

# EZCT S2™

## DIGITAL CURRENT-TRANSFORMER TESTER

### USER'S MANUAL



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## SAFETY SUMMARY

### FOLLOW EXACT OPERATING PROCEDURES

Any deviation from the procedures described in this User's Manual may create one or more safety hazards, may damage the EZCT S2, or cause errors in the test results. Vanguard Instruments Company, Inc. assumes no liability for unsafe or improper use of the EZCT S2.

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 S2 can produce a voltage up to 1,500 Vac that can cause severe injury and/or equipment damage. Due to this reason, the EZCT S2 shall be used only by **trained operators**.

The EZCT S2'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 S2.

Always ground the EZCT S2 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 S2 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.

## TABLE OF CONTENTS

CONVENTIONS USED IN THIS DOCUMENT .....	1
1.0 INTRODUCTION .....	2
1.1 General Description and Features .....	2
1.2 Furnished Accessories .....	3
1.3 Technical Specifications .....	4
1.4 EZCT S2 Controls and Indicators .....	5
2.0 PRE-TEST SETUP .....	7
2.1 Operating Voltages .....	7
2.2 LCD Screen Contrast Control .....	7
2.3 Printer Paper Control .....	7
2.4 Printer Paper .....	7
3.0 OPERATING PROCEDURES .....	9
3.1 EZCT S2 Cable Connections .....	9
3.2 Performing Tests .....	11
3.2.1. Entering Test Record Header Information .....	11
3.2.2. Performing Excitation and Ratio Tests .....	14
3.3 Working With Test Records .....	22
3.3.1. Restoring and Printing a Test Record From Flash EEPROM .....	22
3.3.2. Printing a Restored Test Record .....	25
3.3.3. Printing a Directory of Test Records Stored in the EZCT S2's Memory .....	26
3.3.4. Erasing Test Records From the Flash EEPROM .....	28
3.4 Working With Test Plans .....	30
3.4.1. Extracting the Test Plan From a Test Record .....	30
3.4.2. Printing a Directory of Test Plans Stored in the EZCT S2's Memory .....	32
3.4.3. Printing a Test Plan .....	34
3.4.4. Erasing Test Plans From the Flash EEPROM .....	36
3.4.5. Loading a Test Plan from the EZCT S2's Flash EEPROM .....	38
3.4.6. Running a Test Using a Loaded Test Plan .....	39
3.4.7. Unloading a Test Plan from the Working Memory .....	43
4.0 CHANGING SETUP PARAMETERS .....	44
4.1 Setting the Knee Point Marker .....	44
4.2 Selecting the Buried CT in Transformer Delta Option .....	46
4.3 Setting the Clock .....	49
5.0 DIAGNOSTICS, VERIFICATION, AND TROUBLESHOOTING .....	50
5.1 Performing a Diagnostics Test .....	50
5.2 Verifying the EZCT S2's $V_x$ Sense Circuit Using an External Meter .....	51
5.3 Verifying the EZCT S2's $I_x$ Sense Circuit Using an External Meter .....	52
5.4 Quickly Verifying the EZCT S2's Turns Ratio Circuit .....	53
5.5 Troubleshooting Guide .....	54
6.0 Appendix A - Calculating Turns Ratio on a Shunt Reactor .....	55

## LIST OF TABLES

Table 1. EZCT S2 Technical Specifications .....	4
Table 2. Functional Descriptions of EZCT S2 Controls and Indicators .....	6
Table 3. Descriptions of Tabulated Test Results Elements .....	20
Table 4. Description of Test Plan Elements .....	35

## LIST OF FIGURES

Figure 1. EZCT S2 Controls and Indicators .....	5
Figure 2. Typical EZCT S2 Excitation and Ratio Test Cable Connection .....	9
Figure 3. Bushing CT Connection on Delta Transformer .....	10
Figure 4. Bushing CT Connection on Y Transformer .....	10
Figure 5. Typical EZCT S2 Tabulated Report Printout .....	19
Figure 6. Typical EZCT S2 Graphic Report .....	21
Figure 7. Typical Internal Test Record Directory Printout .....	27
Figure 8. Typical EZCT S2 Flash EEPROM Test Plan Directory Printout .....	33
Figure 9. Typical Test Plan Printout .....	35
Figure 10. Graphic Report Showing Knee Point Marker .....	45
Figure 11. Buried CT in a Delta Transformer Illustration 1 .....	47
Figure 12. Buried CT in a Delta Transformer Illustration 2 .....	47
Figure 13. EZCT S2 $V_x$ Verification Test Connections .....	51
Figure 14. EZCT S2 $I_x$ Verification Test Connections .....	52
Figure 15. EZCT S2 Turns Ratio Verification Test Connections .....	53
Figure 16 .....	55
Figure 17 .....	56
Figure 18 .....	57
Figure 19 .....	58
Figure 20 .....	59
Figure 21 .....	60
Figure 22 .....	61
Figure 23 .....	61

## CONVENTIONS USED IN THIS DOCUMENT

This document uses the following conventions:

- A key or switch on the EZCT S2 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 S2 LCD screen output is shown as:

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

- 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
```

- Warning messages are indicated as:



Warning message

**WARNING**

- Important notes are indicated as:



Note details

**NOTE**

## 1.0 INTRODUCTION

### 1.1 General Description and Features

The EZCT S2 is Vanguard's second-generation, microprocessor-based, current transformer test set. The EZCT S2 can perform the current transformer (CT) excitation, CT current-ratio, and winding polarity tests automatically. The EZCT S2 automatically raises and lowers the excitation test voltage without any operator intervention. With up to 1500 Vac excitation test voltage available, the EZCT S2 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 S2. 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 Test

The EZCT S2 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 S2 features a back-lit LCD screen (4 lines by 20 characters) 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 S2 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 S2 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 S2 itself or created on a PC and downloaded to the EZCT S2 via the unit's built-in RS-232C or USB port.

## Computer Interface

The EZCT S2 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 S2. This software can be used to retrieve test records from the EZCT S2, create test plans, download test plans to the EZCT S2, 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 S2 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 S2 Technical Specifications**

<b>TYPE</b>	Portable current transformer test set
<b>PHYSICAL SPECIFICATIONS</b>	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)
<b>INPUT POWER</b>	100 – 120 Vac or 200 – 240 Vac (factory pre-set), 50 Hz/60 Hz
<b>MEASUREMENT METHOD</b>	ANSI/IEEE C57.12.90, IEC 60044-1 and ANSI/IEEE C57.13.1 standards
<b>TEST OUTPUT VOLTAGES</b>	0 – 50 Vac @ 10A max, 0 – 250 Vac @ 10A max 0 – 500 Vac @ 5A max, 0 – 1500 Vac @ 1.2A max
<b>VOLTAGE READING RANGE</b>	0 – 2,200 Vac; Accuracy: $\pm 1.0\%$ of reading, $\pm 1$ volt
<b>CURRENT READING RANGE</b>	0 – 10A; Accuracy: $\pm 1.0\%$ of reading, $\pm 0.02A$
<b>CURRENT-RATIO RANGE</b>	0.8 – 999: 0.1%, 1000 – 1999: 0.3%, 2000 – 5000: 1%
<b>PHASE ANGLE MEASUREMENT</b>	0 - 360 degrees; Accuracy: $\pm 1.0$ degree
<b>DISPLAY</b>	Back-lit LCD Screen (20 characters by 4 lines); viewable in bright sunlight and low-light levels
<b>PRINTER</b>	Built-in 4.5-inch wide thermal printer
<b>COMPUTER INTERFACES</b>	One RS-232C port (115k baud), one USB port
<b>PC SOFTWARE</b>	Windows <sup>®</sup> XP/Vista-based CT Analysis software is included with purchase price
<b>INTERNAL TEST RECORD STORAGE</b>	Stores 140 test records. Each test record may contain up to 10 sets of excitation, resistance and ratio data
<b>INTERNAL TEST PLAN STORAGE</b>	Stores 128 test plans. Each test plan can store 10 excitation test voltage and current settings
<b>SAFETY</b>	Designed to meet UL 61010A-1 and CAN/CSA C22.2 No. 1010.1-92 standards
<b>ENVIRONMENT</b>	Operating: -10° to 50° C (15°F to +122° F); Storage: -30° C to 70° C (-22°F to +158° F)
<b>CABLES</b>	Two 20-foot X cable sets, One 35-foot H cable set, power cord, One cable-carrying duffel bag
<b>WARRANTY</b>	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 S2 Controls and Indicators

The EZCT S2'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 S2. 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.

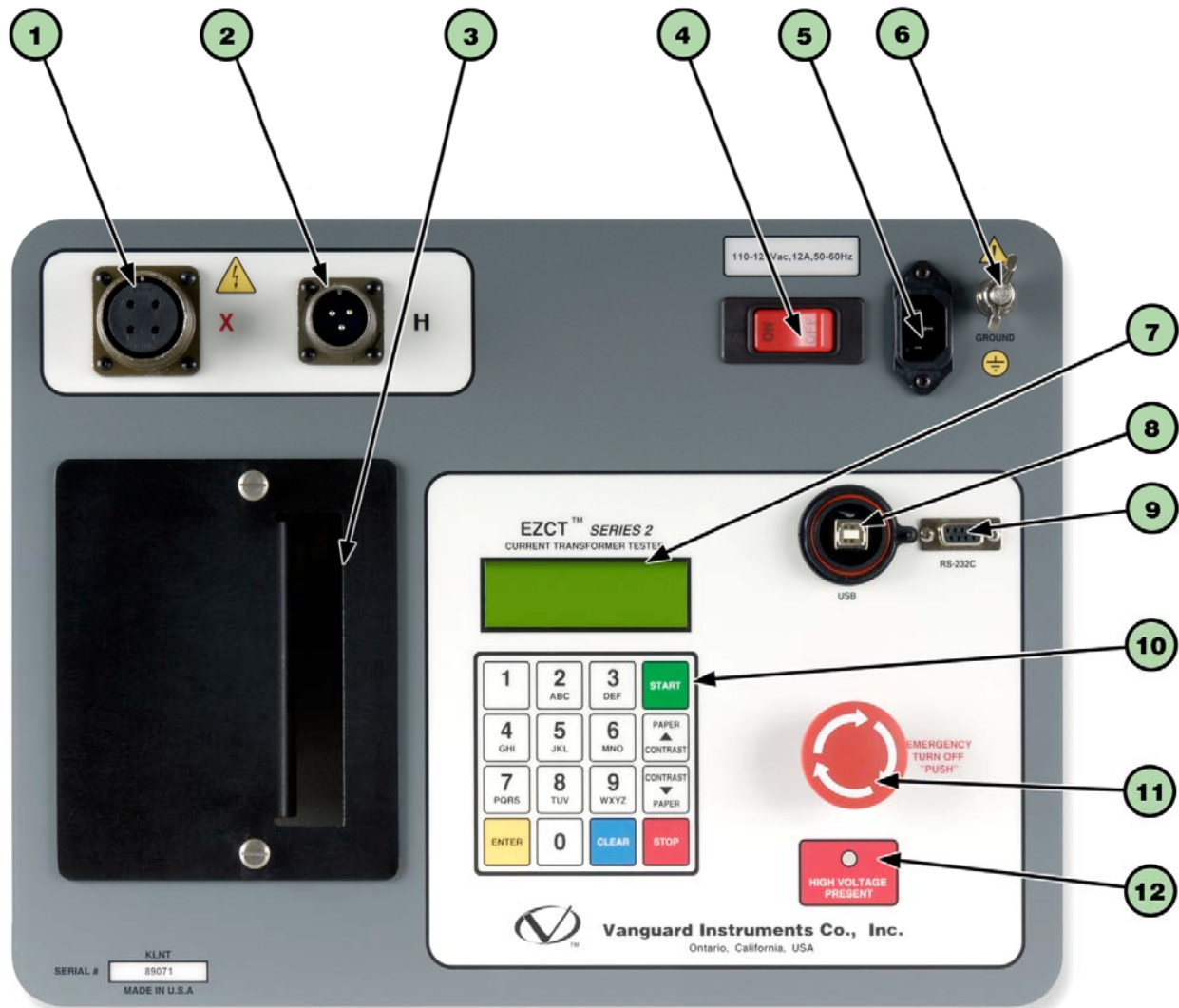


Figure 1. EZCT S2 Controls and Indicators

Table 2. Functional Descriptions of EZCT S2 Controls and Indicators

Item Number	Panel Markings	Functional Description
1	X	Current transformer excitation voltage connector. The EZCT S2's X output terminal is rated to 1500 Vac working voltage. <b>Any voltage above 1500 Vac will damage the input circuitry.</b>
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 (20 characters by 4 lines); viewable in bright sunlight and low-light levels.
8	USB	USB PC interface
9	RS-232C	RS-232C PC interface. Baud rate is set for 115KB, 8 data bits, 2 stop bits.
10		Rugged alpha-numeric keypad.
11	EMERGENCY TURN OFF "PUSH"	Emergency turn off switch.
12	HIGH VOLTAGE PRESENT	Test voltage presence indicator.

## 2.0 PRE-TEST SETUP

### 2.1 Operating Voltages

The EZCT S2'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 S2'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 S2 features one USB and one RS-232C PC interface port. A Windows-based “Current Transformer Analysis” software application is supplied with the EZCT S2. For further information, please see the software user’s manual.

### 3.0 OPERATING PROCEDURES

#### 3.1 EZCT S2 Cable Connections

Always connect the EZCT S2 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.

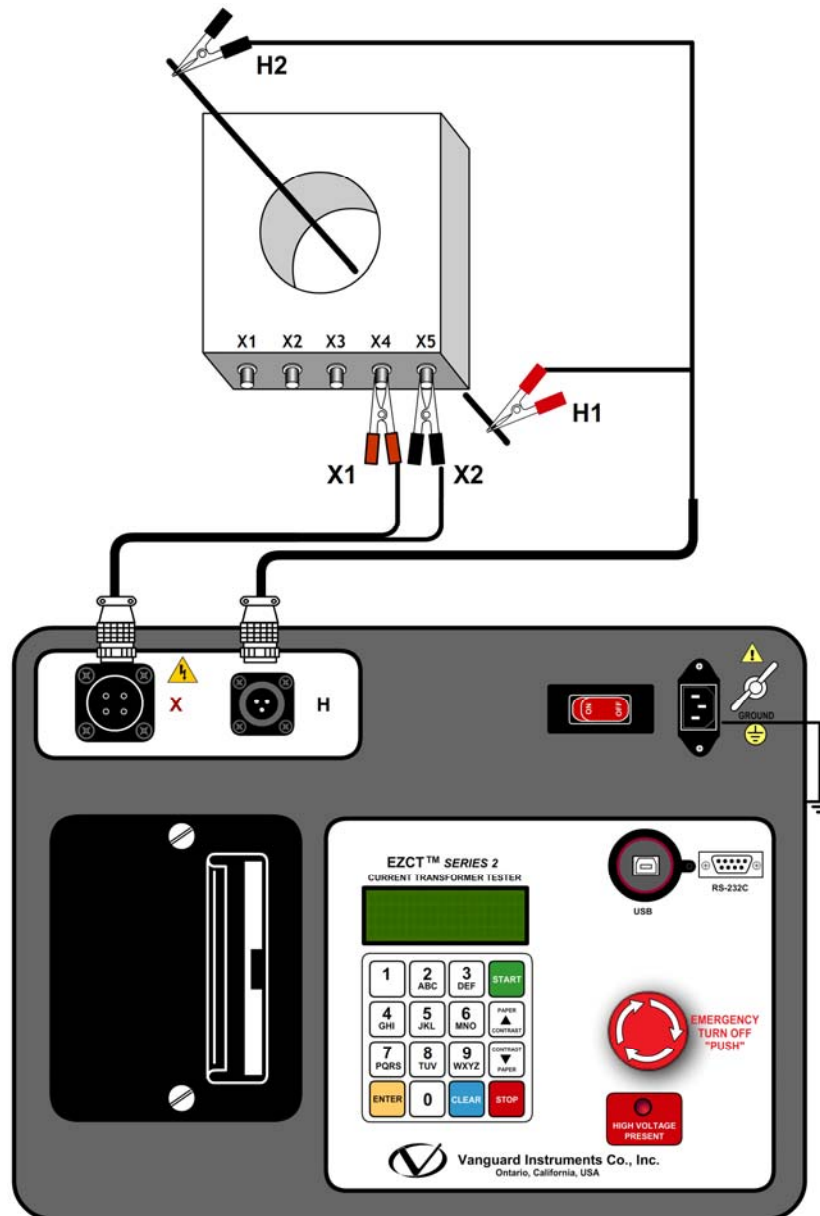


Figure 2. Typical EZCT S2 Excitation and Ratio Test Cable Connection

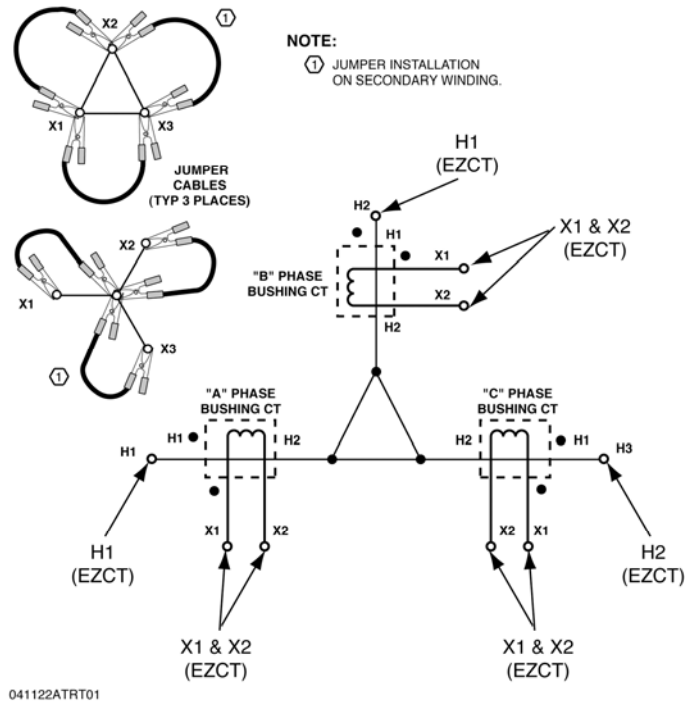


Figure 3. Bushing CT Connection on Delta Transformer

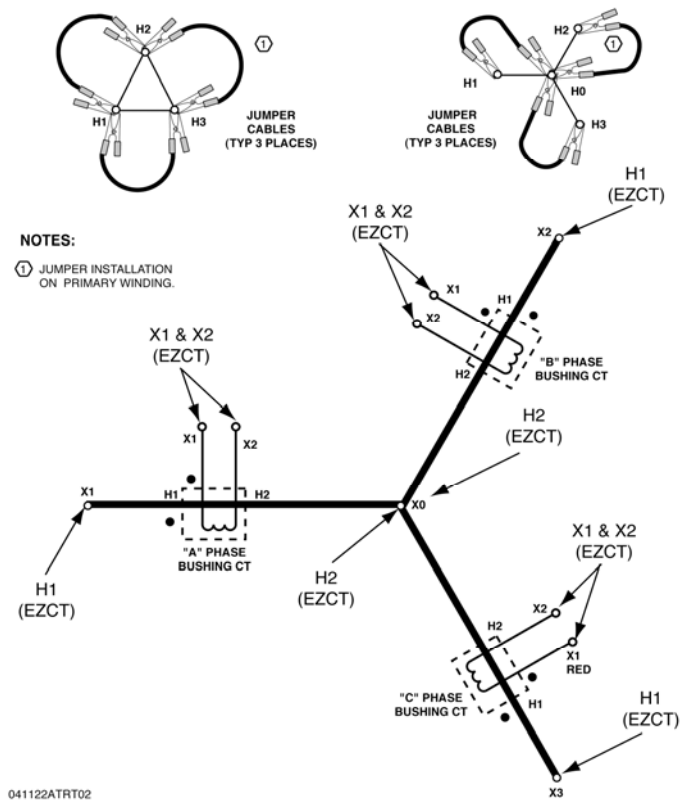


Figure 4. Bushing CT Connection on Y Transformer

## 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 12/01/09
2. SETUP    08:16:25
3. TEST PLANS
4. DIAGNOSTIC
```

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

- b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. RESTORE RECORD
4. NEXT PAGE
```

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

- c. The following screen will be displayed:

```
COMPANY:

↑/↓ TO POSITION
"ENTER" TO ACCEPT
```

Type the company name using the alpha-numeric keypad.

When pressing a key, the corresponding number on the key will be displayed first. Pressing the key again will display the first letter on the key. Pressing the key again will display the second letter on the key. For example, to type the letter "A", you must press the **[2]** key twice. To erase the character at the cursor position, press the **[CLEAR]** key. Press the **[PAPER ^ Contrast]** key to move to the next character. Press the **[PAPER 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:
↑/↓ TO POSITION
"ENTER" TO ACCEPT
```

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

- e. The following screen will be displayed:

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

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

- f. The following screen will be displayed:

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

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

- g. The following screen will be displayed:

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

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

- h. The following screen will be displayed:

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

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

- i. The following screen will be displayed:

```
COMMENTS :  
↑/↓ 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:

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

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

### 3.2.2. Performing Excitation and Ratio Tests

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

- a. When the EZCT S2 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 12/01/09
2. SETUP    08:20:19
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    3. X1-X4
2. X1-X3    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:

```
H00K CABLES TO CT:
X1 CABLE to CT-X1
X2 CABLE to CT-X2
"ENTER" TO CONTINUE
```



#### NOTE

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

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 ratio test is complete, the final results will be displayed:

```
ANY KEY TO CONTINUE

Vx= 39.9   Vh= 0.4984
I=0.1324  RAT=+80.058
```

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 S2 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:

```
TEST 1 SAVED
```

Press any key to continue.

- o. The following screen will be displayed:

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

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

- p. 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...
```

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

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



The test record number is automatically assigned to each test record stored in the EZCT S2'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 <sub>k</sub> p: 67.2 VOLTS			
ASA 10/50 I <sub>k</sub> p: 0.2538 AMPS			
IEEE 30° V <sub>k</sub> p: 60.8 VOLTS			
IEEE 30° I <sub>k</sub> p: 0.2004 AMPS			
IEEE 45° V <sub>k</sub> p: 49.0 VOLTS			
IEEE 45° I <sub>k</sub> p: 0.1564 AMPS			
NAME PLATE RATIO: 80:1			
MEASURED RATIO: 80.058			
PERCENT ERROR: 0.08 %			
POLARITY: 0 IN PHASE			
PHASE ANGLE: - 0.02°			
EXCITATION VTG: 39.9 VOLTS			
EXCITATION CUR: 0.1324 AMPS			

Figure 5. Typical EZCT S2 Tabulated Report Printout

**Table 3. Descriptions of Tabulated Test Results Elements**

<b>Item Number</b>	<b>Description</b>
<b>1</b>	Test record header information.
<b>2</b>	The X terminals (taps) that were selected for this test.
<b>3</b>	Test note for this particular test. The test note can be up to 20-characters long.
<b>4</b>	Recorded excitation current readings on the CT secondary winding.
<b>5</b>	Recorded excitation test voltages applied to the CT secondary winding.
<b>6</b>	Impedance calculated at each data point.
<b>7</b>	The voltage, current, and impedance data points recorded on the graph grid-marks.
<b>8</b>	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)
<b>9</b>	IEEE 30° knee point voltage and excitation current.
<b>10</b>	IEEE 45° knee point voltage and excitation current.
<b>11</b>	CT nameplate turns ratio.
<b>12</b>	Measured turns ratio.
<b>13</b>	Turns ratio percentage error.
<b>14</b>	Polarity of the CT.
<b>15</b>	Measured phase angle.
<b>16</b>	Excitation voltage used in CT turns ratio test.
<b>17</b>	Excitation current in turns ratio test.

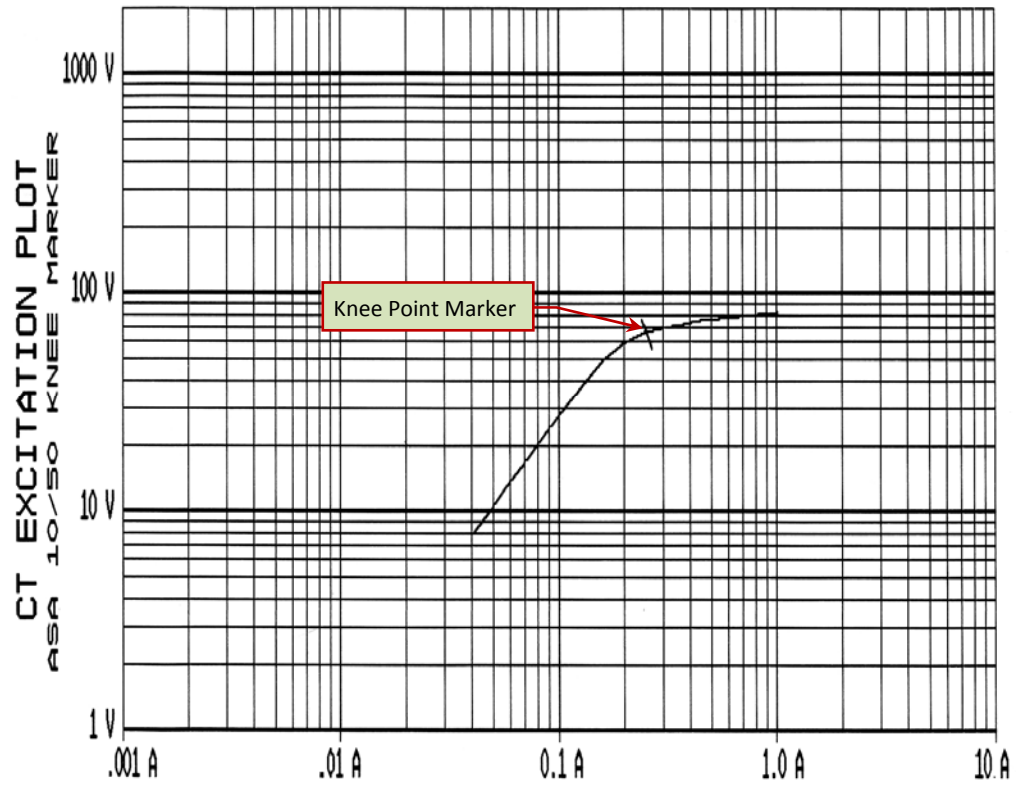


Figure 6. Typical EZCT S2 Graphic Report

### 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 S2'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 12/01/09
2. SETUP    14:52:19
3. TEST PLANS
4. DIAGNOSTIC
```

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

- b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. RESTORE RECORD
4. NEXT PAGE
```

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

- c. The following screen will be displayed:

```
RESTORE RECORD

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

1. *ENTER RECORD NUMBER*

If you know the record number that you would like to restore, press the **[1]** key. The following screen will be displayed:

```
RESTORE RECORD
NUMBER:
```

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

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

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

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

2. *SCROLL TO SELECT*

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

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

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

```
#1      12/01/09  13:16
5 TESTS
SHA 586
MITSUBISHI ELECTRIC
```

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

The following screen will be displayed:

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

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

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

- d. The following screen will be displayed:



```
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. 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 09/24/09
2. SETUP    08:20:19
3. TEST PLANS
4. DIAGNOSTIC
```

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

- b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. RESTORE RECORD
4. 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.

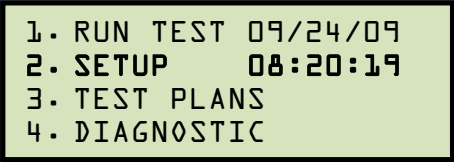
Press the **[1]** key to print the tabulated data and graphics results on the thermal printer. The test record will be printed on the thermal printer and you will be returned to the “START-UP” menu.

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.

### 3.3.3. Printing a Directory of Test Records Stored in the EZCT S2's Memory

You can print a directory of all the test records stored in the EZCT S2's Flash EEPROM using the steps below:

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



```
1. RUN TEST 09/24/09
2. SETUP      08:20:19
3. TEST PLANS
4. DIAGNOSTIC
```

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

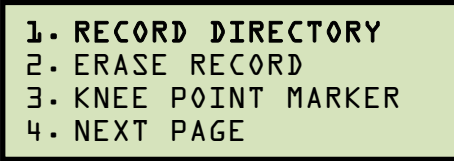
- b. The following screen will be displayed:



```
1. RECORD ID
2. PRINT RECORD
3. RESTORE RECORD
4. NEXT PAGE
```

Press the **[4]** key (*NEXT PAGE*).

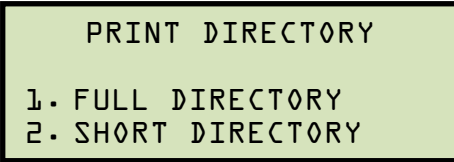
- c. The following screen will be displayed:



```
1. RECORD DIRECTORY
2. ERASE RECORD
3. KNEE POINT MARKER
4. NEXT PAGE
```

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

- d. The following screen will be displayed:



```
PRINT DIRECTORY

1. FULL DIRECTORY
2. SHORT DIRECTORY
```

Press the **[1]** key to print a full directory listing of all the test records stored in the EZCT S2'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 S2'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: S2	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:
MODEL: MITSUBISHI ELECTRIC	S/N:
COMMENTS:	D100739H09M
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:
MODEL: SQ-D	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

### 3.3.4. Erasing Test Records From the Flash EEPROM

You can erase individual or all test records stored in the EZCT S2's Flash EEPROM. To erase a test record:

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

```
1. RUN TEST 09/24/09
2. SETUP    08:20:19
3. TEST PLANS
4. DIAGNOSTIC
```

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

- b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. RESTORE RECORD
4. NEXT PAGE
```

Press the **[4]** key (*NEXT PAGE*).

- c. The following screen will be displayed:

```
1. RECORD DIRECTORY
2. ERASE RECORD
3. KNEE POINT MARKER
4. NEXT PAGE
```

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

- d. The following screen will be displayed:

```
ERASE RECORD

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

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 3.3.3.

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 S2'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.

### 3.4 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 S2's Flash EEPROM. The ability to use test plans makes CT testing an extremely simple process. To perform a test, the EZCT S2 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 12/05/09
2. SETUP    08:20:25
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. NEXT PAGE
```

Press the **[4]** key (*NEXT PAGE*)

- d. The following screen will be displayed:

```
1. EXTRACT TEST PLAN
2. PRINT TEST PLAN
3. ERASE TEST PLAN
```

Press the **[1]** key (*EXTRACT TEST PLAN*)



**NOTE**

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

- e. The following screen will be displayed:



TEST PLAN NUMBER 1  
HAS BEEN SAVED!

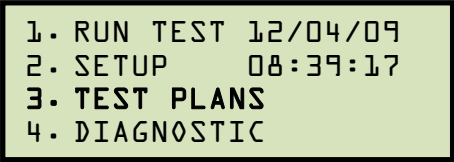
The test plan will be extracted from the test record in the working memory and will be saved to the EZCT S2's Flash EEPROM as a new test plan. The test plan number will be automatically incremented by the EZCT S2.

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

### 3.4.2. Printing a Directory of Test Plans Stored in the EZCT S2's Memory

You can print a directory of all the test plans stored in the EZCT S2's Flash EEPROM using the steps below:

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



```
1. RUN TEST 12/04/09
2. SETUP    08:39:17
3. TEST PLANS
4. DIAGNOSTIC
```

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

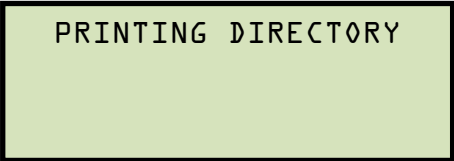
- b. The following screen will be displayed:



```
1. LOAD TEST PLAN
2. UNLOAD TEST PLAN
3. PLAN DIRECTORY
4. NEXT PAGE
```

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
```

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.

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:	
TEST PLAN NUMBER: 128	
NUMBER OF TESTS: 1	
COMPANY:	
STATION:	
CIRCUIT:	
MFR:	
MODEL:	
COMMENTS:	

Figure 8. Typical EZCT S2 Flash EEPROM Test Plan Directory Printout

### 3.4.3. Printing a Test Plan

To print a test plan:

- a. Start from the “START-UP” menu:

```
1. RUN TEST 12/04/09
2. SETUP    09:15:25
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. NEXT PAGE
```

Press the **[4]** key (*NEXT PAGE*).

- c. The following screen will be displayed:

```
1. EXTRACT TEST PLAN
2. PRINT TEST PLAN
3. ERASE TEST PLAN
```

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

- d. 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 9. 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 9. 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)

### 3.4.4. Erasing Test Plans From the Flash EEPROM

To erase one or all test plans from the EZCT S2's Flash EEPROM:

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

```
1. RUN TEST 12/04/09
2. SETUP    09:39:19
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. NEXT PAGE
```

Press the **[4]** key (*NEXT PAGE*).

- c. The following screen will be displayed:

```
1. EXTRACT TEST PLAN
2. PRINT TEST PLAN
3. ERASE TEST PLAN
```

Press the **[3]** key (*ERASE TEST 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 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 return to the "START-UP" menu.

### 3.4.5. Loading a Test Plan from the EZCT S2'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 S2's Flash EEPROM into the working memory:

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

```
1. RUN TEST 09/24/09
2. SETUP    08:20:19
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. NEXT PAGE
```

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

- c. 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 3.4.2.

- d. The following screen will be displayed:

```
TEST PLAN LOADED!
```

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

### 3.4.6. Running a Test Using a Loaded Test Plan

Once a test plan has been loaded into the working memory (see section 3.4.5 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 12/04/09
2. SETUP    10:20:30
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 S2 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 S2 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:

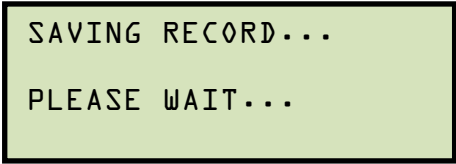
```

SAVE THIS RECORD?
1.YES
2.NO

```

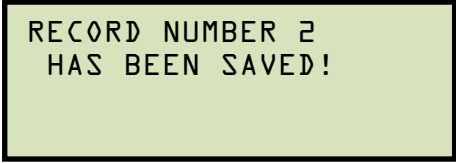
Press the **[1]** key (YES) to save the record.

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.

### 3.4.7. 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 12/04/09
2. SETUP    10:25:35
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. NEXT PAGE
```

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 12/04/09
2. SETUP 10:47:17
3. TEST PLANS
4. DIAGNOSTIC
```

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

- b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. RESTORE RECORD
4. NEXT PAGE
```

Press the **[4]** key (*NEXT PAGE*).

- c. The following screen will be displayed:

```
1. RECORD DIRECTORY
2. ERASE RECORD
3. KNEE POINT MARKER
4. NEXT PAGE
```

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

- d. The following screen will be displayed:

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

Press either the **[1]** key (*IEEE 30 DEGREE*), the **[2]** key (*IEEE 45 DEGREE*), or the **[3]** key (*ASA 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 10.



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

**NOTE**

```
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.

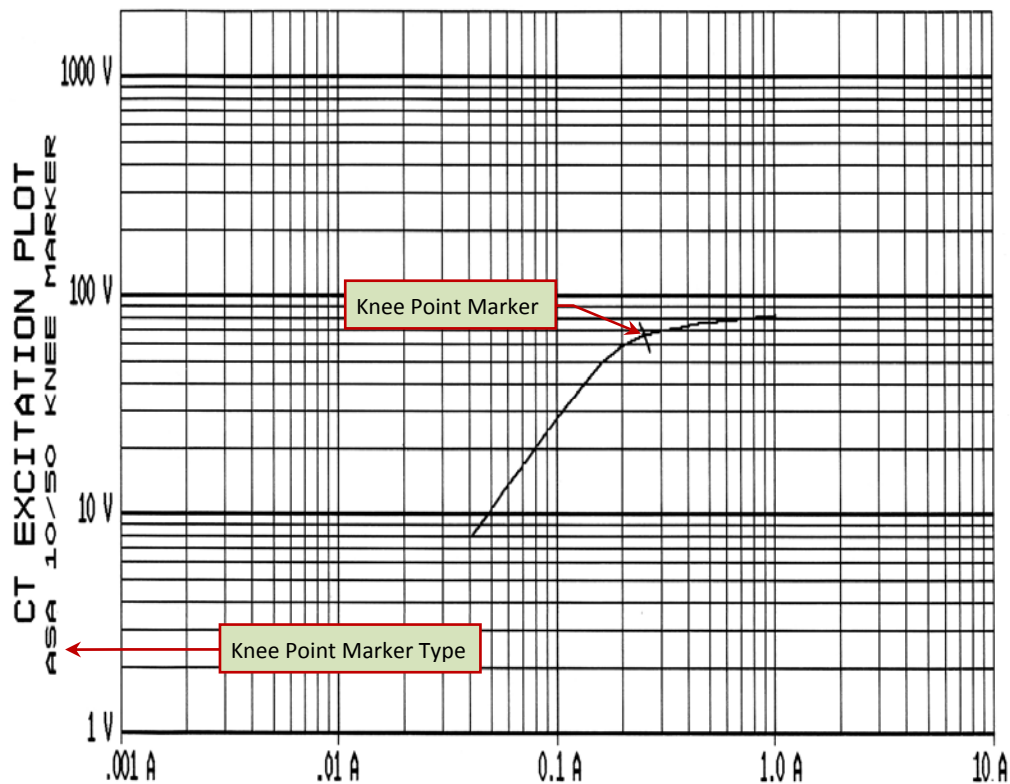


Figure 10. Graphic Report Showing Knee Point Marker

## 4.2 Selecting the Buried CT in Transformer Delta Option

The EZCT S2 can be used to measure the turns ratio of a CT buried in the transformer Delta windings (see Figure 11 and Figure 12 for further information). However, in order for the unit to correctly calculate the turns ratio of a CT buried in the transformer Delta windings, the "CT Buried in Delta" option must first be selected. Use the steps below to set the "Buried CT in Delta" option:

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

```
1. RUN TEST 09/24/09
2. SETUP    08:20:19
3. TEST PLANS
4. DIAGNOSTIC
```

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

- b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. RESTORE RECORD
4. NEXT PAGE
```

Press the **[4]** key (*NEXT PAGE*).

- c. The following screen will be displayed:

```
1. RECORD DIRECTORY
2. ERASE RECORD
3. KNEE POINT MARKER
4. NEXT PAGE
```

Press the **[4]** key (*NEXT PAGE*).

- d. The following screen will be displayed:

```
1. SET TIME
2. BURIED CT IN DELTA
```

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

- e. 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.

**NOTE**

The “Buried CT in Delta” option will stay active for all subsequent tests performed. Turning off the EZCT S2 will reset this option.

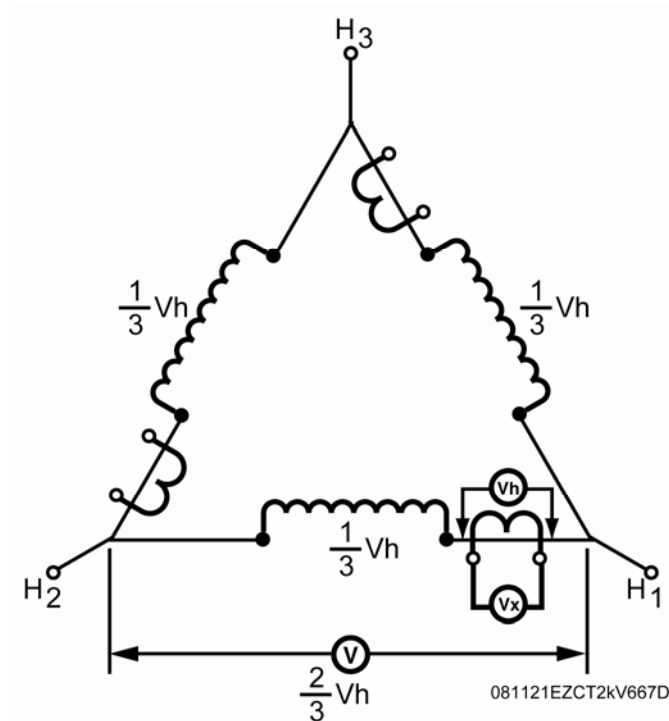


Figure 11. Buried CT in a Delta Transformer Illustration 1

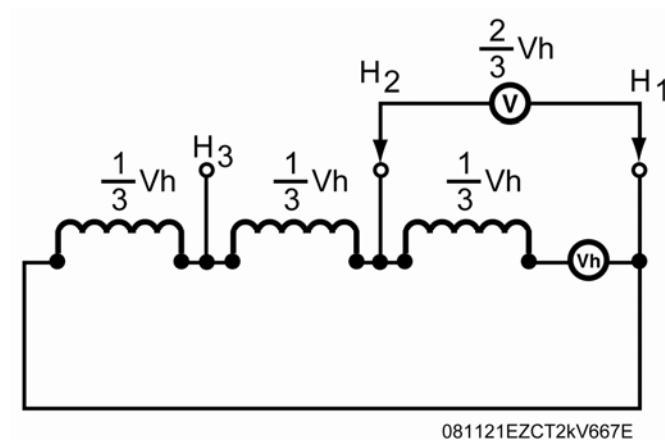


Figure 12. Buried CT in a Delta Transformer Illustration 2

**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 S2 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 S2's internal clock:

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

```
1. RUN TEST 12/04/09
2. SETUP    11:11:11
3. TEST PLANS
4. DIAGNOSTIC
```

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

- b. The following screen will be displayed:

```
1. RECORD ID
2. PRINT RECORD
3. RESTORE RECORD
4. NEXT PAGE
```

Press the **[4]** key (*NEXT PAGE*).

- c. The following screen will be displayed:

```
1. RECORD DIRECTORY
2. ERASE RECORD
3. KNEE POINT MARKER
4. NEXT PAGE
```

Press the **[4]** key (*NEXT PAGE*).

- d. The following screen will be displayed:

```
1. SET TIME
2. BURIED CT IN DELTA
```

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

- e. 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.

## 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 09/24/09
2. SETUP    08:20:19
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 = 3.3  Ix = 0.0227
Vh = 0.03
↑/↓ - "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 S2's $V_x$ Sense Circuit Using an External Meter

The excitation voltage ( $V_x$ ) sensed by the EZCT S2 can be verified using an external RMS volt meter. Follow the steps below to verify the EZCT S2's  $V_x$  sense circuit:

- Connect the X cables to an RMS volt meter as shown in Figure 13.
- Select the EZCT S2'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 S2 LCD screen against the value displayed on the external volt meter.
- Press the **[STOP]** key to end the test.

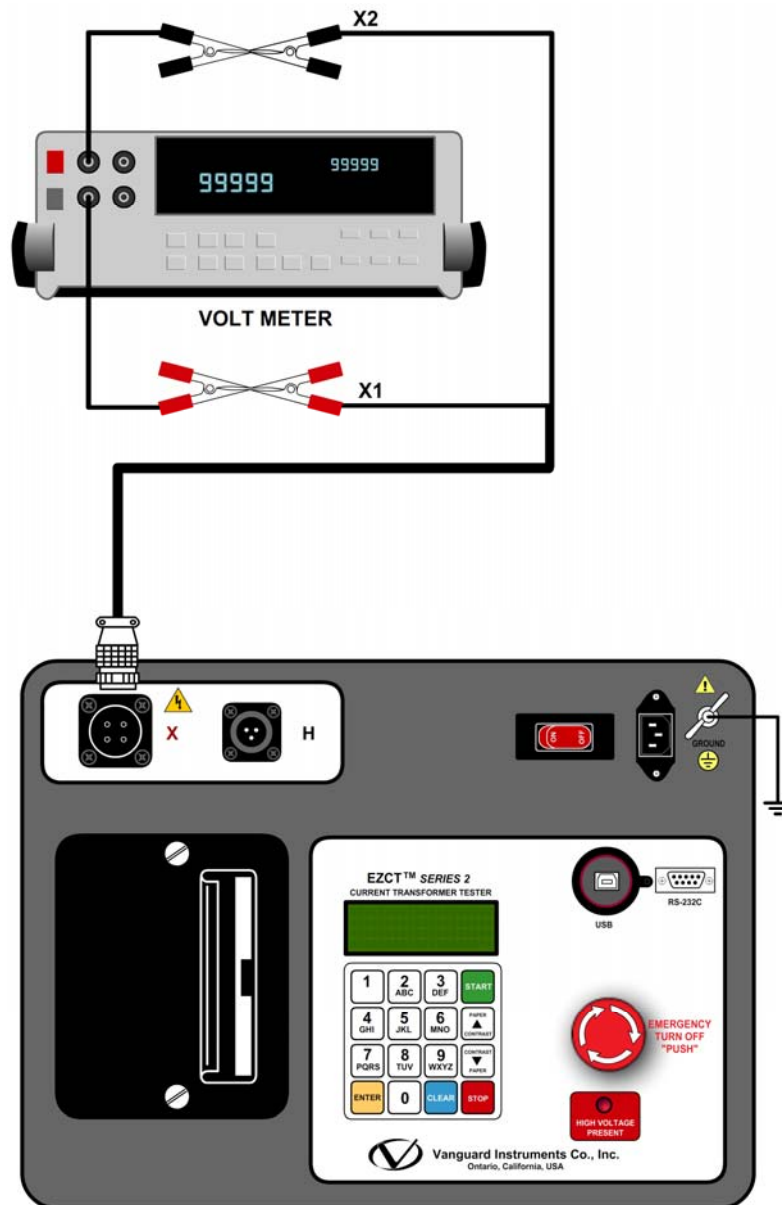


Figure 13. EZCT S2  $V_x$  Verification Test Connections

### 5.3 Verifying the EZCT S2's $I_x$ Sense Circuit Using an External Meter

You can verify the excitation current ( $I_x$ ) sensed by the EZCT S2 by using an external RMS ampere meter. Follow the steps below to verify the EZCT S2's  $I_x$  sense circuit:

- Connect the X cables to a power resistor and an RMS ampere meter as shown in Figure 14.
- Select the EZCT S2'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 S2's LCD screen against the value displayed on the external RMS ampere meter.
- Press the **[STOP]** key to end the test.

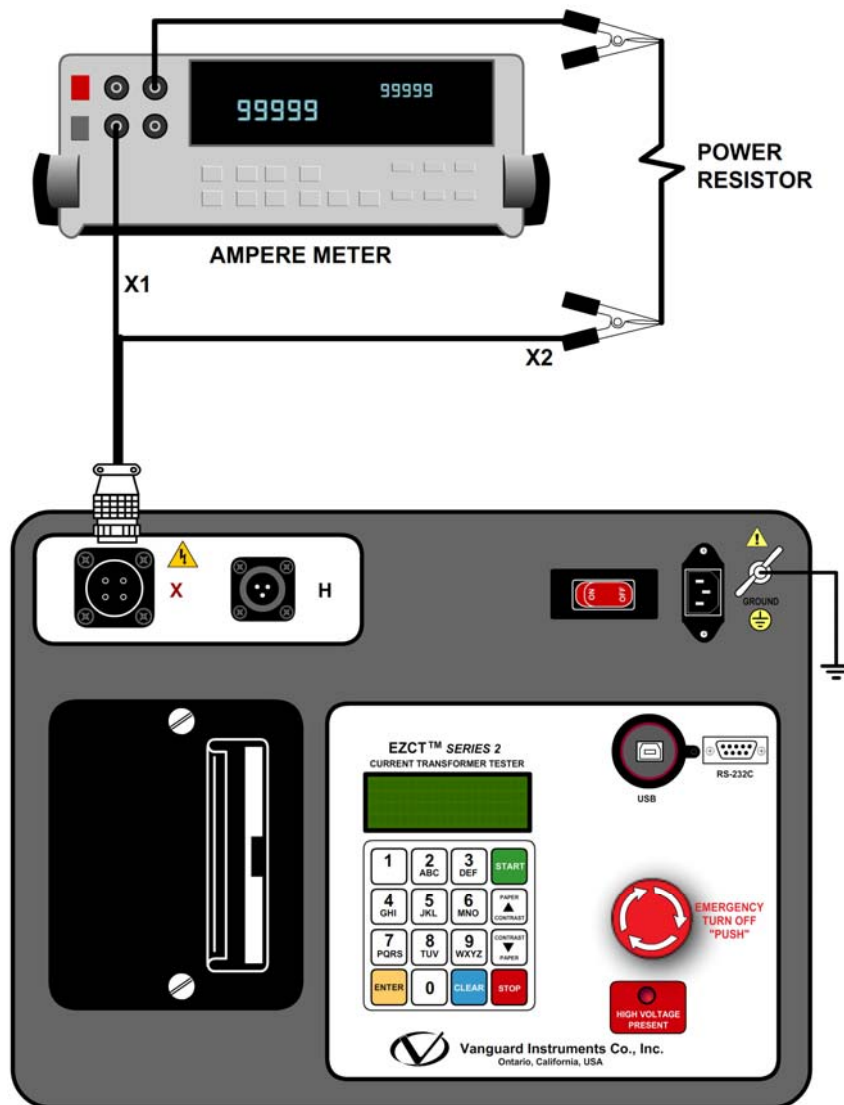


Figure 14. EZCT S2  $I_x$  Verification Test Connections

## 5.4 Quickly Verifying the EZCT S2's Turns Ratio Circuit

You can quickly verify the EZCT S2's turns ratio circuit by performing the following ratio test:

- Connect the X1 test lead to the H1 test lead as shown in Figure 15.
- Connect the X2 test lead to the H2 test lead as shown in Figure 15.
- 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.

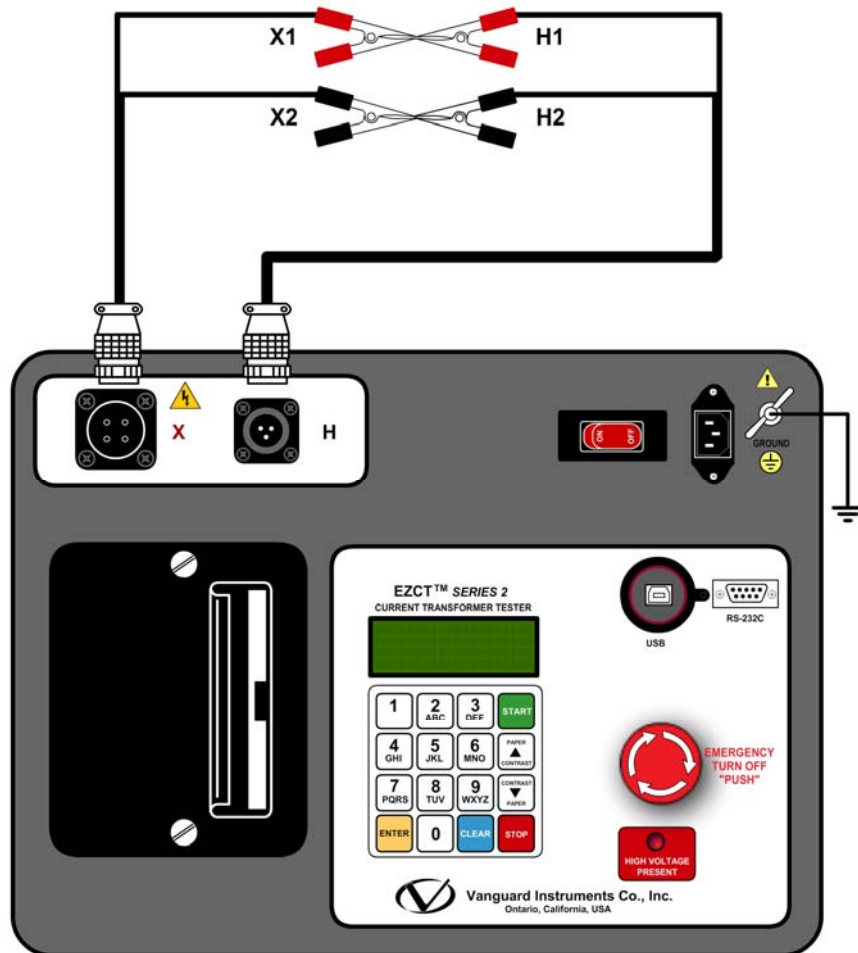


Figure 15. EZCT S2 Turns Ratio Verification Test Connections

## 5.5 Troubleshooting Guide

PROBLEM DESCRIPTION	Probable Cause	Suggested Solution
<b>When running the excitation test, the <math>V_x</math> voltage is always zero. The excitation current can be raised during a test.</b>	<ul style="list-style-type: none"> <li>The EZCT S2 X cables are driving a short circuit.</li> </ul>	<ul style="list-style-type: none"> <li>Check CT shorting screws.</li> <li>Check X lead connections.</li> </ul>
<b>When running the excitation test, the <math>V_x</math> voltage can be raised but the excitation current is always zero during a test.</b>	<ul style="list-style-type: none"> <li>The EZCT S2 X cable is driving an opened circuit.</li> </ul>	<ul style="list-style-type: none"> <li>Check the CT terminal connection.</li> </ul>
<b>Cannot reach the CT knee point voltage (the current did not reach at least 1A)</b>	<ul style="list-style-type: none"> <li>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.</li> </ul>	<ul style="list-style-type: none"> <li>Select a higher test voltage for the test.</li> </ul>
<b>When running the excitation test, the <math>V_x</math> reading is erratic.</b>	<ul style="list-style-type: none"> <li>The EZCT S2 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 <math>V_x</math> readings will be erratic.</li> </ul>	<ul style="list-style-type: none"> <li>Remove X cables from the EZCT S2 and the CT terminals.</li> <li>Check cable integrity using an Ohm Meter.</li> </ul>
<b>The turns ratio reading is incorrect.</b>	<ul style="list-style-type: none"> <li>No H cable connection.</li> <li>No excitation voltage</li> </ul>	<ul style="list-style-type: none"> <li>Check the H cable connection.</li> <li>Check the X cable connection.</li> </ul>
<b>Saturation test is correct but turns ratio test is erroneous.</b>	<ul style="list-style-type: none"> <li><math>V_H</math> cables problem.</li> </ul>	<ul style="list-style-type: none"> <li>Check the <math>V_H</math> cable connection.</li> <li>Check the <math>V_H</math> cable integrity with an Ohmmeter</li> </ul>
<b>Turns ratio test of a CT mounted on a transformer bushing is incorrect.</b>	<ul style="list-style-type: none"> <li>Transformer windings opposite side of CT windings may not be shorted.</li> </ul>	<ul style="list-style-type: none"> <li>See Figure 4.</li> </ul>

## 6.0 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 16.

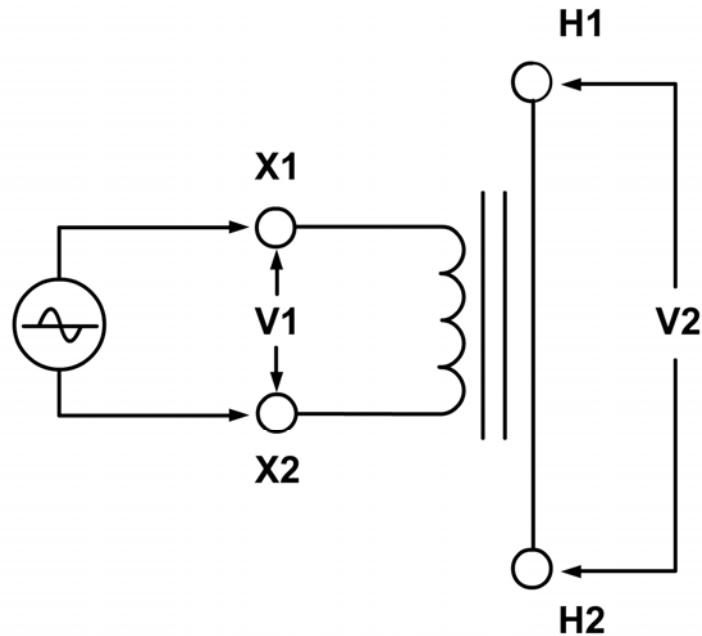


Figure 16

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 17 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:

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

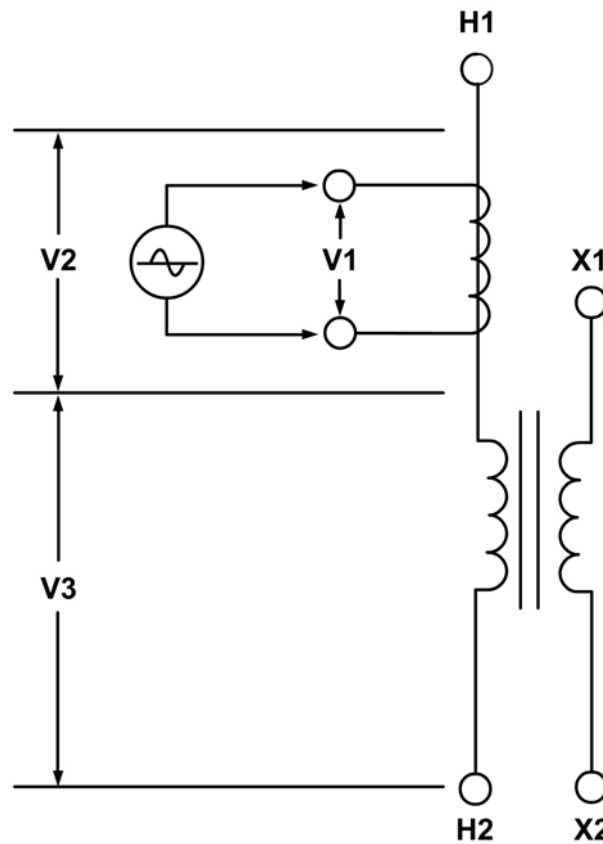


Figure 17

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 18. By shorting out the transformer secondary winding, the user can eliminate most of the V3 voltage ( $V3=0V$ ).

Now the turns-ratio will be:

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

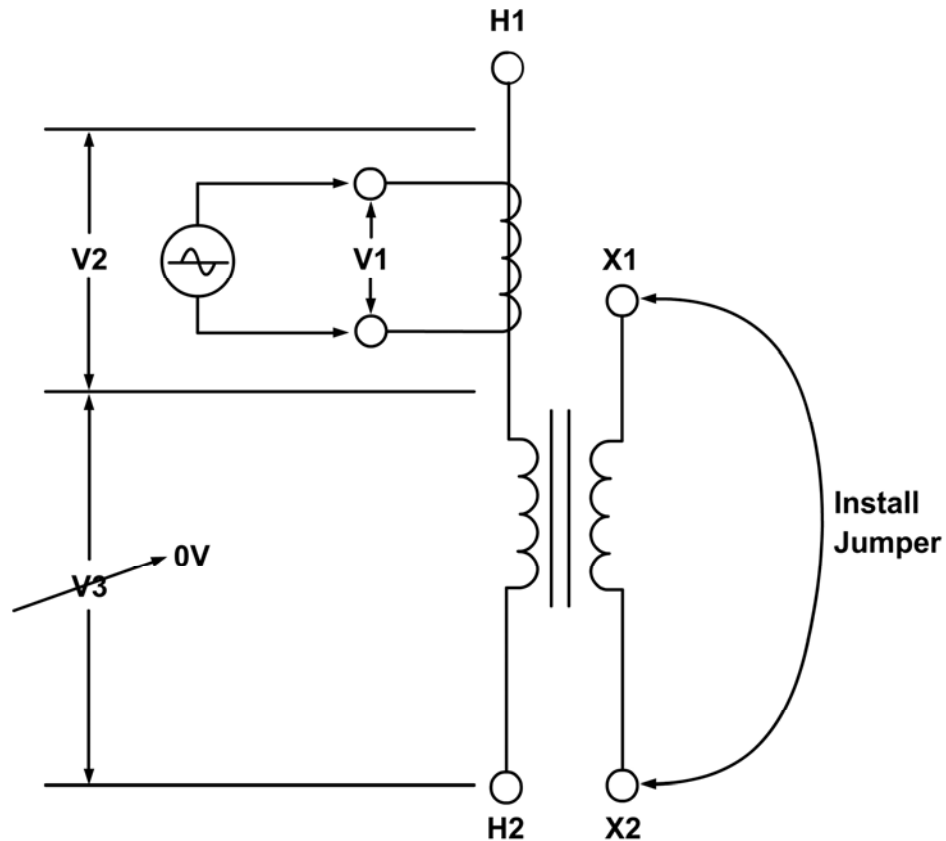


Figure 18

Figure 19 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:

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

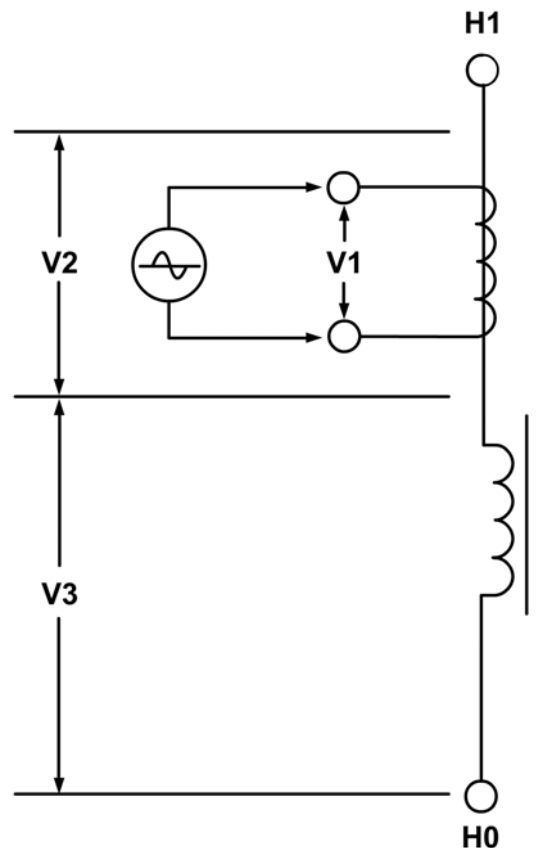


Figure 19

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 20 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:

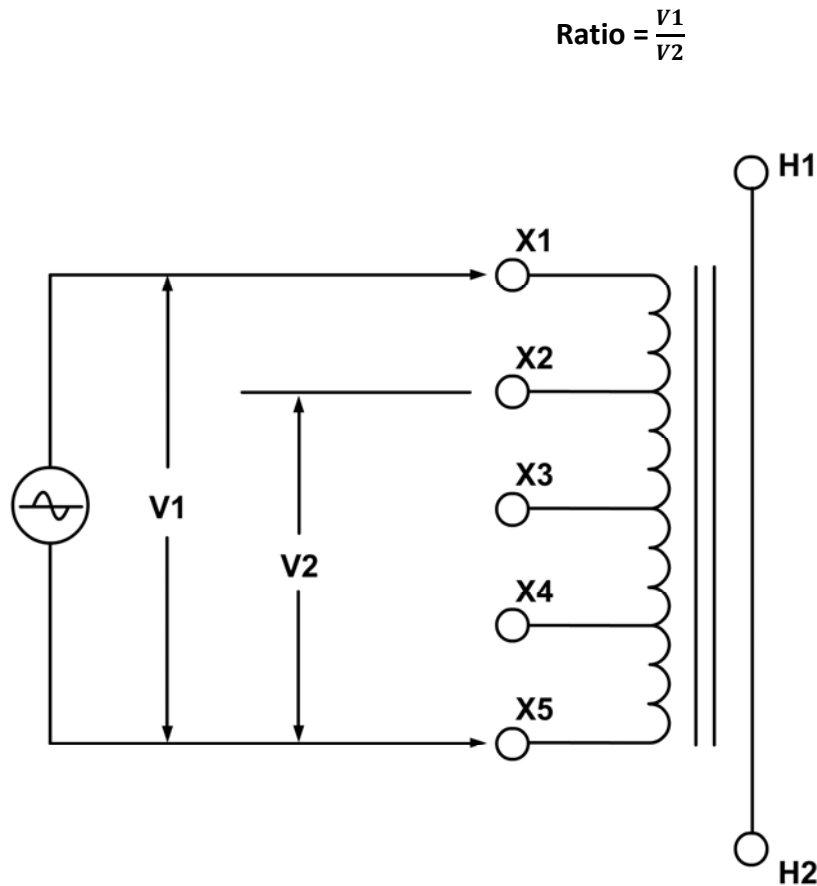


Figure 20

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:

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

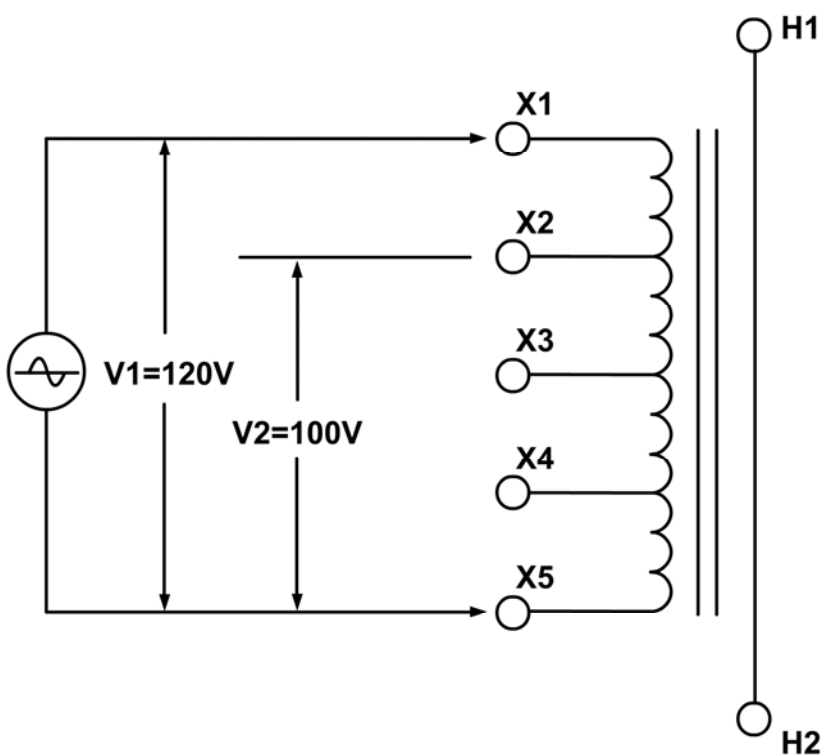


Figure 21

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

# ALSTOM SHUNT REACTOR

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

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

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

RATED VOLTAGE (kV) <div style="text-align: center; font-size: 1.2em;">345</div>	PHASORIAL DIAGRAM 	TEMPERATURES (°C) MAXIMUM AMBIENT TEMPERATURE 40 MINIMUM AMBIENT TEMPERATURE -30 TOP OIL RISE 55 WINDING AVERAGE RISE 50 HOT SPOT RISE 65	CORE AND COILS MASS <div style="text-align: right;">70768 lb 32100 kg</div>																																																											
RATED POWER (MVAR) <div style="text-align: center; font-size: 1.2em;">50</div>			OIL MASS <div style="text-align: right;">48921 lb 22190 kg</div>																																																											
SHUNT REACTOR TERMINALS <table border="1" style="width: 100%;"> <tr> <th>LINE H1, H2, H3</th> <th>NEUTRAL H0</th> </tr> <tr> <td>RATED VOLTAGE (V)</td> <td>RATED CURRENT (A)</td> </tr> <tr> <td>345000</td> <td>83.67</td> </tr> </table>	LINE H1, H2, H3	NEUTRAL H0	RATED VOLTAGE (V)	RATED CURRENT (A)	345000	83.67		OIL VOLUME <div style="text-align: right;">6586 gal 24930 l</div>	TANK AND FITTINGS MASS <div style="text-align: right;">41006 lb 18600 kg</div>																																																					
LINE H1, H2, H3	NEUTRAL H0																																																													
RATED VOLTAGE (V)	RATED CURRENT (A)																																																													
345000	83.67																																																													
INSULATION LEVELS <table border="1" style="width: 100%;"> <thead> <tr> <th></th> <th>LINE</th> <th>NEUTRAL</th> </tr> </thead> <tbody> <tr> <td>RATED SYSTEM VOLTAGE (V rms)</td> <td>345</td> <td>-</td> </tr> <tr> <td>IMPULSE LEVEL IRL WINDINGS (V crest)</td> <td>1300</td> <td>200</td> </tr> <tr> <td>IMPULSE LEVEL IRL BUSHINGS (V crest)</td> <td>1300</td> <td>200</td> </tr> <tr> <td>SWITCHING SURGE LEVEL (V crest)</td> <td>1080</td> <td>-</td> </tr> <tr> <td>APPLIED VOLTAGE (V rms)</td> <td>70</td> <td>70</td> </tr> <tr> <td>INDUCED VOLTAGE (V rms) 7200 CYCLES (PHASE TO GROUND)</td> <td>418</td> <td>-</td> </tr> <tr> <td></td> <td>376</td> <td>-</td> </tr> </tbody> </table>		LINE	NEUTRAL	RATED SYSTEM VOLTAGE (V rms)	345	-	IMPULSE LEVEL IRL WINDINGS (V crest)	1300	200	IMPULSE LEVEL IRL BUSHINGS (V crest)	1300	200	SWITCHING SURGE LEVEL (V crest)	1080	-	APPLIED VOLTAGE (V rms)	70	70	INDUCED VOLTAGE (V rms) 7200 CYCLES (PHASE TO GROUND)	418	-		376	-		SHIPPING (WITHOUT OIL) MASS <div style="text-align: right;">100751 lb 45700 kg</div>	COMPLETE REACTOR MASS <div style="text-align: right;">160695 lb 72890 kg</div>																																			
	LINE	NEUTRAL																																																												
RATED SYSTEM VOLTAGE (V rms)	345	-																																																												
IMPULSE LEVEL IRL WINDINGS (V crest)	1300	200																																																												
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SWITCHING SURGE LEVEL (V crest)	1080	-																																																												
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TANK, CONSERVATOR AND RADIATORS WITHSTAND FULL VACUUM			<table border="1" style="width: 100%;"> <thead> <tr> <th colspan="2">CT's 1 to 6 and 13 to 19</th> <th colspan="2">CT's 7 TO 12</th> </tr> <tr> <th>RATIO</th> <th>TERMINAL</th> <th>RATIO</th> <th>TERMINAL</th> </tr> </thead> <tbody> <tr> <td>1200-5A</td> <td>X1-X5</td> <td>5000-5A</td> <td>X1-X5</td> </tr> <tr> <td>1000-5A</td> <td>X2-X5</td> <td>4000-5A</td> <td>X1-X4</td> </tr> <tr> <td>900-5A</td> <td>X3-X5</td> <td>3500-5A</td> <td>X2-X5</td> </tr> <tr> <td>800-5A</td> <td>X1-X4</td> <td>3000-5A</td> <td>X3-X5</td> </tr> <tr> <td>600-5A</td> <td>X2-X4</td> <td>2500-5A</td> <td>X2-X4</td> </tr> <tr> <td>500-5A</td> <td>X3-X4</td> <td>2000-5A</td> <td>X3-X4</td> </tr> <tr> <td>400-5A</td> <td>X4-X5</td> <td>1500-5A</td> <td>X1-X2</td> </tr> <tr> <td>300-5A</td> <td>X1-X3</td> <td>1000-5A</td> <td>X4-X5</td> </tr> <tr> <td>200-5A</td> <td>X1-X2</td> <td>500-5A</td> <td>X2-X3</td> </tr> <tr> <td>100-5A</td> <td>X2-X3</td> <td></td> <td></td> </tr> </tbody> </table>	CT's 1 to 6 and 13 to 19		CT's 7 TO 12		RATIO	TERMINAL	RATIO	TERMINAL	1200-5A	X1-X5	5000-5A	X1-X5	1000-5A	X2-X5	4000-5A	X1-X4	900-5A	X3-X5	3500-5A	X2-X5	800-5A	X1-X4	3000-5A	X3-X5	600-5A	X2-X4	2500-5A	X2-X4	500-5A	X3-X4	2000-5A	X3-X4	400-5A	X4-X5	1500-5A	X1-X2	300-5A	X1-X3	1000-5A	X4-X5	200-5A	X1-X2	500-5A	X2-X3	100-5A	X2-X3			<table border="1" style="width: 100%;"> <thead> <tr> <th colspan="2">CT WTI</th> </tr> <tr> <th>RATIO</th> <th>TERMINAL</th> </tr> </thead> <tbody> <tr> <td>500-5A</td> <td>X1-X2</td> </tr> <tr> <td>CLASS</td> <td>C800</td> </tr> <tr> <td>FUNCTION</td> <td>RELAYING</td> </tr> </tbody> </table>	CT WTI		RATIO	TERMINAL	500-5A	X1-X2	CLASS	C800	FUNCTION	RELAYING
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ALSTOM Grid Energia Ltda. AV. GUILHERME SCHELL, 11500 CANOAS - RS CNPJ: 05.356.949/0009-08 MADE IN BRAZIL

Figure 22



Figure 23



**Vanguard Instruments  
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