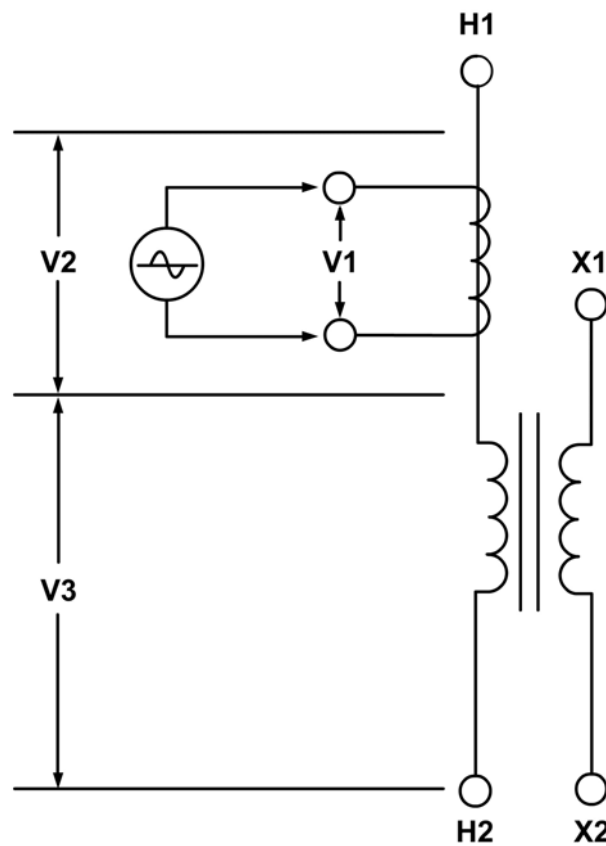


Figure 19

Ideally, we would like to eliminate the V_3 voltage and only see the V_2 voltage. If the induced V_3 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 20. By shorting out the transformer secondary winding, the user can eliminate most of the V3 voltage ($V3=0V$).

Now the turns-ratio will be:

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

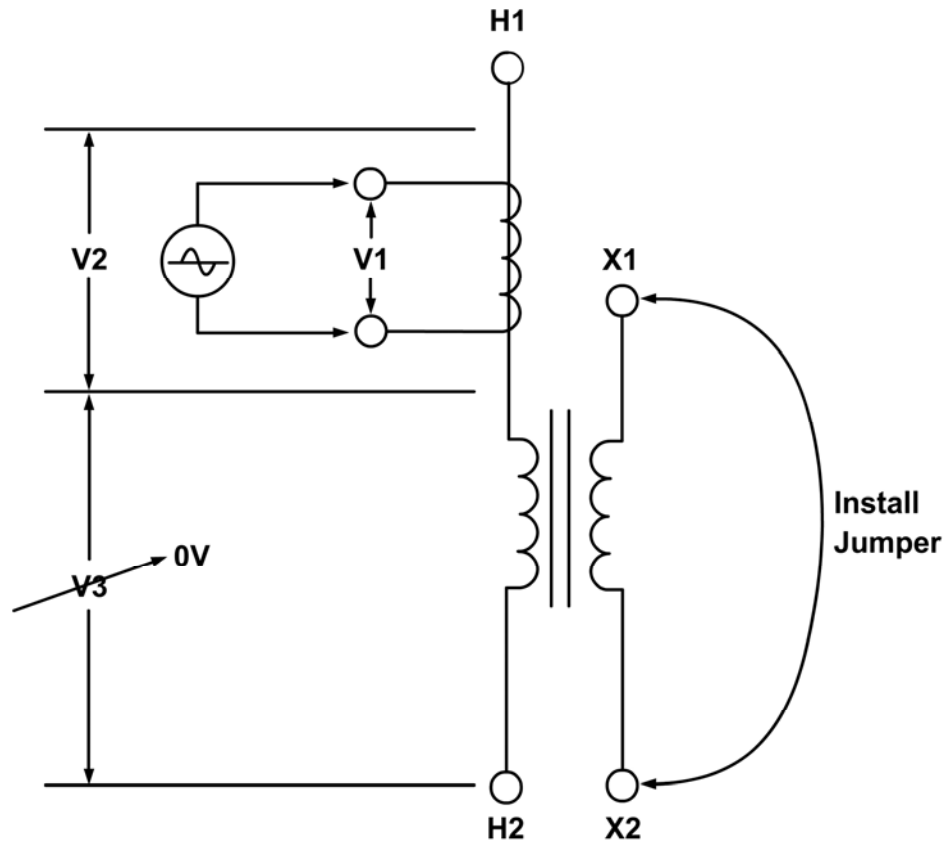


Figure 20

Figure 21 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:

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

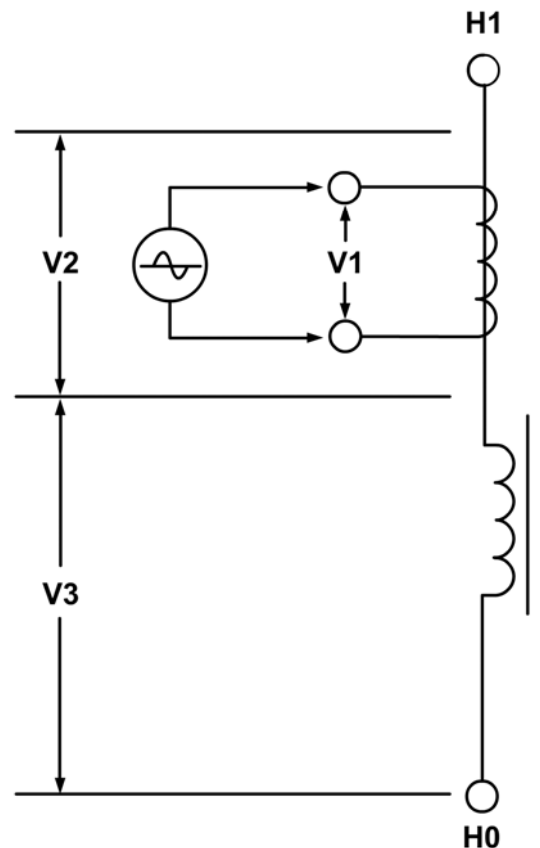


Figure 21

Since there is no secondary winding on the shunt reactor, 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 user does not have an alternative method for verifying the CT turns-ratio in this situation since there is no secondary winding and a jumper can't be used.

Figure 22 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 measured by the EZCT or any electronic TTR is calculated as follows:

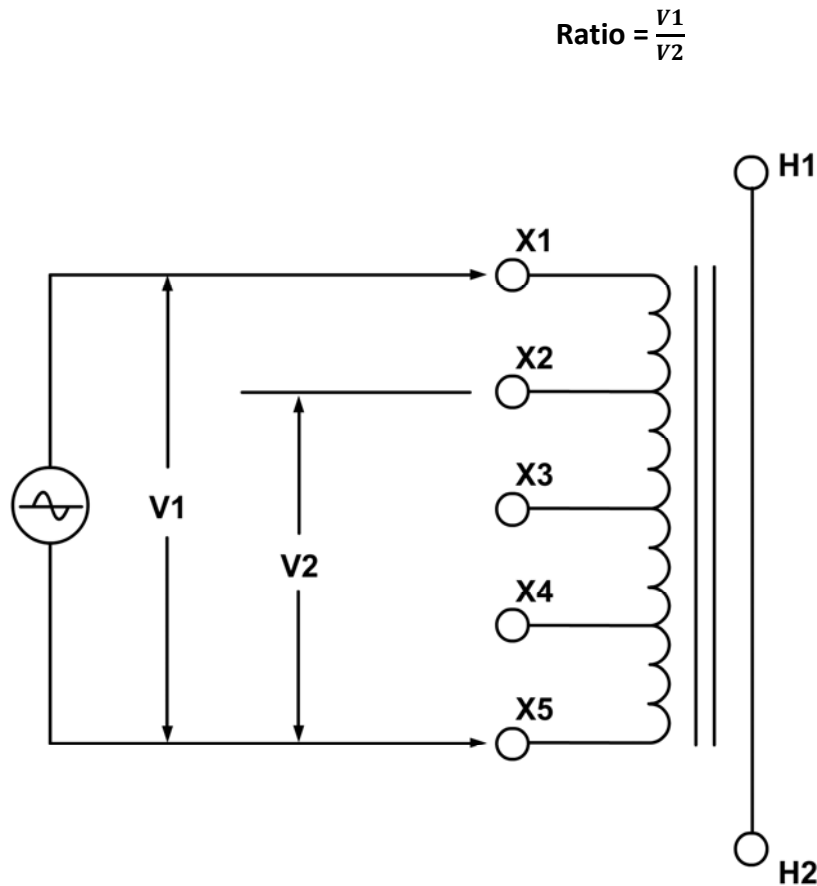


Figure 22

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

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

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

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:

$$\text{Voltage (X2-X5)} = 120 \text{ V} \times \left(\frac{1000}{1200}\right) = 100 \text{ V}$$

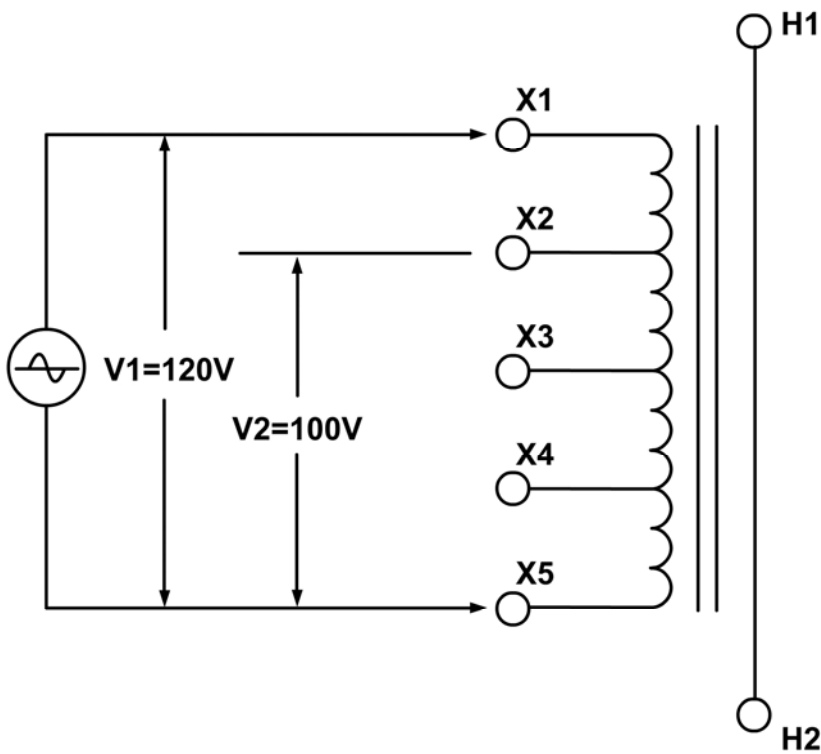


Figure 23

This method also eliminates the effect of the (reactor) winding on the H1 – H2 terminals.

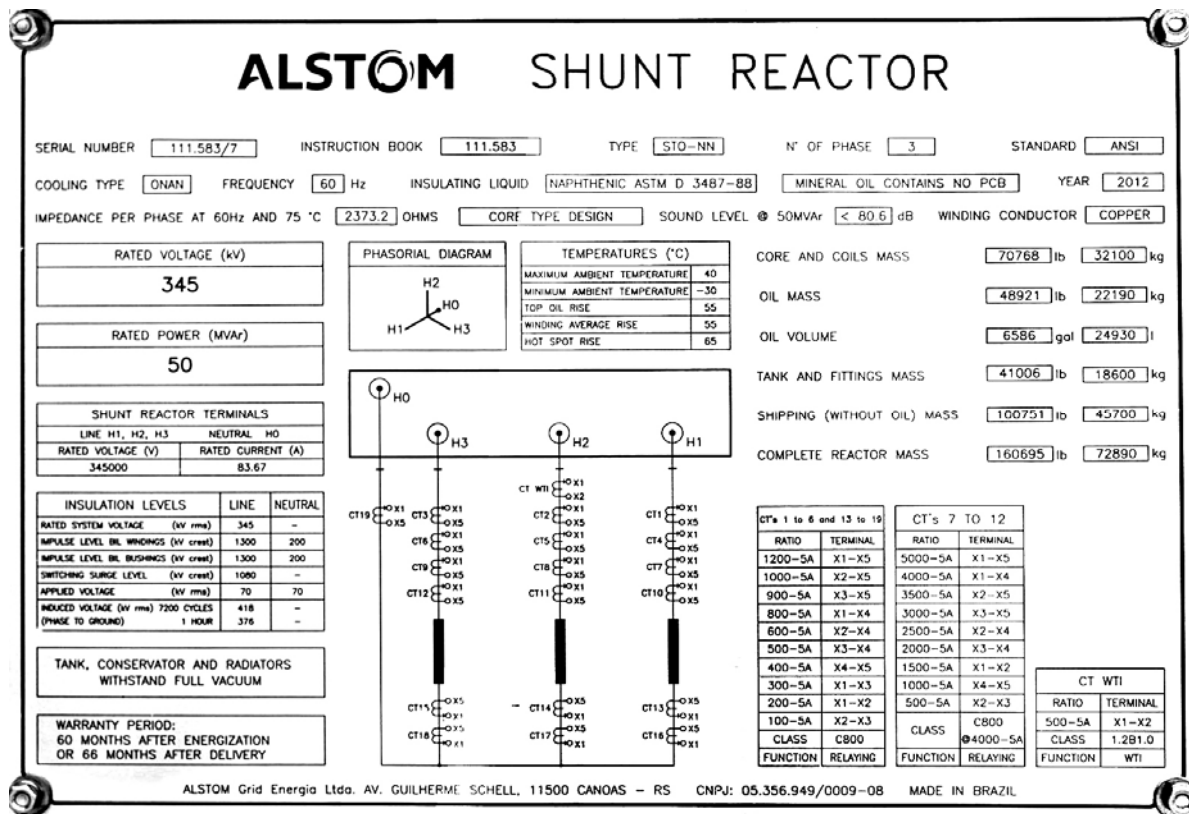


Figure 24



Figure 25



**Vanguard Instruments
Company, Inc.**

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

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

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