ATRT-03, ATRT-03A, and ATRT-03B

THREE-PHASE TRANSFORMER TURNS-RATIO METERS

USER'S MANUAL

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SAFETY SUMMARY

This manual applies to the ATRT-03, ATRT-03A, and ATRT-03B current transformer turns-ratio meters. The operating procedures are virtually the same for all three models, and any differences are clearly described where applicable.

FOLLOW EXACT OPERATING PROCEDURES

Any deviation from procedures described in this User's Manual may create one or more safety hazards, damage the ATRT-03/03A/03B, damage the test transformer, or cause errors in the test results. Vanguard Instruments Company, Inc. assumes no liability for unsafe or improper use of the ATRT-03/03A/03B.

SAFETY WARNINGS AND CAUTIONS

The ATRT-03/03A/03B shall be used only by **trained operators**. All transformers under test shall be **off-line** and **fully isolated**. Always ground the ATRT-03/03A/03B to a substation ground before connecting the test cables to a transformer. Do not perform test procedures or service unless another person is also present who is capable of rendering aid and resuscitation.

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 ATRT-03/03A/03B test unit. To ensure that all designed safety features are maintained, it is highly recommended that repairs be performed only by Vanguard Instruments Company factory personnel or by an authorized repair service provider. Unauthorized modifications can cause safety hazards and will void the manufacturer's warranty.

WARNING

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

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CONVENTIONS USED IN THIS DOCUMENT

This document uses the following conventions:

- The general term "ATRT" is used in this manual to refer to any of the ATRT-03 models (ATRT-03, ATRT-03A, and ATRT-03B).
- A key, switch, or knob on the ATRT is indicated as **[KEY], [SWITCH], [KNOB]**.
- Menu names are referenced as "MENU NAME"
- ATRT 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** (option 3 should be selected):

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


- 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 ATRT-03 line is Vanguard's second generation family of microprocessor-based, automatic, three phase, transformer turns-ratio testers. The ATRT-03 line consists of the following three models:

- The ATRT-03 is a line-powered, 120/240 Vac (selectable), 50/60 Hz turns-ratio tester featuring a built-in thermal printer.
- The ATRT-03A can be powered either by an internal rechargeable lead acid battery, by 90-240 Vac, by 110-240 Vdc, or by a 12 Vdc external source. The internal battery provides 3 hours of operational time. The ATRT-03A also features a built-in thermal printer.
- The ATRT-03B is a line-powered, 120/240 Vac (selectable), 50/60 Hz turns-ratio tester without a built-in thermal printer.

The general term "ATRT-03" or "ATRT" is used in this manual to refer to any of the ATRT-03 models. Any differences are clearly described where applicable.

The ATRT-03 determines the transformer turns-ratio using the IEEE C57.12.90 measurement method. The transformer turns-ratio (ranging from 0.8 to 15,000) is determined by precisely measuring the voltages across the unloaded transformer windings. To ensure accuracy, the ATRT-03's measuring circuitry self-calibrates before each measurement. It requires neither adjustment nor temperature compensation. The ATRT-03's turns-ratio measurement accuracy is 0.1% or better.

The ATRT-03 can perform a specific test for each transformer type (such as single phase, delta to Y, Y to delta, delta to delta, or Y to Y) without the need to switch test hookup cables. Also, the unit's automatic transformer phase detection feature can detect different transformer vector diagrams. The ATRT-03 can automatically detect and test 67 transformer types defined by ANSI, CEI/IEC and Australian standards.

Transformer Test Voltage

To prevent an accidental wrong test-lead hook-up (e.g., when the operator reverses H and X leads), the ATRT-03 outputs a low-level test voltage to verify the hook-up condition before applying the full test voltage to the transformer. Three test voltages (8 Vac, 40 Vac, 100 Vac) allow the ATRT-03 to test CT's and PT's, as well as power transformers.

User Interface

The ATRT-03 features a back-lit LCD screen (20 characters by 4 lines) that is viewable in both bright sunlight and low-light levels. The test results screen displays the transformer turns-ratio, excitation current, and turns-ratio accuracy. The unit is controlled via a rugged, 16-key, membrane keypad.

Transformer Test Plans

The ATRT-03 can store up to 128 transformer test-plans in its Flash EEPROM. A test plan is comprised of the transformer nameplate voltages for each tap setting. The calculated turns-ratio based on the nameplate voltages is compared with the measured turns-ratio. By recalling a test plan, a transformer can be quickly tested and turns-ratio Pass/Fail reports can be reviewed. Test plans can be created with the included PC software and can be transferred to the ATRT-03 via the RS-232C interface.

Internal Test Record Storage

Up to 200 test records can be stored in the ATRT-03's Flash EEPROM memory. Each test record may contain up to 99 turns-ratio, excitation current, phase angle, and nameplate voltage readings. Test records can be recalled locally or transferred to a PC via the RS-232C interface.

Computer Interface

The ATRT-03 can be computer-controlled via the RS-232C interface using the supplied PC software. The Windows® XP/Vista-based software can be used to run a test and to store test results on a PC. Test results can also be exported to Microsoft® Excel.

Transformer Load Tap Changer Control

An optional Tap-Changer Remote Control Box can be used to remotely change transformer taps. This remote-controlled tap-changer box eliminates the need to manually change the transformer's step-up and step-down taps.

Built-in Thermal Printer (ATRT-03 and ATRT-03A only)

A built-in 4.5-inch wide thermal printer prints test results in a 14 point font for easy viewing. The printer and paper dispenser are mounted under the front panel for protection.

1.2 Technical Specifications

1.2.1. ATRT-03 Technical Specifications

Table 1. ATRT-03 Technical Specifications

TYPE	Portable, lightweight, automatic, three-phase transformer turns-ratio meter
PHYSICAL SPECIFICATIONS	17"W x 7"H x 13"D (43.2cm x 17.8 cm x 33.0 cm); Weight: 14 lbs (6.4 kg)
INPUT POWER	3 amps, 110 – 120 Vac or 220 – 240 Vac (selectable), 50/60 Hz
MEASUREMENT METHOD	ANSI/IEEE C57.12.90
RATIO-MEASURING RANGE	0.8 – 15,000 (5-digit resolution)
TURNS-RATIO ACCURACY	0.8 – 1999: ±0.1%, 2,000 – 3,999: ±0.25%, 4,000 – 15,000: ±1% @ 8 Vac 0.8 – 1999: ±0.1%, 2,000 – 3,999: ±0.20%, 4,000 – 15,000: ±1% @ 40 Vac 0.8 – 1999: ±0.1%, 2,000 – 3,999: ±0.15%, 4,000 – 15,000: ±1% @ 100 Vac
ADJUSTMENT	None required
TEST VOLTAGES	8 Vac @ 1 amp, 40 Vac @ 0.6 amp, 100 Vac @ 0.1 amp
EXCITATION CURRENT READING RANGE	0 – 2 Amperes; Accuracy: ±1mA, ±2% of reading (±1 digit)
PHASE-ANGLE MEASUREMENT	0 – 360 degrees; Accuracy: ±0.2 degrees (±1 digit)
DISPLAY	Back-lit LCD screen (20 Characters by 4 Lines); Viewable in bright sunlight and low-light levels
PRINTER	Built-in 4.5-inch wide thermal printer
COMPUTER INTERFACE	RS-232C (19,200 baud) port
PC SOFTWARE	Windows® XP/Vista-based Transformer Turns-Ratio Analyzer application is included with purchase price
INTERNAL TEST RECORD STORAGE	Stores 200 complete transformer test records. Each test record includes nameplate voltage, winding turns-ratios, excitation current, and winding phase angle.
INTERNAL TEST PLAN STORAGE	Stores up to 128 transformer test plans
SAFETY	UL Certified (UL 61010A-1), CAN/CSA Certified (C22.2 No. 1010.1-92)
ENVIRONMENT	Operating: -10° to 50° C (15° to +122° F); Storage: -30° C to 70° C (-22° to +158° F)
HUMIDITY (MAX)	90% RH @ 40° C (104° F) non-condensing
ALTITUDE (MAX)	2000m (6562 ft) to fully safety specifications
CABLES	One 15-foot single-phase cable set, One 15-foot 3-phase cable set, One 25-foot extension cable set, One cable-carrying duffel bag included
OPTIONS	Transportation case, transformer tap-changer remote control device
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.

1.2.2. ATRT-03A Technical Specifications

Table 2. ATRT-03A Technical Specifications

TYPE	Portable, lightweight, automatic, battery-powered three-phase transformer turns-ratio meter
PHYSICAL SPECIFICATIONS	19"W x 7"H x 15"D (48.2cm x 17.8 cm x 38.1 cm); Weight: 25 lbs (11.3 kg)
INPUT POWER	3 amps, 85 – 264 Vac or 110 – 370 Vdc or 12 Vdc
BATTERIES	Two 12Vdc/2AH, rechargeable Sealed Lead Acid batteries (up to 3-hours operation)
MEASUREMENT METHOD	ANSI/IEEE C57.12.90
RATIO-MEASURING RANGE	0.8 – 15,000 (5-digit resolution)
TURNS-RATIO ACCURACY	0.8 – 1999: ±0.1%, 2,000 – 3,999: ±0.25%, 4,000 – 15,000: ±1% @ 8 Vac 0.8 – 1999: ±0.1%, 2,000 – 3,999: ±0.20%, 4,000 – 15,000: ±1% @ 40 Vac 0.8 – 1999: ±0.1%, 2,000 – 3,999: ±0.15%, 4,000 – 15,000: ±1% @ 100 Vac
ADJUSTMENT	None required
TEST VOLTAGES	8 Vac @ 350 mA, 40 Vac @ 70 mA, 100 Vac @ 20 mA
EXCITATION CURRENT READING RANGE	0 – 2 Amperes; Accuracy: ±1mA, ±2% of reading (±1 digit)
PHASE-ANGLE MEASUREMENT	0 – 360 degrees; Accuracy: ±0.2 degrees (±1 digit)
DISPLAY	Back-lit LCD screen (20 Characters by 4 Lines); Viewable in bright sunlight and low-light levels
PRINTER	Built-in 4.5-inch wide thermal printer
COMPUTER INTERFACE	RS-232C (19,200 baud) port
PC SOFTWARE	Windows® XP/Vista-based Transformer Turns-Ratio Analyzer application is included with purchase price
INTERNAL TEST RECORD STORAGE	Stores 200 complete transformer test records. Each test record includes nameplate voltage, winding turns-ratios, excitation current, and winding phase angle.
INTERNAL TEST PLAN STORAGE	Stores up to 128 transformer test plans
SAFETY	Designed to meet UL 61010A-1 and CAN/CSA C22.2 No. 1010.1-92 standards
ENVIRONMENT	Operating: -10˚ to 50˚ C (15˚ to +122˚ F); Storage: -30˚ C to 70˚ C (-22˚ to +158˚ F)
HUMIDITY (MAX)	90% RH @ 40˚ C (104˚ F) non-condensing
ALTITUDE (MAX)	2000m (6562 ft) to fully safety specifications
CABLES	One 15-foot single-phase cable set, One 15-foot 3-phase cable set, One 25-foot extension cable set, One cable-carrying duffel bag included
OPTIONS	Transportation case, transformer tap-changer remote control device
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.

1.2.3. ATRT-03B Technical Specifications

Table 3. ATRT-03B Technical Specifications

TYPE	Portable, lightweight, automatic, three-phase transformer turns-ratio meter
PHYSICAL SPECIFICATIONS	17"W x 7"H x 13"D (43.2cm x 17.8 cm x 33.0 cm); Weight: 13 lbs (5.9 kg)
INPUT POWER	3 amps, 110 – 120 Vac or 220 – 240 Vac (selectable), 50/60 Hz
MEASUREMENT METHOD	ANSI/IEEE C57.12.90
RATIO-MEASURING RANGE	0.8 – 15,000 (5-digit resolution)
TURNS-RATIO ACCURACY	0.8 – 1999: ±0.1%, 2,000 – 3,999: ±0.25%, 4,000 – 15,000: ±1% @ 8 Vac 0.8 – 1999: ±0.1%, 2,000 – 3,999: ±0.20%, 4,000 – 15,000: ±1% @ 40 Vac 0.8 – 1999: ±0.1%, 2,000 – 3,999: ±0.15%, 4,000 – 15,000: ±1% @ 100 Vac
ADJUSTMENT	None required
TEST VOLTAGES	8 Vac @ 1 amp, 40 Vac @ 0.6 amp, 100 Vac @ 0.1 amp
EXCITATION CURRENT READING RANGE	0 – 2 Amperes; Accuracy: ±1mA, ±2% of reading (±1 digit)
PHASE-ANGLE MEASUREMENT	0 – 360 degrees; Accuracy: ±0.2 degrees (±1 digit)
DISPLAY	Back-lit LCD screen (20 Characters by 4 Lines); Viewable in bright sunlight and low-light levels
COMPUTER INTERFACE	RS-232C (19,200 baud) port
PC SOFTWARE	Windows® XP/Vista-based Transformer Turns-Ratio Analyzer application is included with purchase price
INTERNAL TEST RECORD STORAGE	Stores 200 complete transformer test records. Each test record includes nameplate voltage, winding turns-ratios, excitation current, and winding phase angle.
INTERNAL TEST PLAN STORAGE	Stores up to 128 transformer test plans
SAFETY	Designed to meet UL 61010A-1 and CAN/CSA C22.2 No. 1010.1-92 standards
ENVIRONMENT	Operating: -10˚ to 50˚ C (15˚ to +122˚ F); Storage: -30˚ C to 70˚ C (-22˚ to +158˚ F)
HUMIDITY (MAX)	90% RH @ 40˚ C (104˚ F) non-condensing
ALTITUDE (MAX)	2000m (6562 ft) to fully safety specifications
CABLES	One 15-foot single-phase cable set, One 15-foot 3-phase cable set, One 25-foot extension cable set, One cable-carrying duffel bag included
OPTIONS	Transportation case, transformer tap-changer remote control device
WARRANTY	One year on parts and labor

NOTE

The above specifications are valid at nominal operating voltage and at a temperature of 25°C (77°F). Specifications may change without prior notice.

1.3 Controls and Indicators

The ATRT-03, ATRT-03A, and ATRT-03B controls and indicators are shown in Figure 1, Figure 2, and Figure 3, respectively. A leader line with an index number points to each control and indicator, which is cross-referenced to a functional description in the corresponding table. The purpose of the controls and indicators may seem obvious, but users should familiarize themselves with them before using the ATRT. Accidental misuse of the controls will usually cause no serious harm. Users should also familiarize themselves with the safety summary information found on the front page of this User's Manual.

Figure 1. ATRT-03 Controls and Indicators

Table 4. Functional Descriptions of ATRT-03 Controls and Indicators

Item Number	Panel Markings	Functional Description
1		Back-lit LCD screen (20 characters by 4 lines), viewable in bright sunlight and low-light levels.
2	H	H voltage connector.
3	X	X voltage connector.
4		4.5-inch wide thermal printer.
5	120/240 Vac, 1A, 50/60Hz Fuse: 250Vac, 2A Fast-Blow	Input power connector and fused power switch with third-wire safety ground.
6		Ground stud for connecting to sub-station ground.
7	RS-232C	RS-232C PC interface connector.
8	TEST IN PROGRESS	This LED flashes in response to commands or when a test voltage is applied to the test transformer.
9		Rugged alpha-numeric keypad.
10	EMERGENCY TURN OFF "PUSH"	Emergency turn off test voltage switch.

Figure 2. ATRT-03A Controls and Indicators

Table 5. Functional Descriptions of ATRT-03A Controls and Indicators

Item Number	Panel Markings	Functional Description
1		Back-lit LCD screen (20 characters by 4 lines), viewable in bright sunlight and low-light levels.
2	H	H voltage connector.
3	X	X voltage connector.
4		4.5-inch wide thermal printer.
5	POWER	Power switch.
6	120/240 Vac, 1A, 50/60Hz Fuse: 250Vac, 2A Fast-Blow	Input power connector with third-wire safety ground.
7	GROUND	Ground stud for connecting to sub-station ground.
8	CHARGE	LED is lit when internal batteries are being charged.
9	+12V GROUND	12 VDC input connectors.
10	RS-232C	RS-232C PC interface connector.
11		Rugged alpha-numeric keypad.
12	TEST IN PROGRESS	This LED flashes in response to commands or when a test voltage is applied to the test transformer.
13	EMERGENCY TURN OFF "PUSH"	Emergency turn off test voltage switch.

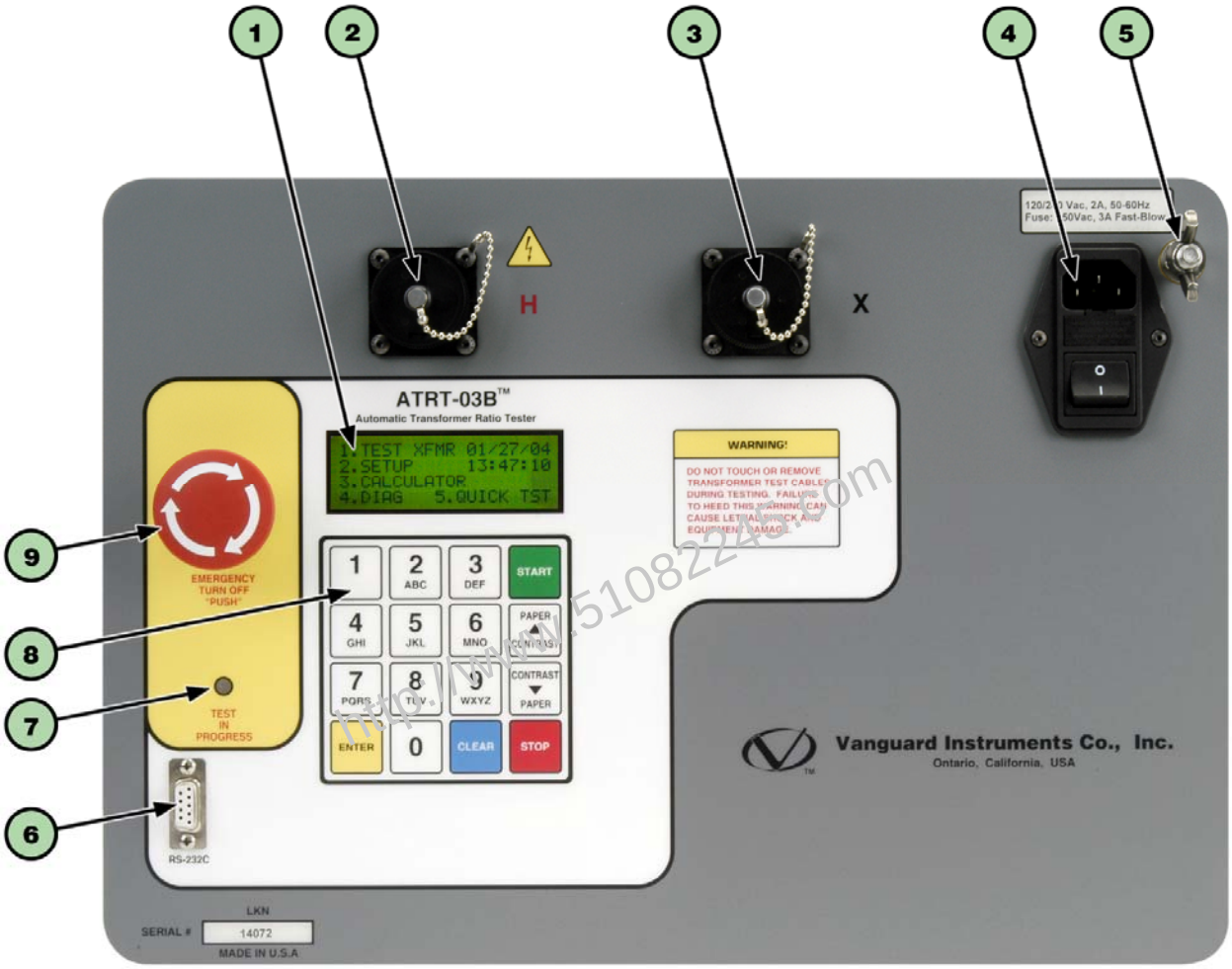


Figure 3. ATRT-03B Controls and Indicators

Table 6. Functional Descriptions of ATRT-03B Controls and Indicators

Item Number	Panel Markings	Functional Description
1		Back-lit LCD screen (20 characters by 4 lines), viewable in bright sunlight and low-light levels.
2	H	H voltage connector.
3	X	X voltage connector.
4	120/240 Vac, 1A, 50/60Hz Fuse: 250Vac, 2A Fast-Blow	Input power connector and fused power switch with third-wire safety ground.
5		Ground stud for connecting to sub-station ground.
6	RS-232C	RS-232C PC interface connector.
7	TEST IN PROGRESS	This LED flashes in response to commands or when a test voltage is applied to the test transformer.
8		Rugged alpha-numeric keypad.
9	EMERGENCY TURN OFF "PUSH"	Emergency turn off test voltage switch.

2.0 PRE-TEST SETUP

2.1 ATRT-03 and ATRT-03B Operating Voltages

The ATRT-03 and ATRT-03B's voltage is preset at the factory and is selectable between 110-120 Vac, 50/60 Hz or 220-240 Vac, 50/60 Hz. The voltage is set by placing jumpers on the reference transformer as listed in Table 7 and illustrated in Figure 4.

Table 7. Voltage Selection Jumper Settings

Voltage Selection	Transformer Jumpers
110 – 120 Vac	Pin 1 & 3, Pin 2 & 4
220 – 240 Vac	Pin 2 & 3

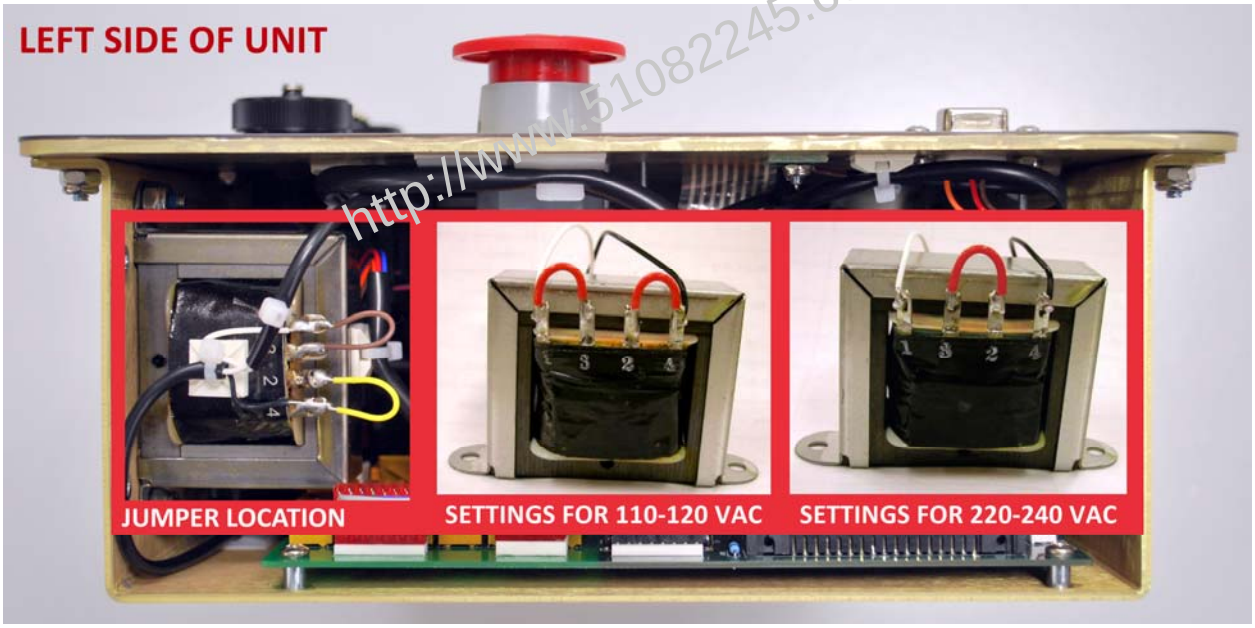


Figure 4. Voltage Selection Jumper Location and Settings

2.2 ATRT-03A Operating Voltages

The ATRT-03A uses a special switching power supply. The input AC receptacle can accept voltages that range from 90-264 Vac or 110-240 Vdc. The ATRT-03A can also accept 12 Vdc from a battery via the front panel jacks.

2.3 LCD Screen Contrast Control

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

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

2.4 Printer Paper Control (ATRT-03 and ATRT-03A Only)

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

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

2.5 Printer Paper (ATRT-03 and ATRT-03A Only)

The ATRT-03 and ATRT-03A's built-in thermal printers use 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

3.0 OPERATING PROCEDURES

The ATRT-03 should always be grounded with the provided ground cable before connecting H and X cables. The transformer bushings should also be grounded before connecting test leads to the transformer. This will prevent inducing any voltages into the ATRT-03. All transformer bus connections must be removed, and the transformer must be isolated before performing any tests. Typical transformer connection diagrams are illustrated in the sections below.

3.1 Connection Diagrams

3.1.1. Typical Front Panel Connections

Figure 5. Typical Front Panel Cable Connections

3.1.2. Typical Connections to a Delta-Wye Transformer

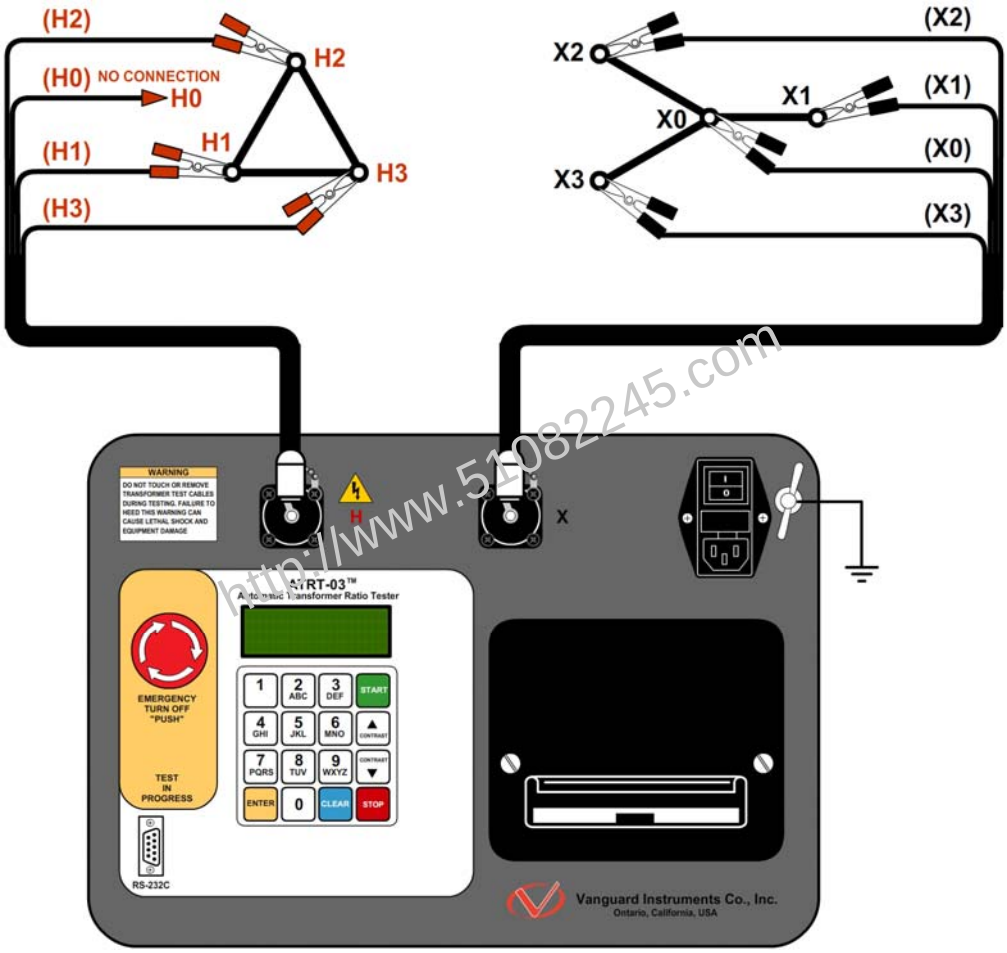


Figure 6. Typical H & X Cable Connections to a Delta-Wye Transformer

3.1.3. Typical Connections to a Single Phase Transformer

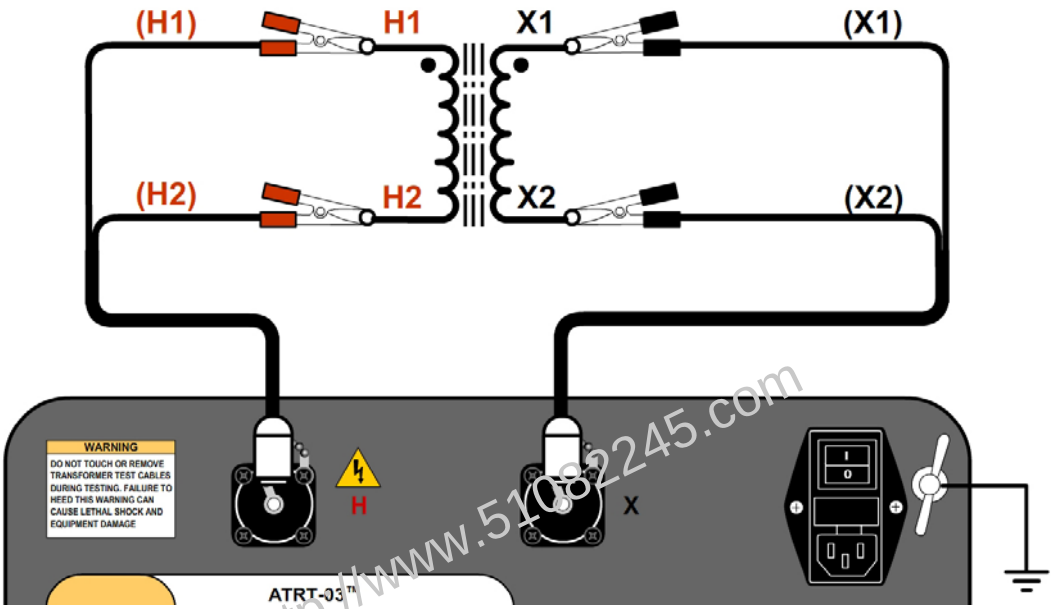


Figure 7. Typical Connections to a Single Phase Transformer

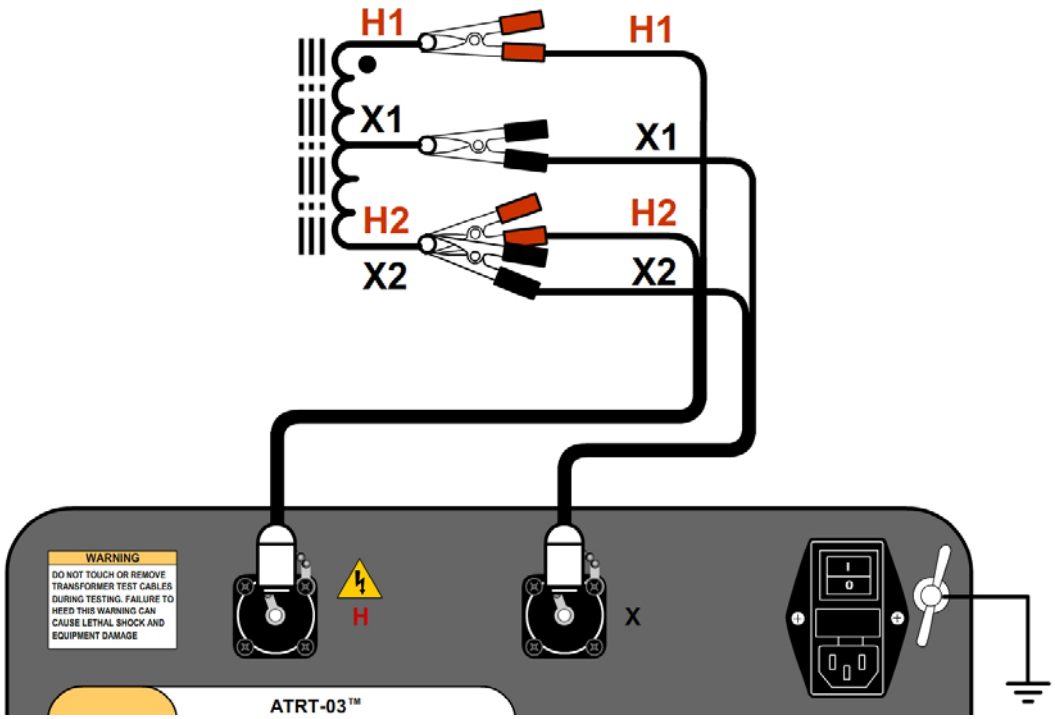


Figure 8. Typical Connections to a Single Phase Auto Transformer

3.1.4. Typical Connections to a Voltage Regulator

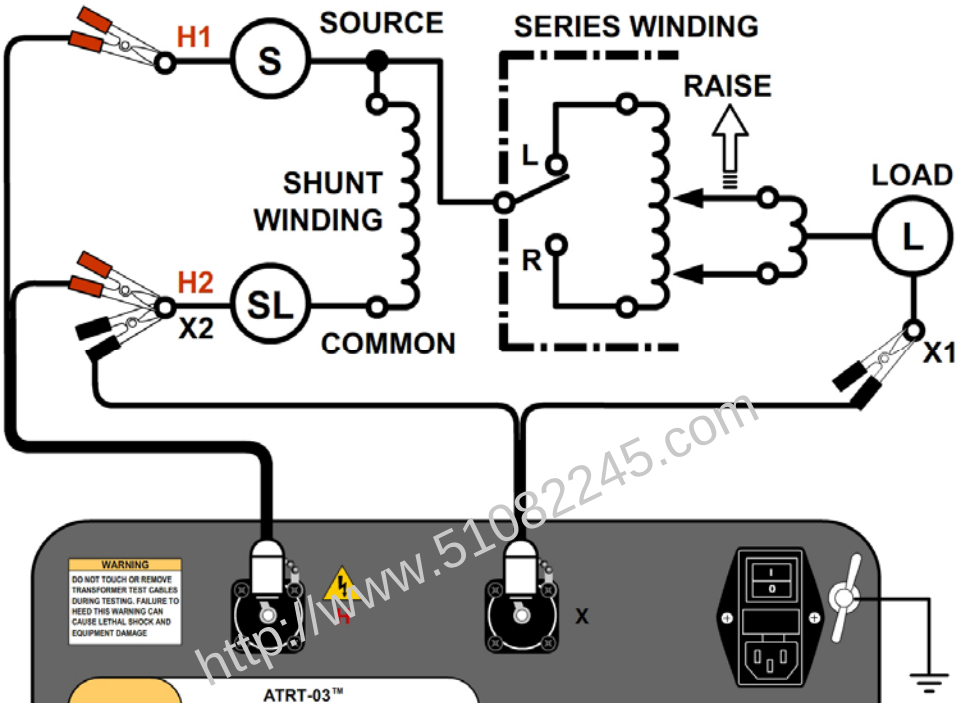


Figure 9. Typical Connections to a Type A Voltage Regulator

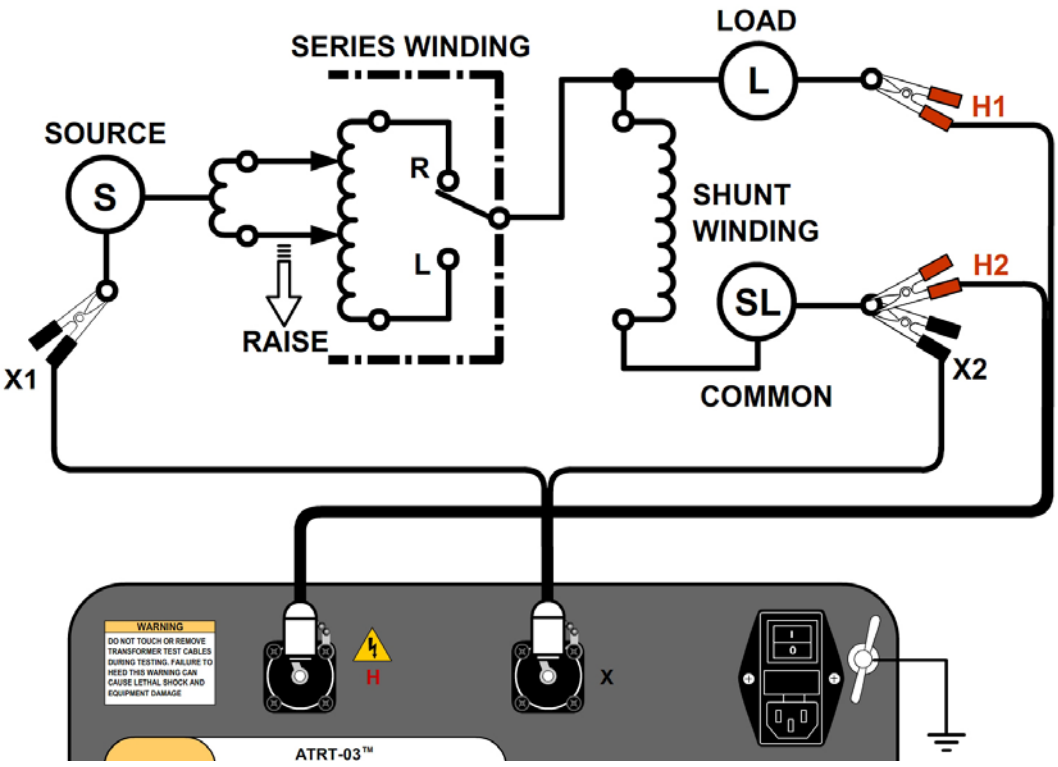


Figure 10. Typical Connections to a Type B Voltage Regulator

3.1.5. Typical Connections to a Donut Type (un-mounted) Current Transformer

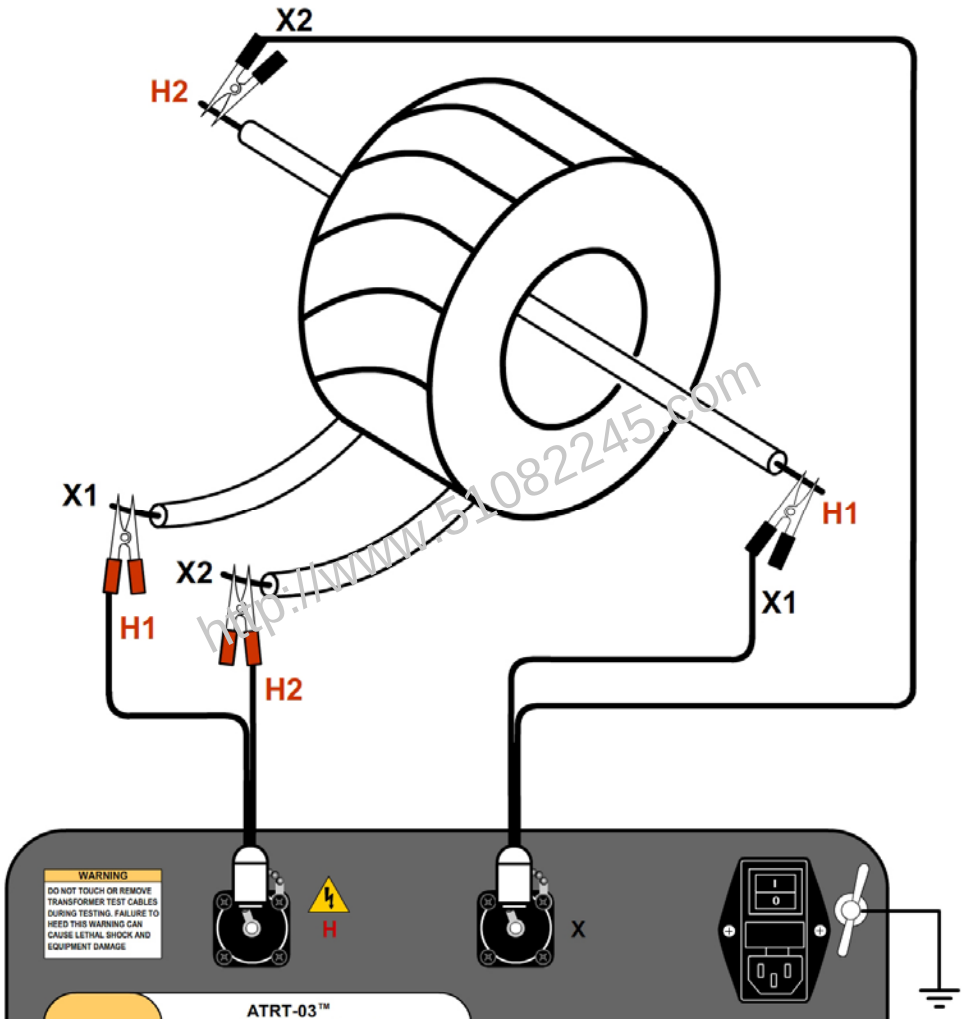


Figure 11. Typical Connections to a Donut Type (un-mounted) Current Transformer (CT)

NOTE

The H and X test leads are reversed for the CT ratio test connections shown above.

3.1.6. Typical Connections to a Multi-Tap Current Transformer

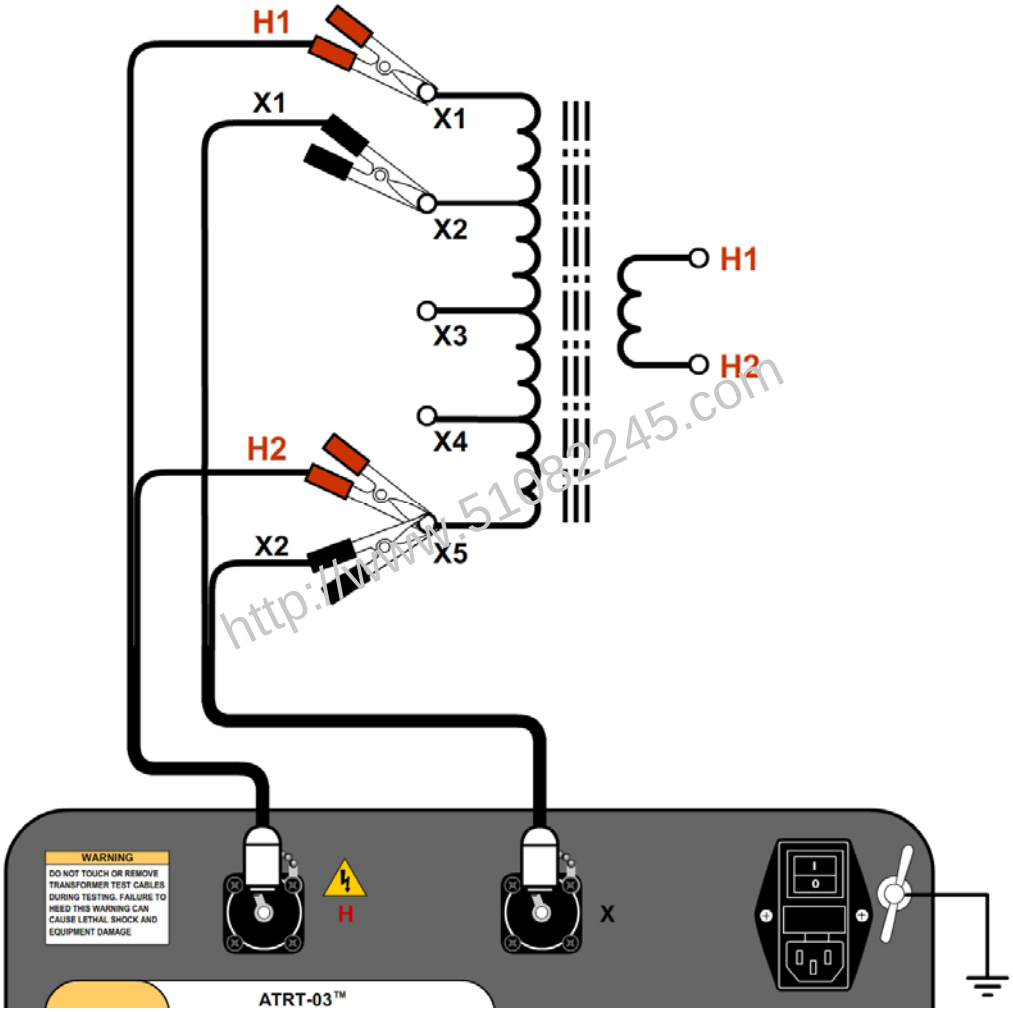


Figure 12. Typical Connections to a Multi-Tap Current Transformer

3.1.7. Typical Connections to a Bushing Mount CT on a Single Phase Transformer

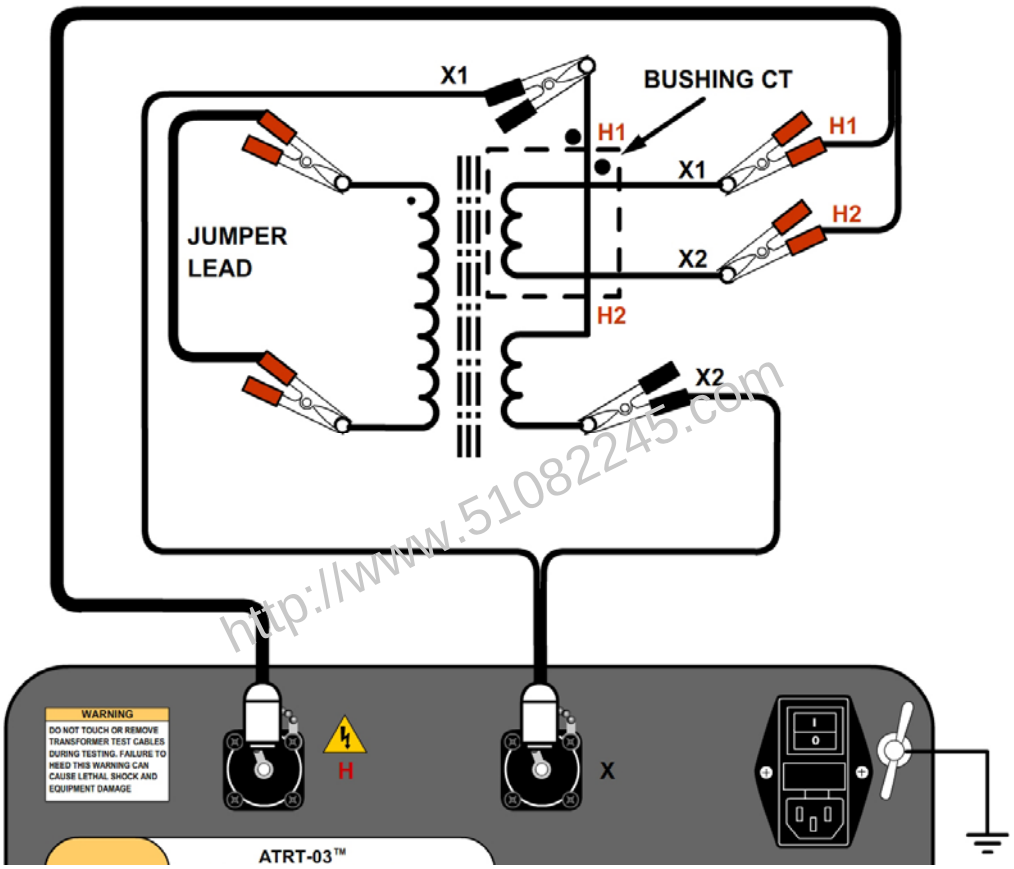


Figure 13. Typical Connections to a Bushing Mount CT on a Single Phase Transformer

3.1.8. Typical Connections to Bushing Mount CT's on Delta Transformer

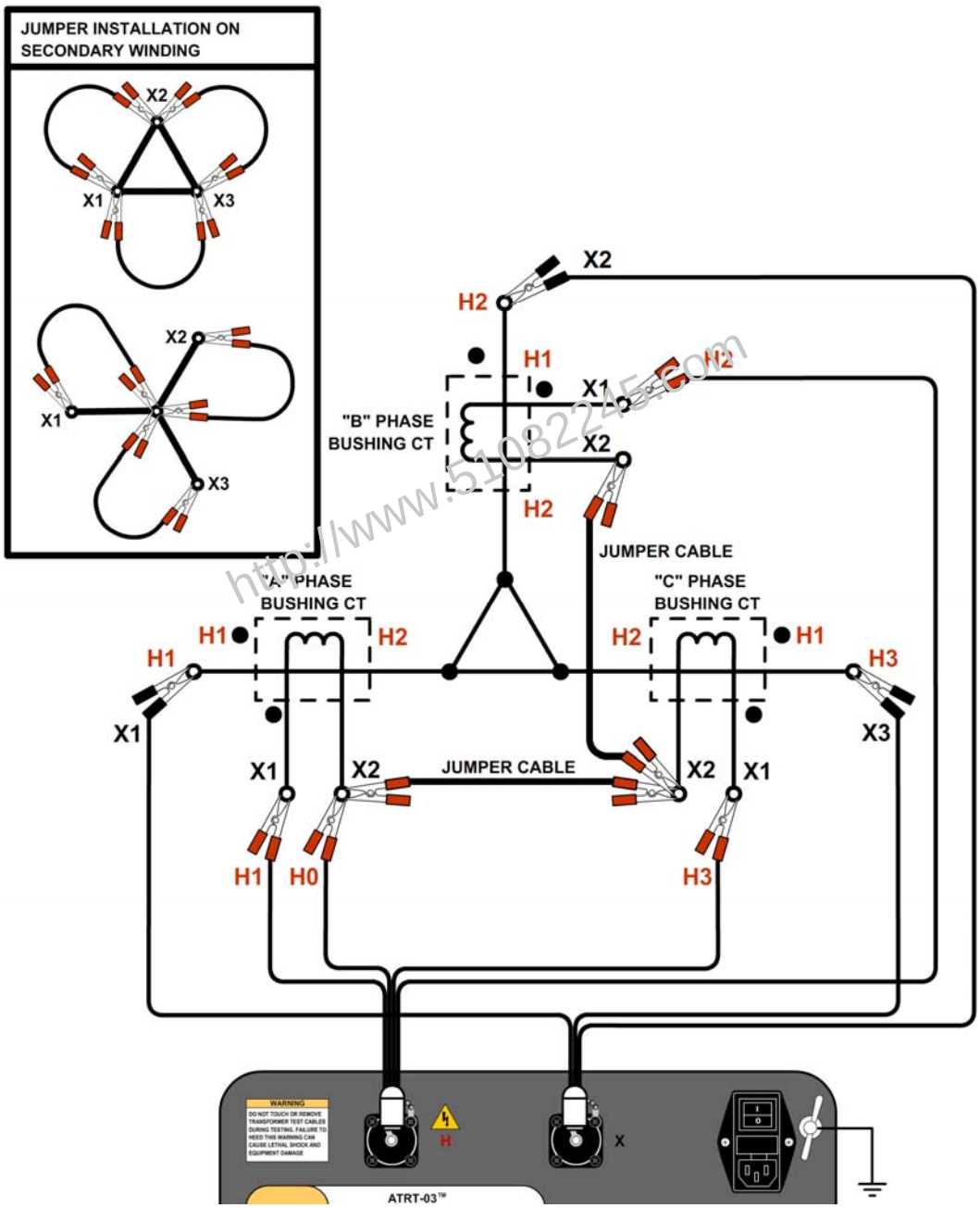


Figure 14. Typical Connections to Bushing Mount CT's on Delta Transformer

NOTE The CT turns-ratio is obtained by performing a Ynd11 test.

3.1.9. Typical Connections to Bushing Mount CT's on Wye Transformer

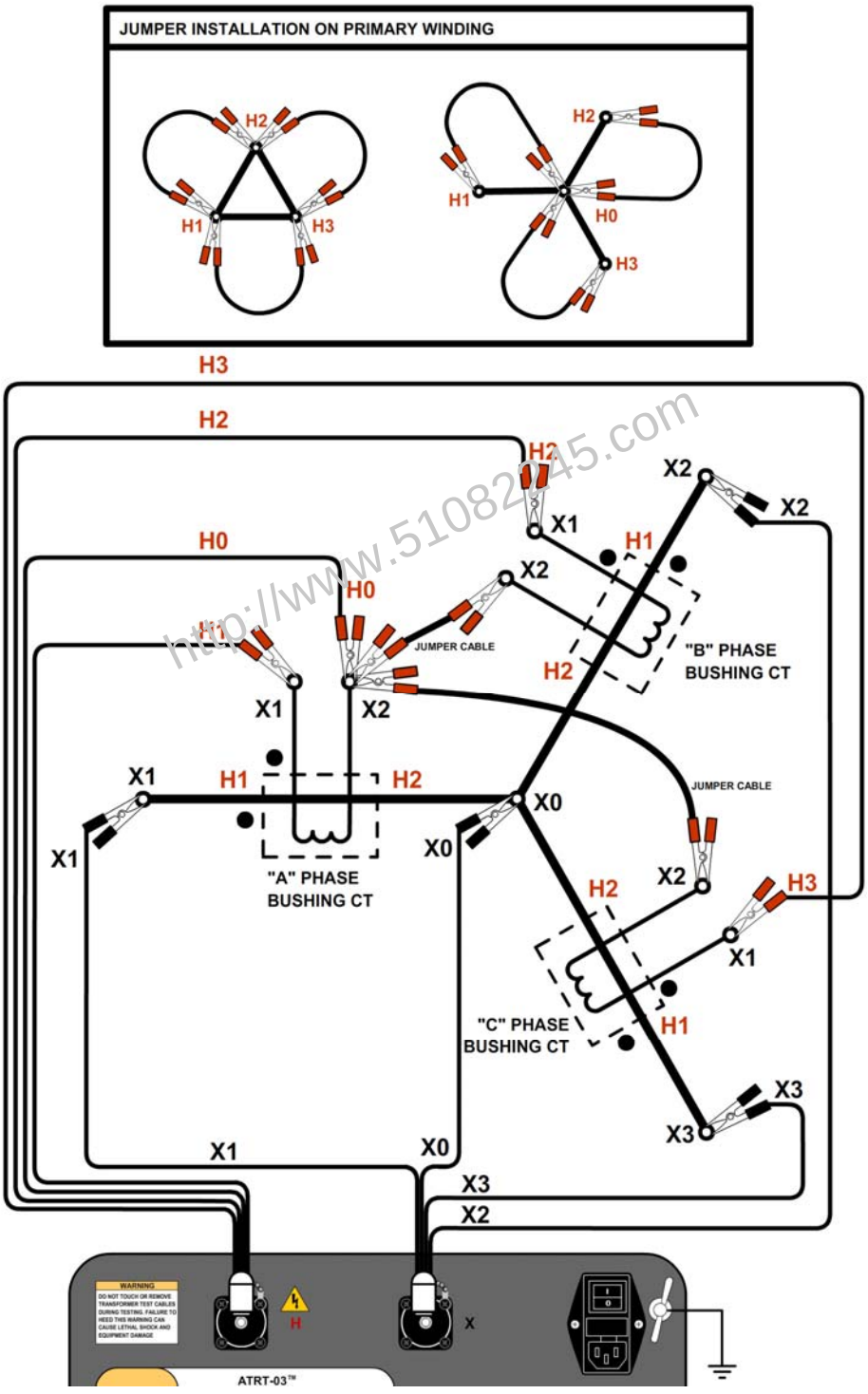


Figure 15. Typical Connections to Bushing Mount CT's on Wye Transformer

NOTE

The CT turns-ratio is obtained by performing a Ynyn0 test.

3.2 Setting the Test Voltage

The ATRT-03 offers three test voltages, 8 Vac, 40 Vac, and 100 Vac. The unit always defaults to 40 Vac at power-on. The 8 Vac test voltage is for testing transformers which require low test voltages, such as metering Current Transformers (CT's). For metering CT's, higher voltages may drive the CT's into saturation, thus giving invalid results. The 40 Vac test voltage is recommended for testing power transformers. The 100 Vac test voltage is recommended for testing power transformers in noisy environments. Follow the steps below to set the test voltage:

NOTE Pressing the **[STOP]** key at any time will return you to the "START-UP" menu.

a. Turn on the unit and start from the " START-UP" menu:

```
1.TEST XFMR 08/16/10
2.SETUP     08:14:58
3.CALCULATOR
4.DIAG   5.QUICK TST
```

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

b. The following screen will be displayed:

```
1.ENTER XFMR ID
2.REVIEW RECORD
3.RESTORE RECORD
4.NEXT PAGE
```

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

c. The following screen will be displayed:

```
1.COMPUTER CONTROL
2.SET TIME
3.SET TEST VOLTAGE
4.TEST PLANS
```

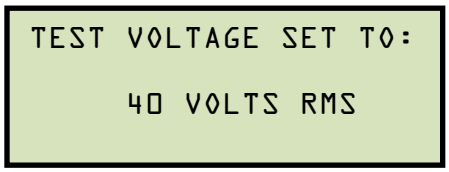
Press the **[3]** key (*SET TEST VOLTAGE*).

d. The following screen will be displayed:

```
SELECT TEST VOLTAGE
1.8V   (CT TEST)
2.40V  (NORMAL TEST)
3.100V (NOISY ENV.)
```

Select the desired test voltage by pressing the corresponding key on the numeric keypad (**[1]**, **[2]**, or **[3]**).

e. The voltage will be set and the following confirmation message will be displayed:

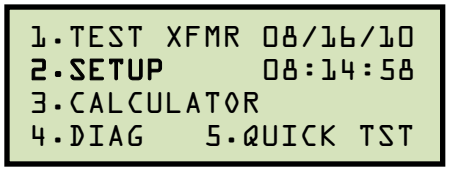


Press any key to return to the "START-UP" menu.

3.3 Setting the Date and Time

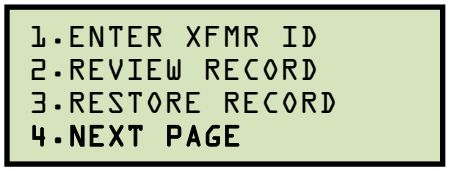
To set the date and time:

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



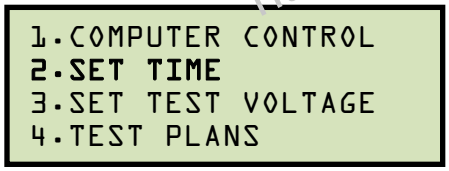
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:



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

c. The following screen will be displayed:



Press the **[2]** key (*SET TIME*).

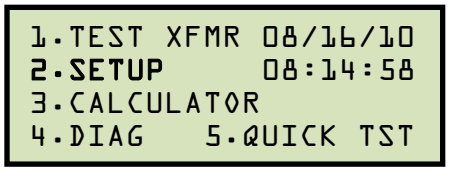
d. The following screen will be displayed:

Using the alpha-numeric keypad, enter the date and time in the format shown on the screen. You do not need to enter dashes or colons. When the complete date and time has been entered, you will be immediately returned to the "START-UP" menu.

3.4 Enabling the Computer Interface

The ATRT-03 can be connected to a computer via the RS-232C interface port. In order to remotely control the unit using the provided Transformer Turns Ratio Analysis (TTRA) software, the unit must be placed in Computer Control mode. Follow the steps below to place the unit in Computer Control mode:

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

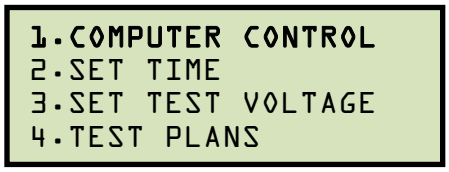


Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:

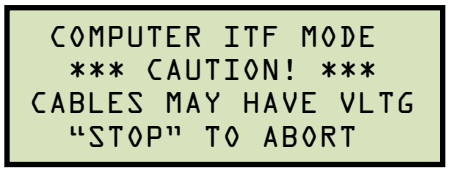
Press the **[4]** key (*NEXT PAGE*).

c. The following screen will be displayed:



Press the **[1]** key (*COMPUTER CONTROL*).

d. The following screen will be displayed:



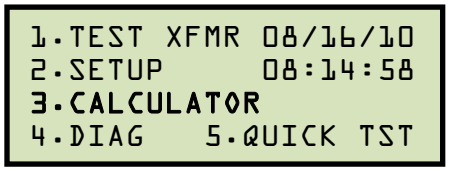
You can now use the TTRA software to remotely control the unit from the PC. Please see the software User's Manual for further information.

Press the **[STOP]** key to abort Computer Control mode and return to the "START-UP" menu.

3.5 Using the Turns Ratio Calculator

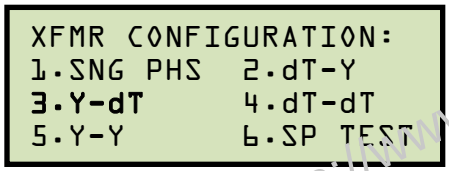
The ATRT-03 features a turns ratio calculator that can be used to calculate the turns ratio for various transformer types. The user only needs to provide the H and X name plate voltage values. Follow the steps below to use the turns ratio calculator.

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



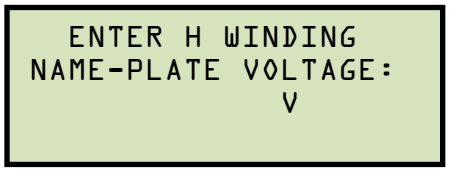
Press the **[3]** key (*CALCULATOR*).

b. The following screen will be displayed:



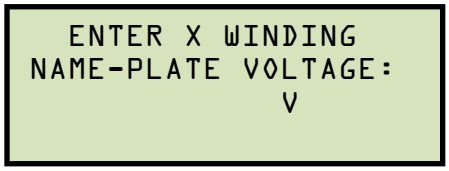
Select the transformer configuration by pressing the corresponding key on the keypad. For this example, press the **[3]** key to select the Y-dT transformer type.

c. The following screen will be displayed:



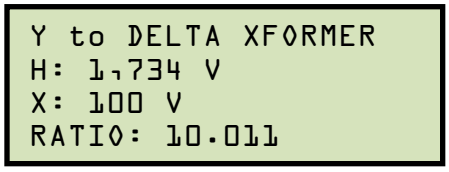
Type the H name plate voltage value using the keypad and then press the **[ENTER]** key.

d. The following screen will be displayed:



Type the X name plate voltage value using the keypad and then press the **[ENTER]** key.

e. The following screen will be displayed showing the H and X name plate voltages along with the calculated turns ratio:



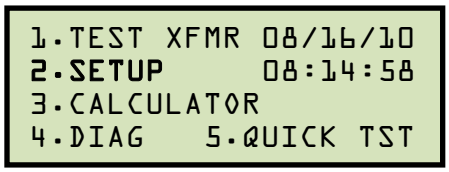
Press any key to return to the "START-UP" menu.

3.6 Performing Tests

3.6.1. 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, manufacturer, etc. Once the header information has been set, it will apply to all subsequent test records. To enter the header information:

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

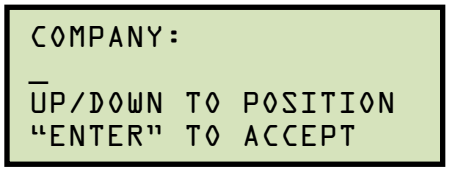


Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:

Press the **[1]** key (*ENTER XFMR ID*).

c. The following screen will be displayed:



Type the company name using the alpha-numeric keypad.

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

d. The following screen will be displayed:

```
STATION:
_
UP/DOWN 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:
_
UP/DOWN 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:
_
UP/DOWN 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:
_
UP/DOWN TO POSITION
"ENTER" TO ACCEPT
```

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

h. The following screen will be displayed:

```
SERIAL NUMBER:
_
UP/DOWN TO POSITION
"ENTER" TO ACCEPT
```

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

i. The following screen will be displayed:

```
KVA RATING:
_
UP/DOWN TO POSITION
"ENTER" TO ACCEPT
```

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

j. The following screen will be displayed:

```
OPERATOR:
_
UP/DOWN 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.

3.6.2. Testing a Single Phase Transformer

Follow the steps below to test a single phase transformer:

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

```
1.TEST XFMR 08/16/10
2.SETUP     08:14:58
3.CALCULATOR
4.DIAG   5.QUICK TST
```

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

b. The following screen will be displayed:

```
XFMR CONFIGURATION:
1.SNG PHS  2.dT-Y
3.Y-dT     4.dT-dT
5.Y-Y      6.SP TEST
```

Press the **[1]** key (*SNG PHS*).

c. The following screen will be displayed:

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


NOTE

If you had entered name plate voltages for a previous test, the following screen will be displayed instead of the above screen:

```
XFMR NAME PLATE VLTG
1.YES
2.NO
3.USE PREVIOUS DATA
```

Press the **[3]** key if you would like to use the name plate voltage values from the previous test performed, and then **continue to step d**.

See below for details about options 1 and 2.

1. *YES*

Press the **[1]** key (*YES*) if you would like to enter the transformer name plate voltage values. The following screen will be displayed:

```
  ENTER H WINDING
NAME-PLATE VOLTAGE:
              V
```

Type the H winding name plate voltage value using the numeric keypad. The screen will be updated as shown below:

```
  ENTER H WINDING
NAME-PLATE VOLTAGE:
      2,400 V
```

Press the **[ENTER]** key.

The following screen will be displayed:

```
  ENTER X WINDING
NAME-PLATE VOLTAGE:
            V
```

Type the X winding name plate voltage value using the numeric keypad. The screen will be updated as shown below:

```
  ENTER X WINDING
NAME-PLATE VOLTAGE:
          240 V
```

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

2. *NO*

   Press the **[2]** key (*NO*) if you do not want to enter the transformer name plate voltage values. **Continue to step d.**

d. The following screen will be displayed:

```
SINGLE PHASE XFORMER
"START" TO RUN TEST
        OR
  "STOP" TO ABORT
```

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

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

```
SINGLE PHASE XFORMER

     PLEASE WAIT
  TEST IN PROGRESS
```

The test results will be displayed on the LCD screen when testing has finished:

```
 RATIO    mA    % DIFF
+10.009  0005    0.09
```

The polarity is displayed as either a plus sign (+) for "in-phase" or a minus sign (-) for "out-of-phase". The value listed under "% DIFF" is the percentage error.

NOTE

The percentage error (% DIFF) is calculated as the absolute value of: [(Calculated Ratio – Measured Ratio) / Calculated Ratio)] x 100

Press any key to continue.

If using an ATRT-03 or ATRT-03A, continue to step f.

If using an ATRT-03B, continue to step h.

f. The following screen will be displayed:

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

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

g. The following screen will be displayed:

```
PRINT FORMAT?
1.COLUMN
2.DETAILED
```

Press the **[1]** key (*COLUMN*) to print a columnar report (see Figure 16) or press the **[2]** key (*DETAILED*) to print a detailed report (see Figure 17).

h. The following screen will be displayed:

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

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

i. The following screen will be displayed:

```
TEST SAVED
```

Press any key to continue.

NOTE

The above screen will be displayed if there is currently no data in the unit's memory buffer. If a test was previously performed or a test record was restored from Flash EEPROM or from a Flash drive, the following screen will be displayed instead:

```
PREVIOUS DATA IN BUF
 08/17/10  10:56:05
1.APPEND PREV. DATA
2.CLEAR PREV. DATA
```

Press the **[1]** key (*APPEND PREV. DATA*) to append the data in the unit's working memory to the current test results, or press the **[2]** key (*CLEAR PREV. DATA*) to clear any previous data from the unit's memory buffer and only save the current test results.

The following screen will then be displayed:

```
TEST SAVED
```

Press any key to continue to step j.

j. The following screen will be displayed:

```
RUN ANOTHER TEST?
1.YES
2.NO
3.REPEAT PREV. TEST
```

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

k. The following screen will be displayed:

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

Press the **[1]** key (*YES*) to save the test record to the unit's Flash EEPROM.

l. The following screen will be displayed momentarily:

```
SAVING RECORD...

PLEASE WAIT...
```

The following confirmation screen will then be displayed:

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


NOTE

The unit will automatically assign the record number and will not over-write existing test records.

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

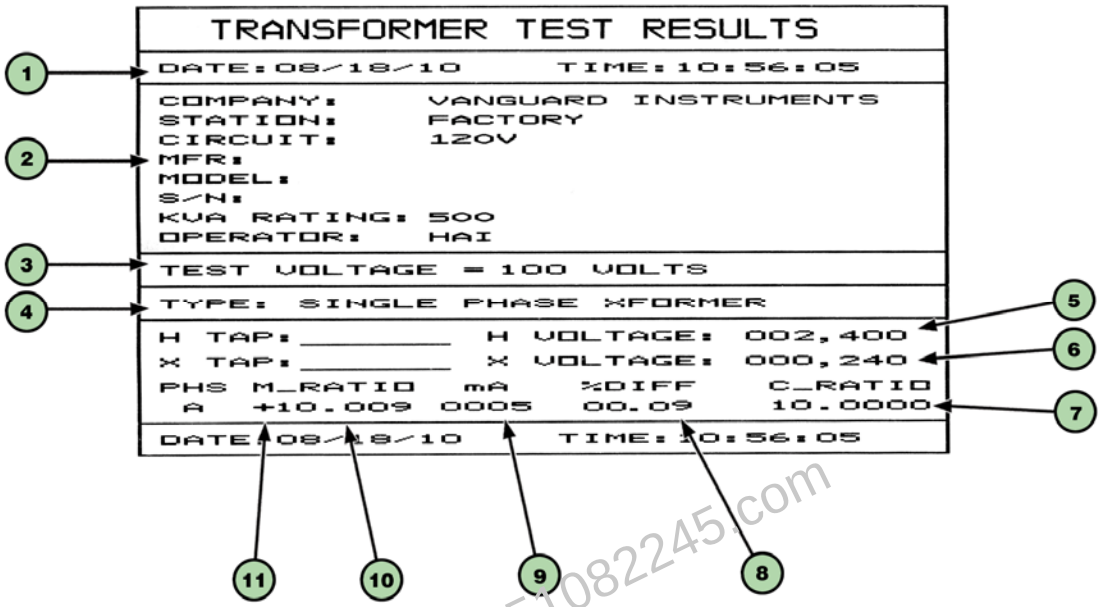


Figure 16. Single Phase Test Results Printout - Column Format (ATRT-03 and ATRT-03A only)

Table 8. Descriptions of Single Phase Test Results Elements (Column Format)

Item Number	Description
1	Test record date and time.
2	Test record header information (see section 3.6.1).
3	Test voltage.
4	Type of transformer under test.
5	H tap voltage.
6	X tap voltage.
7	Calculated ratio.
8	Percentage error between the calculated ratio and the measured ratio.
9	Excitation current.
10	Measured ratio.
11	Winding polarity.

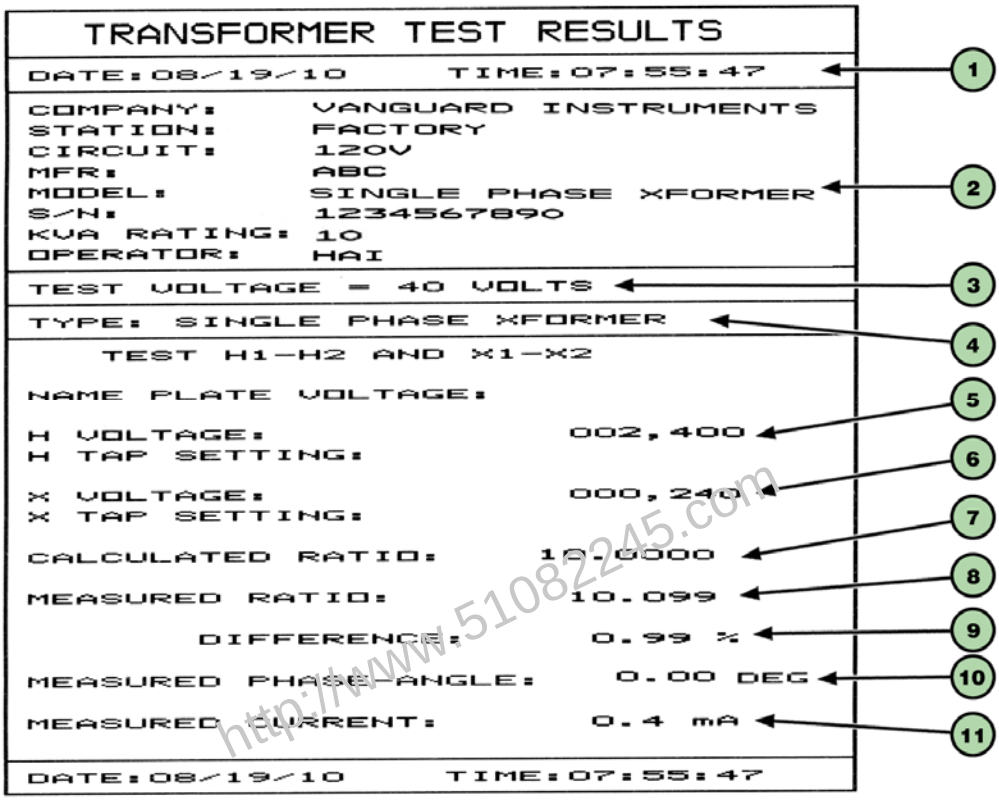


Figure 17. Single Phase Test Results Printout - Detailed Format (ATRT-03 and ATRT-03A only)

Table 9. Descriptions of Single Phase Test Results Elements (Detailed Format)

Item Number	Description
1	Test record date and time.
2	Test record header information (see section 3.6.1).
3	Test voltage.
4	Type of transformer under test.
5	H tap voltage.
6	X tap voltage.
7	Calculated ratio.
8	Measured ratio.
9	Percentage error between the calculated ratio and the measured ratio.
10	Winding phase angle.
11	Excitation current.

3.6.3. Performing a Three-Phase Test (Y-dT Example)

Follow the steps below to perform a three-phase test. The following example is for testing a Y-dT type transformer:

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

```
1.TEST XFMR 08/16/10
2.SETUP     08:14:58
3.CALCULATOR
4.DIAG   5.QUICK TST
```

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

b. The following screen will be displayed:

```
XFMR CONFIGURATION:
1.SNG PHS  2.dT-Y
3.Y-dT     4.dT-dT
5.Y-Y      6.SP TEST
```

Press the **[2]** key (*dT-Y*).

c. The following screen will be displayed:

```
STOP BETWEEN PHASES?
1.NO
2.YES
```

Press the **[1]** key (*NO*).

d. The following screen will be displayed:

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

NOTE

If you had entered name plate voltages for a previous test, the following screen will be displayed instead of the above screen:

```
XFMR NAME PLATE VLTG
1.YES
2.NO
3.USE PREVIOUS DATA
```

Press the **[3]** key if you would like to use the name plate voltage values from the previous test performed, and then **continue to step d**.

See below for details about options 1 and 2.

1. *YES*

   Press the **[1]** key (*YES*) if you would like to enter the transformer name plate voltage values. The following screen will be displayed:

   ```
     ENTER H WINDING
   NAME-PLATE VOLTAGE:
                V
   ```

   Type the H winding name plate voltage value using the numeric keypad. The screen will be updated as shown below:

   ```
     ENTER H WINDING
   NAME-PLATE VOLTAGE:
          1,734 V
   ```

   Press the **[ENTER]** key.

   The following screen will be displayed:

   ```
     ENTER X WINDING
   NAME-PLATE VOLTAGE:
                V
   ```

   Type the X winding name plate voltage value using the numeric keypad. The screen will be updated as shown below:

   ```
     ENTER X WINDING
   NAME-PLATE VOLTAGE:
            100 V
   ```

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

2. *NO*

   Press the **[2]** key (*NO*) if you do not want to enter the transformer name plate voltage values. **Continue to step e.**

e. The following screen will be displayed:

   ```
   Y to DELTA XFORMER
   "START" TO RUN TEST
           OR
     "STOP" TO ABORT
   ```

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

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

```
Y to DELTA XFORMER


   PLEASE WAIT...
```

The screen will be updated with the Phase A test results as shown:

```
 RATIO    mA    % DIFF
+10.021 0011    0.10

   PLEASE WAIT...
```

Testing will continue, and the screen will be updated with the Phase B test results as shown:

```
 RATIO    mA    % DIFF
+10.021 0011    0.10
+10.005 0010    0.06
   PLEASE WAIT...
```


Finally, the screen will be updated with the Phase C test results as shown:

```
 RATIO    mA    % DIFF
+10.021 0011    0.10
+10.005 0010    0.06
+10.021 0012    0.09
```

Press any key to continue.

If using an ATRT-03 or ATRT-03A, continue to step g.

If using an ATRT-03B, continue to step i.

g. The following screen will be displayed:

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

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

h. The following screen will be displayed:

```
PRINT FORMAT?
1.COLUMN
2.DETAILED
```

Press the **[1]** key (*COLUMN*) to print a columnar report (see Figure 18) or press the **[2]** key (*DETAILED*) to print a detailed report (see Figure 19).

i. The following screen will be displayed:

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

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

j. The following screen will be displayed:

```
TEST SAVED
```

Press any key to continue.

k. The following screen will be displayed:

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

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

l. The following screen will be displayed:

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

Press the **[1]** key (*YES*) to save the test record to the unit's Flash EEPROM.

m. The following screen will be displayed momentarily:

```
SAVING RECORD...

PLEASE WAIT...
```

The following confirmation screen will then be displayed:

```
RECORD NUMBER 4
 HAS BEEN SAVED!
```

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

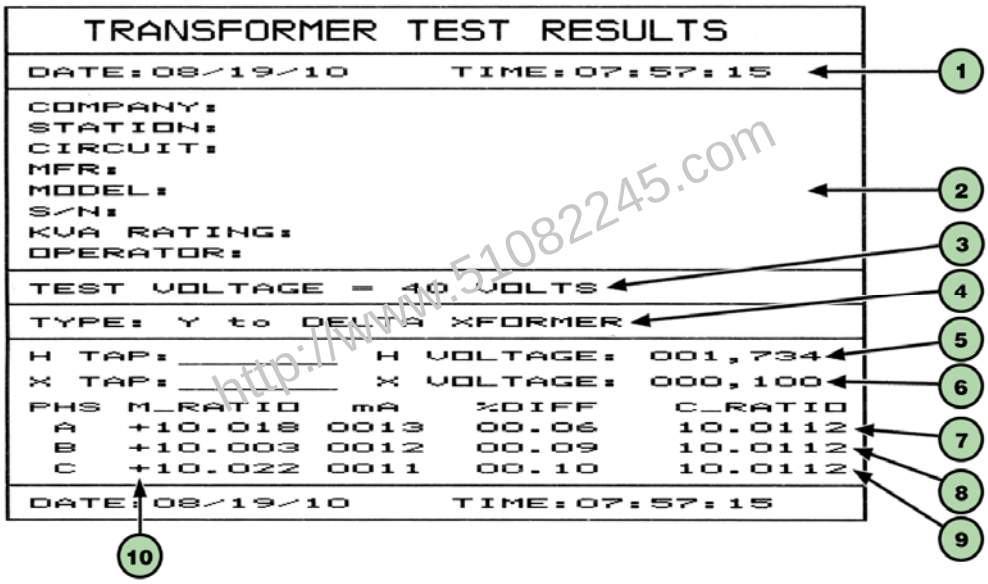


Figure 18. Y to Delta Test Results Printout - Column Format
(ATRT-03 and ATRT-03A only)

Table 10. Descriptions of Y to Delta Test Results Elements (Column Format)

Item Number	Description
1	Test record date and time.
2	Test record header information (see section 3.6.1).
3	Test voltage.
4	Type of transformer under test.
5	H tap voltage.
6	X tap voltage.
7	Measured ratio, excitation current, phase angle, and percentage error for Phase A.
8	Measured ratio, excitation current, phase angle, and percentage error for Phase B.
9	Measured ratio, excitation current, phase angle, and percentage error for Phase C.
10	Winding polarity.

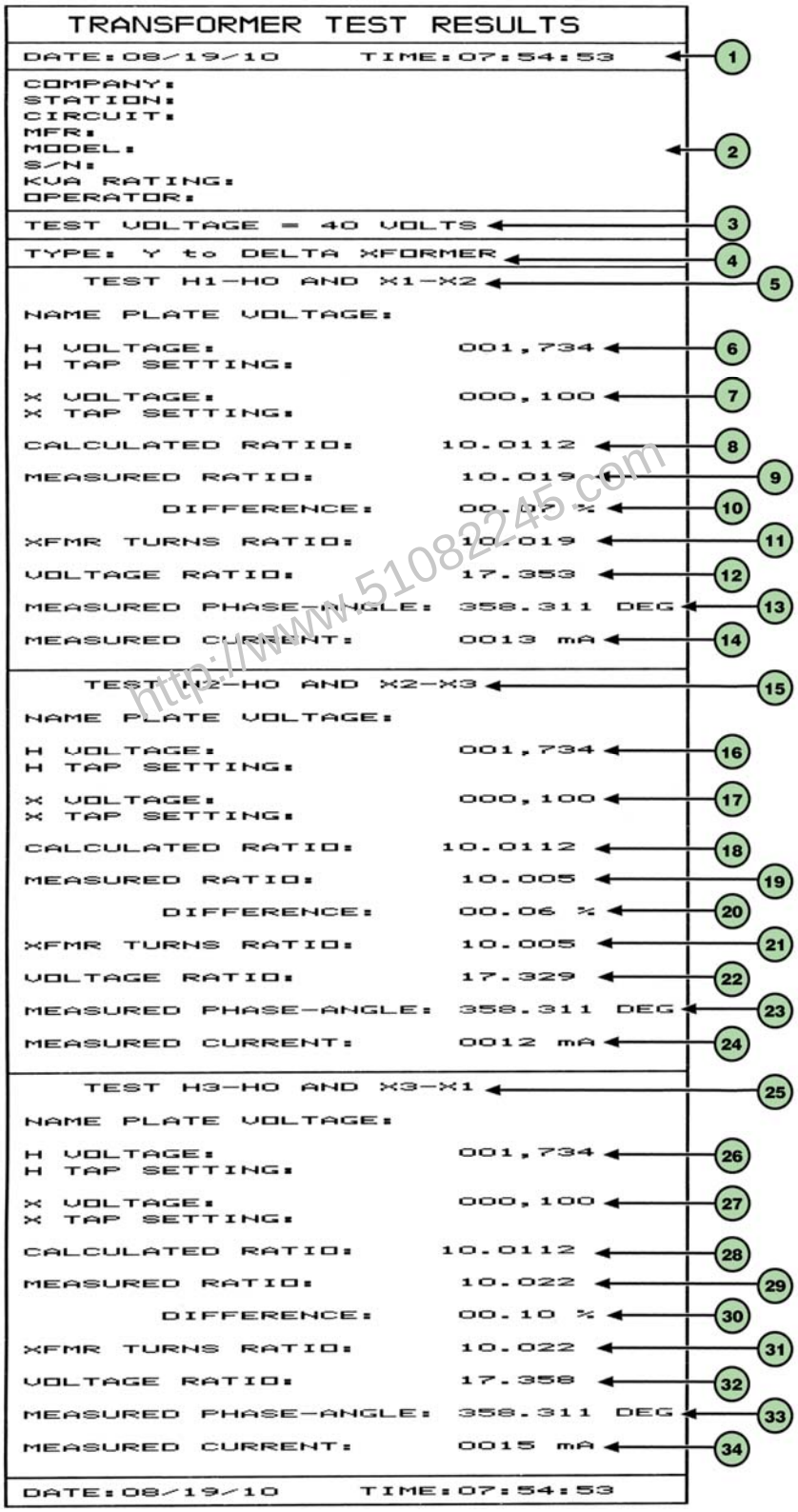


Figure 19. Y to Delta Test Results Printout - Detailed Format (ATRT-03 and ATRT-03A only)

Table 11. Descriptions of Y to Delta Test Results Elements (Detailed Format)

Item Number	Description
1	Test record date and time.
2	Test record header information (see section 3.6.1).
3	Test voltage.
4	Type of transformer under test.
5	Test H1-H0 and X1-X2 section heading.
6	H1-H0 tap voltage.
7	X1-X2 tap voltage.
8	H1-H0, X1-X2 calculated ratio.
9	H1-H0, X1-X2 measured ratio.
10	H1-H0, X1-X2 percentage error between calculated ratio and measured ratio.
11	H1-H0, X1-X2 transformer turns ratio.
12	H1-H0, X1-X2 voltage ratio.
13	H1-H0, X1-X2 measured phase angle.
14	H1-H0, X1-X2 measured excitation current.
15	Test H2-H0 and X2-X3 section heading
16	H2-H0 tap voltage.
17	X2-X3 tap voltage.
18	H2-H0, X2-X3 calculated ratio.
19	H2-H0, X2-X3 measured ratio.
20	H2-H0, X2-X3 percentage error between calculated ratio and measured ratio.
21	H2-H0, X2-X3 transformer turns ratio.
22	H2-H0, X2-X3 voltage ratio.
23	H2-H0, X2-X3 measured phase angle.
24	H2-H0, X2-X3 measured excitation current.
25	Test H3-H0 and X3-X1 section heading.
26	H3-H0 tap voltage.
27	X3-X1 tap voltage.
28	H3-H0, X3-X1 calculated ratio.
29	H3-H0, X3-X1 measured ratio.
30	H3-H0, X3-X1 percentage error between calculated ratio and measured ratio.
31	H3-H0, X3-X1 transformer turns ratio.
32	H3-H0, X3-X1 voltage ratio.
33	H3-H0, X3-X1 measured phase angle.
34	H3-H0, X3-X1 measured excitation current.

3.6.4. Performing a Special Transformer Test

The ATRT-03 can test 67 transformer types defined by ANSI, CEI/IEC and Australian standards. Follow the steps below to perform a test on one of these transformer types (See Appendix B, C, and D for a list of supported transformer types and their corresponding special test numbers):

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

```
1.TEST XFMR 08/23/10
2.SETUP     08:25:15
3.CALCULATOR
4.DIAG   5.QUICK TST
```

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

b. The following screen will be displayed:

```
XFMR CONFIGURATION:
1.SNG PHS  2.dT-Y
3.Y-dT     4.dT-dT
5.Y-Y      6.SP TEST
```

Press the **[6]** key (*SP TEST*).

c. The following screen will be displayed:

```
     SPECIAL TEST

1.ENTER SP TEST NUM
2.SCROLL TO SELECT
```

1. *ENTER SP TEST NUM*

   Press the **[1]** key (*ENTER SP TEST NUM*) to enter the special test number. Please see Appendix B, C, and D for a listing of all the transformer types.

   The following screen will be displayed:

```
ENTER SP TEST NUMBER
"ENTER" TO CONTINUE
        #
```

   Type the test number using the alpha-numeric keypad and then press the **[ENTER]** key. **Continue to step d.**

2. *SCROLL TO SELECT*

   Press the **[2]** key (*SCROLL TO SELECT*) to scroll through the list of supported transformer types. The following screen will be displayed:

```
SPECIAL TEST LISTING

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

   Press the **[PAPER ∧ Contrast]** or **[PAPER ∨ Contrast]** key to scroll through the list of special transformer types. Press the **[ENTER]** key when you have found the transformer type that you would like to test. **Continue to step d.**

d. The following screen will be displayed:

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


NOTE

If you had entered name plate voltages for a previous test, the following screen will be displayed instead of the above screen:

```
XFMR NAME PLATE VLTG
1.YES
2.NO
3.USE PREVIOUS DATA
```

Press the **[3]** key if you would like to use the name plate voltage values from the previous test performed, and then **continue to step d**.

See below for details about options 1 and 2.

1. *YES*

   Press the **[1]** key (*YES*) if you would like to enter the transformer name plate voltage values. The following screen will be displayed:

```
  ENTER H WINDING
NAME-PLATE VOLTAGE:
             V
```

   Type the H winding name plate voltage value using the numeric keypad. The screen will be updated as shown below:

```
  ENTER H WINDING
NAME-PLATE VOLTAGE:
       1,734 V
```

Press the **[ENTER]** key.

The following screen will be displayed:

```
  ENTER X WINDING
NAME-PLATE VOLTAGE:
             V
```

Type the X winding name plate voltage value using the numeric keypad. The screen will be updated as shown below:

```
  ENTER X WINDING
NAME-PLATE VOLTAGE:
         100 V
```

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

2. *NO*

   Press the **[2]** key (*NO*) if you do not want to enter the transformer name plate voltage values. **Continue to step e.**

e. The following screen will be displayed:

```
     Dy11 XFMR
   JUMPER H2-H3

"START" to RUN TEST
```

NOTE

This screen and subsequent screens will differ depending on the transformer type selected. Follow any instructions displayed on the LCD screen.

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

f. The following screen will be displayed temporarily:

```
     Dy11 XFMR


  PLEASE WAIT...
```

The following screen will then be displayed:

```
   JUMPER H1-H3

"ENTER" to CONTINUE
```

Follow the instructions displayed on the LCD screen and then press the **[ENTER]** key.

g. The Phase A test will be performed and the results will be displayed on the screen temporarily as shown:

```
      Dy11 XFMR
+10.021 0011

   PLEASE WAIT...
```

The following screen will then be displayed:

```
    JUMPER H1-H2

 "ENTER" to CONTINUE
```

Follow the instructions displayed on the LCD screen and then press the **[ENTER]** key.

h. The Phase B and C tests will be performed and all results will be displayed on the screen temporarily as shown:

```
RATIO    mA    % DIFF
+100.04 0002
+100.06 0002
+100.05 0002
```

Press any key to continue.

If using an ATRT-03 or ATRT-03A, continue to step i.

If using an ATRT-03B, continue to step k.

i. The following screen will be displayed:

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

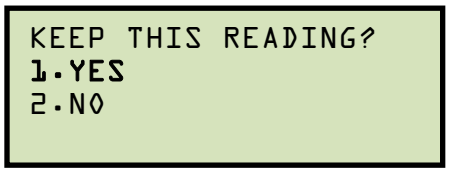
Press the **[1]** key (*YES*) to print the test results.

j. The following screen will be displayed:

```
PRINT FORMAT?
1.COLUMN
2.DETAILED
```

Press the **[1]** key (*COLUMN*) to print a columnar report (see Figure 20) or press the **[2]** key (*DETAILED*) to print a detailed report.

k. The following screen will be displayed:



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

l. The following screen will be displayed:

Press any key to continue.

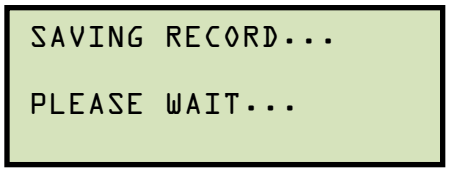
m. The following screen will be displayed:

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

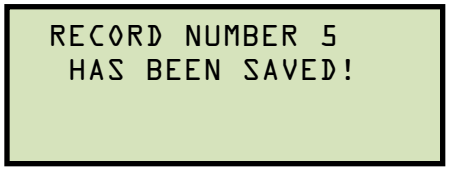
n. The following screen will be displayed:

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

o. The following screen will be displayed momentarily:



The following confirmation screen will then be displayed:



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

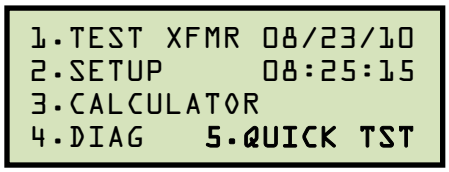
```
TRANSFORMER TEST RESULTS
DATE:08/18/10   TIME:10:35:13
COMPANY:      VANGUARD INSTRUMENT
STATION:
CIRCUIT:
MFR:
MODEL:
S/N:
KVA RATING:
OPERATOR:
TEST VOLTAGE = 40 VOLTS
TYPE: Dy11 XFMR  <SPEC TEST #8>
H TAP:_________  H VOLTAGE:
X TAP:_________  X VOLTAGE:
PHS M_RATIO   mA
 A   +100.04 0002
 B   +100.06 0002
 C   +100.05 0002
DATE:08/18/10   TIME:10:35:13
```

Figure 20. Special Dy11 Transformer Test Printout

3.6.5. Performing a Quick Test

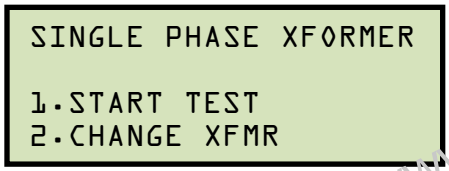
The quick test mode can be used to initiate a transformer ratio test by pressing only two keys. Follow the steps below to perform a quick test:

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



Press the **[5]** key (*QUICK TST*).

b. The following screen will be displayed:



1. *START TEST*

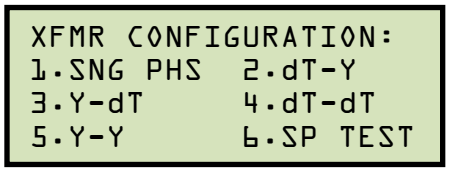
   Press the **[1]** key (*START TEST*) to start the test for the transformer type displayed on the LCD screen. **Continue to step e.**

   
   NOTE

   The initial screen will display the last transformer type that was tested using the Quick Test mode. If a test has not been performed yet, the default is a single phase transformer.

2. *CHANGE XFMR*

   Press the **[2]** key (*CHANGE XFMR*) to select a different transformer type. The following screen will be displayed:



   Select the transformer type by pressing the corresponding key on the keypad. **Continue to step c.**

c. The following screen will be displayed:

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

1. *YES*

   Press the **[1]** key (*YES*) if you would like to enter the transformer name plate voltage values. The following screen will be displayed:

```
  ENTER H WINDING
NAME-PLATE VOLTAGE:
             V
```

   Type the H winding name plate voltage value using the numeric keypad. The screen will be updated as shown below:

```
  ENTER H WINDING
NAME-PLATE VOLTAGE:
       2,400 V
```

   Press the **[ENTER]** key.

   The following screen will be displayed:

```
  ENTER X WINDING
NAME-PLATE VOLTAGE:
             V
```

   Type the X winding name plate voltage value using the numeric keypad. The screen will be updated as shown below:

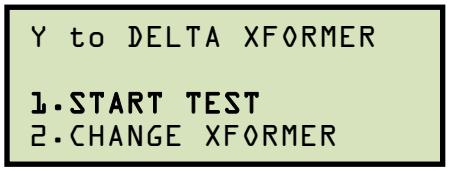
```
  ENTER X WINDING
NAME-PLATE VOLTAGE:
         240 V
```

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

2. *NO*

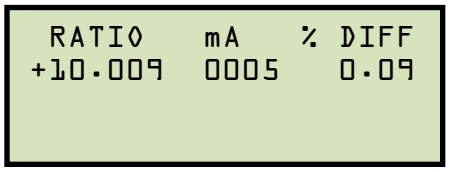
   Press the **[2]** key (*NO*) if you do not want to enter the transformer name plate voltage values. **Continue to step d.**

d. The following screen will be displayed (screen will vary depending on the transformer type selected):

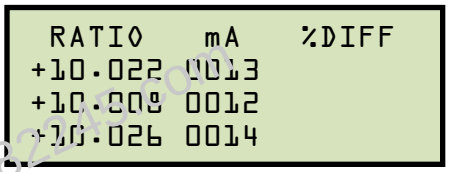


Press the **[1]** key (*START TEST*).

e. The ATRT-03 will perform the selected test and display the test results on the LCD screen as shown below:



Single Phase Test Results Example



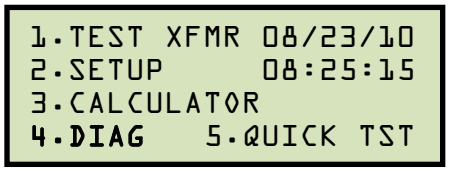
Y-dT Test Results Example

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

3.6.6. Testing a Three Phase Transformer Using Auto Detect Mode

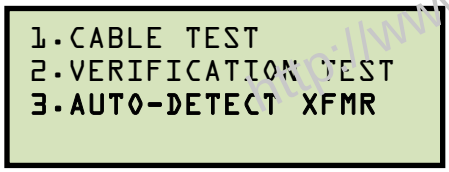
The ATRT-03 provides a convenient Auto Detect mode that can automatically detect 130 specific vector groups for different transformer types defined by ANSI, CEI/IEC, and Australian standards. The transformer configurations supported are listed in Appendix B, C, and D. The ATRT-03 can detect the vector diagrams for Delta-Delta, Wye-Wye, Delta-Wye, and Wye-Delta transformer types. Follow the steps below to test a three phase transformer using the auto detect mode:

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



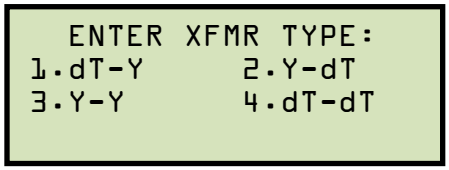
Press the **[4]** key (*DIAG*).

b. The following screen will be displayed:



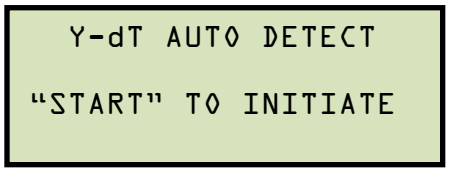
Press the **[3]** key (*AUTO-DETECT XFMR*).

c. The following screen will be displayed:



Select a supported three phase transformer type by pressing the corresponding numeric key on the keypad (**[1]**, **[2]**, **[3]**, or **[4]**). For this example, we will perform a Y-dT test (option 2).

d. The following screen will be displayed:



Press the **[START]** key.

e. The following screen will be displayed while the unit determines the transformer configuration:

```
  Y-dT AUTO DETECT

TESTING YNd1  PHS 1
```

The ATRT-03 will start testing the transformer configurations starting with YNd1. If the transformer is not a type YNd1, it will continue to test for the next type (YNd3, YNd5, etc.) until the transformer type has been determined. The screen will be updated as shown below to indicate which configuration is currently being tested for:

```
  Y-dT AUTO DETECT

TESTING YNd3  PHS 1
```

Once the transformer type has been determined, the unit will start performing the test.

f. The screen will be updated with the test results as shown:

```
 RATIO   mA   %DIFF
+10.022 0013
+10.008 0012
+10.026 0014
```

Press any key to continue.

If using an ATRT-03 or an ATRT-03A, continue to step g.

If using an ATRT-03B, continue to step i.

g. The following screen will be displayed:

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

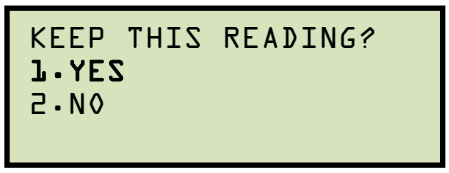
Press the **[1]** key (*YES*) to print the test results.

h. The following screen will be displayed:

```
PRINT FORMAT?
1.COLUMN
2.DETAILED
```

Press the **[1]** key (*COLUMN*) to print a columnar report or press the **[2]** key (*DETAILED*) to print a detailed report.

i. The following screen will be displayed:



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

j. The following screen will be displayed:

Press any key to continue.

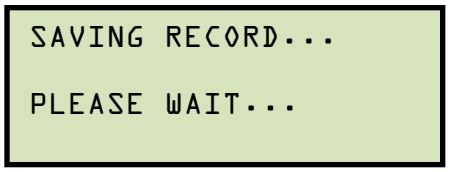
k. The following screen will be displayed:

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

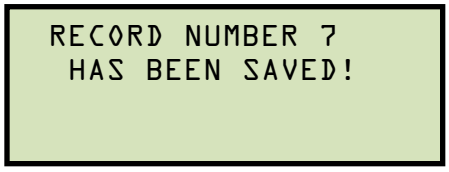
l. The following screen will be displayed:

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

m. The following screen will be displayed momentarily:



The following confirmation screen will then be displayed:



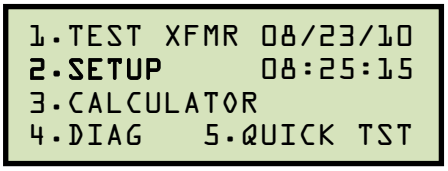
Press any key to return to the "START-UP" menu.

3.7 Working With Test Records

3.7.1. Restoring a Test Record From Flash EEPROM

Use the steps below to restore a test record from the ATRT-03's Flash EEPROM to the working memory:

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



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

b. The following screen will be displayed:

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

c. The following screen will be displayed:

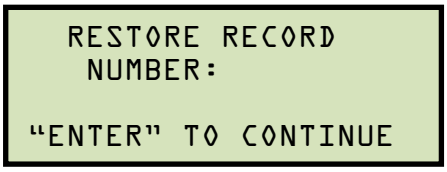
Press the **[1]** key (*RESTORE RECORD*).

d. The following screen will be displayed:

1. *ENTER RECORD NUMBR*

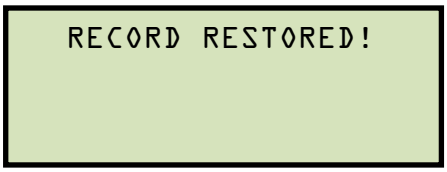
   Press the **[1]** key (*ENTER RECORD NUMBR*) if you know the record number that you would like to restore.

   1.1. The following screen will be displayed:



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

1.2. The following screen will be displayed:

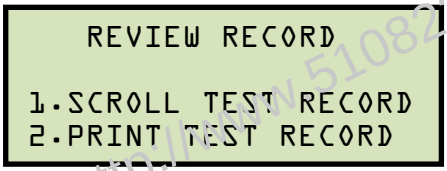


Press any key to continue.

If using an ATRT-03 or ATRT-03A, continue to step 1.3.

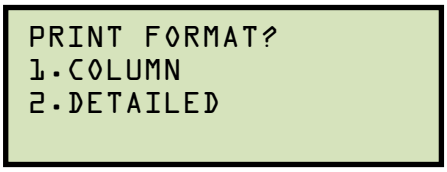
If using an ATRT-03B, continue to step 1.4.

1.3. The following screen will be displayed:



Press the **[1]** key (*SCROLL TEST RECORD*) to display the restored test record data on the unit's LCD screen. **Continue to step 1.4.**

Press the **[2]** key (*PRINT TEST RECORD*) to print the restored test record data on the unit's built-in thermal printer. The following screen will be displayed:



Press the **[1]** key (*COLUMN*) to print the test report in columnar format, or press the **[2]** key (*DETAILED*) to print the test report in detailed format.

The test report will be printed, and you will be returned to the "START-UP" menu. The restored test record will remain loaded in the working memory.

1.4. The basic information about the restored test record will be displayed as shown:

```
  RECORD ID INFO:

SIEMENS
```

Press the **[PAPER ∨ Contrast]** key. The test record details will be displayed as shown:

```
Y to DELTA XFORMER
       1 TAPS
 08/25/10  07:32:21
   TEST VTG = 40
```

Press the **[PAPER ∨ Contrast]** key again to view the test data:

```
 1 RATIO mA   % DIFF
+10.021 0010
+10.002 0010
+10.022 0011
```

Press the **[STOP]** key to return to the "START-UP" menu. The restored test record will remain loaded in the working memory.

2. *SCROLL TEST RECORD*

Press the **[2]** key (*SCROLL TEST RECORD*) to scroll through a directory of the stored test records.

2.1. The following screen will be displayed:

```
 RECORDS DIRECTORY

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

Press the **[PAPER ∧ Contrast]** button or the **[PAPER ∨ Contrast]** key to display the next or previous test record, respectively.

The basic test record information will be displayed as shown:

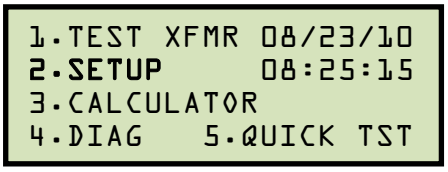
```
#7    08/25/10 07:52
Y-DELTA     TAPS:1

SIEMENS
```

When you have located the test record that you would like to restored, press the **[ENTER]** key. **Continue to step 1.2 on page 60.**

3.7.2. Reviewing a Test Record

You can print (ATRT-03 and ATRT-03A only) or display (all models) a test record at the time that it is restored, or you can restore it to the working memory and review it later. To print or display the current test record in the working memory:

a. Perform a test or restore a test record to the working memory (see section 3.4) and then start from the "START-UP" menu:



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

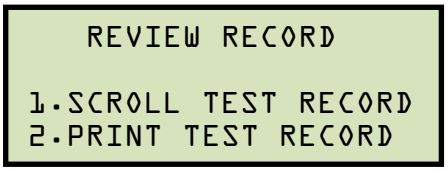
b. The following screen will be displayed:

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

If using an ATRT-03 or ATRT-03A, continue to step c.

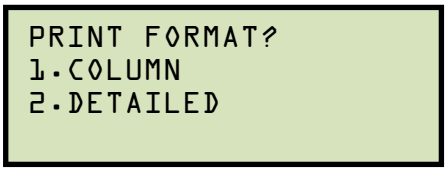
If using an ATRT-03B, continue to step d.

c. The following screen will be displayed:



Press the **[1]** key (*SCROLL TEST RECORD*) to display the test record data on the unit's LCD screen. **Continue to step d.**

Press the **[2]** key (*PRINT TEST RECORD*) to print the restored test record on the unit's built-in thermal printer. The following screen will be displayed:



Press the **[1]** key (*COLUMN*) to print the test record in columnar format, or press the **[2]** key (*DETAILED*) to print the test record in detailed format. The test record will be printed, and you will be returned to the "START-UP" menu.

d. The basic information about the restored test record will be displayed as shown below:

```
  RECORD ID INFO:

SIEMENS
```

Press the **[PAPER ∨ Contrast]** key. The test record details will be displayed as shown below:

```
Y to DELTA XFORMER
       1 TAPS
 08/25/10  07:32:21
   TEST VTG = 40
```

Press the **[PAPER ∨ Contrast]** key again to view the test data:

```
 1 RATIO mA    % DIFF
+10.021 0010
+10.002 0010
+10.022 0011
```


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

3.7.3. Printing or Viewing the Test Record Directory

Follow the steps below to print a directory of the test records stored in the unit's Flash EEPROM (ATRT-03 and ATRT-03A only) or view the directory on the LCD screen (ATRT-03B):

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

```
1.TEST XFMR 08/23/10
2.SETUP     08:25:15
3.CALCULATOR
4.DIAG   5.QUICK TST
```

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

b. The following screen will be displayed:

```
1.ENTER XFMR ID
2.REVIEW RECORD
3.RESTORE RECORD
4.NEXT PAGE
```

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

c. The following screen will be displayed:

```
1.RESTORE RECORD
2.DIRECTORY
3.ERASE RECORDS
```

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

If using an ATRT-03 or ATRT-03A, continue to step d.

If using an ATRT-03B, continue to step e.

d. The following screen will be displayed:

```
  PRINT DIRECTORY

1.FULL DIRECTORY
2.SHORT DIRECTORY
```

Press the **[1]** key (*FULL DIRECTORY*) to print a directory of all the test records stored in the unit's Flash EEPROM. The directory will be printed and you will be returned to the "START-UP" menu.

Press the **[2]** key (*SHORT DIRECTORY*) to print a directory of the last test records stored in the unit's Flash EEPROM. The directory will be printed and you will be returned to the "START-UP" menu.

Please see Figure 21 for a sample test record directory printout.

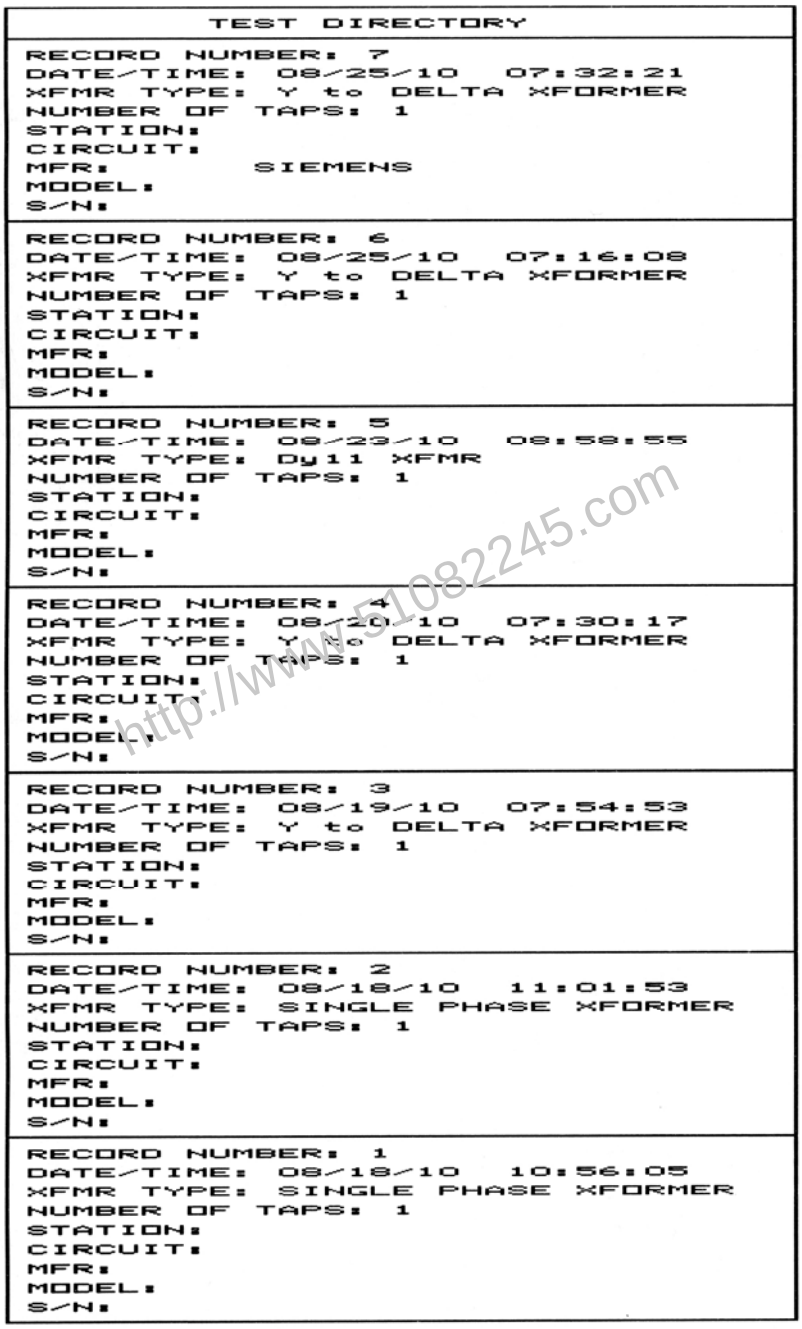
e. The following screen will be displayed:

```
 RECORDS DIRECTORY

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

Press either the **[PAPER ∧ Contrast]** key or the **[PAPER ∨ Contrast]** key to scroll through the test record directory. The test record header information will be displayed as shown below:

```
#1    08/26/10 07:58
SGL PHASE   TAPS:1
```

Press the **[STOP]** key when you are down browsing through the test record directory. You will be returned to the "START-UP" menu.



```
TEST DIRECTORY

RECORD NUMBER: 7
DATE/TIME: 08/25/10 07:32:21
XFMR TYPE: Y to DELTA XFORMER
NUMBER OF TAPS: 1
STATION:
CIRCUIT:
MFR: SIEMENS
MODEL:
S/N:

RECORD NUMBER: 6
DATE/TIME: 08/25/10 07:16:08
XFMR TYPE: Y to DELTA XFORMER
NUMBER OF TAPS: 1
STATION:
CIRCUIT:
MFR:
MODEL:
S/N:

RECORD NUMBER: 5
DATE/TIME: 09/23/10 08:58:55
XFMR TYPE: Dy11 XFMR
NUMBER OF TAPS: 1
STATION:
CIRCUIT:
MFR:
MODEL:
S/N:

RECORD NUMBER: 4
DATE/TIME: 08/20/10 07:30:17
XFMR TYPE: Y to DELTA XFORMER
NUMBER OF TAPS: 1
STATION:
CIRCUIT:
MFR:
MODEL:
S/N:

RECORD NUMBER: 3
DATE/TIME: 08/19/10 07:54:53
XFMR TYPE: Y to DELTA XFORMER
NUMBER OF TAPS: 1
STATION:
CIRCUIT:
MFR:
MODEL:
S/N:

RECORD NUMBER: 2
DATE/TIME: 08/18/10 11:01:53
XFMR TYPE: SINGLE PHASE XFORMER
NUMBER OF TAPS: 1
STATION:
CIRCUIT:
MFR:
MODEL:
S/N:

RECORD NUMBER: 1
DATE/TIME: 08/18/10 10:56:05
XFMR TYPE: SINGLE PHASE XFORMER
NUMBER OF TAPS: 1
STATION:
CIRCUIT:
MFR:
MODEL:
S/N:
```


Figure 21. Typical Test Record Directory Printout

3.7.4. Erasing Test Records from the Flash EEPROM

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

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

```
1.TEST XFMR 08/23/10
2.SETUP     08:25:15
3.CALCULATOR
4.DIAG   5.QUICK TST
```

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

b. The following screen will be displayed:

```
1.ENTER XFMR ID
2.REVIEW RECORD
3.RESTORE RECORD
4.NEXT PAGE
```

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

c. The following screen will be displayed:

```
1.RESTORE RECORD
2.DIRECTORY
3.ERASE RECORDS
```

Press the **[3]** key (*ERASE RECORDS*).

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.*) to erase a single test record from the unit's internal Flash EEPROM. The following screen will be displayed:

```
    ERASE RECORD
    NUMBER:
```

NOTE

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

Type the record number that you would like to erase using the alpha-numeric keypad and then press the **[ENTER]** key. If you do not know the test record number, you can first print or view a test record directory using the instructions in section 3.7.3 and **Error! Reference source not found.**, respectively. The following screen will be displayed while the record is being erased:

```
   ERASING RECORD
   NUMBER: 1
   PLEASE WAIT...
```

The following screen will be displayed when the test record has been completely erased:

```
RECORD NUMBER 1
 ERASED!
```


Press any key to continue. You will be returned to "START-UP" menu.

2. *ERASE ALL RECORDS*

Press the **[2]** key (*ERASE ALL RECORDS*) to erase all the test records from the unit's internal Flash EEPROM. The following warning screen will be displayed:

```
 ERASE ALL RECORDS!
   Are you SURE?

"ENTER" TO CONTINUE
```

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

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

```
  ERASING RECORDS

   PLEASE WAIT...
```

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

```
  RECORDS ERASED!
```

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

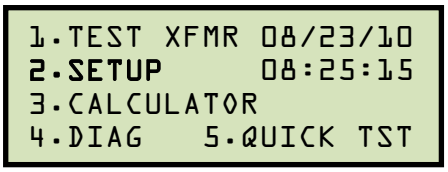
3.8 Working With Test Plans

The ATRT-03 comes with the Vanguard Transformer Turns Ratio Analyzer software (TTRA) that can be used to create transformer test plans on a PC (see the TTRA software manual for details). Test plans can then be transferred to the ATRT-03 and used to quickly perform tests.

3.8.1. Performing a Test Using a Transformer Test Plan

Follow the steps below to perform a test using a test plan:

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

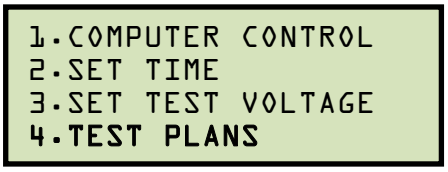


Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:

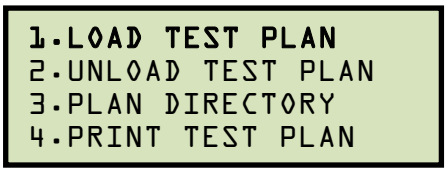
Press the **[4]** key (*NEXT PAGE*).

c. The following screen will be displayed:



Press the **[4]** key (*TEST PLANS*).

d. The following screen will be displayed:



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

e. The following screen will be displayed:

```
   LOAD TEST PLAN

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

1. *ENTER PLAN NUMBER*

   Press the **[1]** key (*ENTER PLAN NUMBER*) if you know the test plan number that you would like to use. The following screen will be displayed:

```
   LOAD TEST PLAN
   NUMBER:
```

   Type the test plan number to load from the unit's Flash EEPROM and then press the [ENTER] key. The test plan will be loaded and you will be returned to the "START-UP" menu. **Continue to step f to perform a test using the loaded test plan.**

2. *SCROLL TO SELECT*

   Press the **[2]** key (*SCROLL TO SELECT*) to scroll through a directory of the test plans stored in the unit's Flash EEPROM. The following screen will be displayed:

```
TEST PLAN DIRECTORY

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

   Press either the **[PAPER ∧ Contrast]** or **[PAPER ∨ Contrast]** key to scroll forward or reverse through the test plan directory. The test plan header will be displayed:

```
1    Y-DELTA TAPS:20
Siemens
```

   Continue to press the **[PAPER ∧ Contrast]** or **[PAPER ∨ Contrast]** key until you have located the test plan that you would like to use, and then press the **[ENTER]** key. The selected test plan will be loaded and you will be returned to the "START-UP" menu. **Continue to step f to perform a test using the loaded test plan.**

f. Start from the "START-UP" menu again to run a test using the loaded test plan from the previous steps:

```
1.TEST XFMR 08/23/10
2.SETUP     08:25:15
3.CALCULATOR
4.DIAG   5.QUICK TST
```

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

g. The following screen will be displayed (test details will differ depending on the test type defined in the test plan):

```
#1   Y-DELTA TAPS:20
  TEST PLAN LOADED
1.CONTINUE
2.UNLOAD TEST PLAN
```

NOTE The above screen will be displayed only if a test plan is loaded first.

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

h. The following screen will be displayed:

```
STOP BETWEEN PHASES?
1.NO
2.YES
```

Press the **[1]** key (*NO*).

i. The following screen will be displayed:

```
TAP NUMBER 1
H VTG: 1,734
X VTG: 100
"START" to RUN TEST
```

Set the transformer to the tap position indicated on the LCD screen. Press the **[START]** key to run the test using the test plan.

j. The unit will start performing the test and the screen will be updated with the test results as shown:

```
 RATIO    mA   % DIFF
+10.022 0012    0.10P
+10.005 0011    0.06P
+10.023 0017    0.11P
```

NOTE

For each phase (A, B, and C) a "P" or "F" will be displayed to indicate Pass or Fail, respectively.

Press any key to continue.

If using an ATRT-03 or ATRT-03A, continue to step k.

If using an ATRT-03B, continue to step m.

k. The following screen will be displayed:

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

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

l. The following screen will be displayed:

```
PRINT FORMAT?
1.COLUMN
2.DETAILED
```

Press the **[1]** key (*COLUMN*) to print a columnar report or press the **[2]** key (*DETAILED*) to print a detailed report. Please see Figure 22 for a sample printout.

m. The following screen will be displayed:

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

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

n. The following screen will be displayed:

```
     TEST SAVED
```

Press any key to continue.

o. If the test plan included multiple tests, the start-up screen for the next test will be displayed as shown:

```
TAP NUMBER 2
H VTG: 1500
X VTG: 150
"START" to RUN TEST
```

Repeat steps i through n for this test.

p. The following screen will be displayed after the last defined test in the test plan has been performed:

```
  END OF TEST PLAN
```

Press any key to continue.

q. The following screen will be displayed:

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

Press the **[1]** key (*YES*) to save the test record to the unit's Flash EEPROM.

r. The following screen will be displayed momentarily:

```
SAVING RECORD...

PLEASE WAIT...
```

The following confirmation screen will then be displayed:

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

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

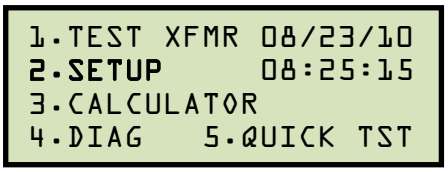
```
                TRANSFORMER TEST RESULTS
DATE:08/25/10          TIME:11:47:10
COMPANY:          VANGUARD
STATION:
CIRCUIT:
MFR:              SIEMENS
MODEL:
S/N:
KVA RATING:
OPERATOR:         HAI
TEST VOLTAGE = 40 VOLTS
TYPE: Y to DELTA XFORMER
H TAP:_________   H VOLTAGE:  001,734
X TAP:_________   X VOLTAGE:  000,100
PHS  M_RATIO   mA     %DIFF     C_RATIO
 A   +10.022  0012   00.10 P  10.0112
 B   +10.005  0011   00.06 P  10.0112
 C   +10.023  0013   00.11 P  10.0112
DATE:08/25/10          TIME:11:55:34
```

Figure 22. Test Plan Test Results Printout

3.8.2. Unloading a Test Plan From the Working Memory

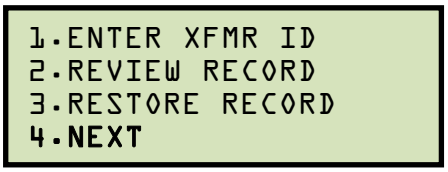
Follow the steps below to unload a test plan from the working memory:

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



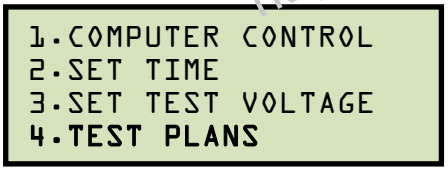
Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:



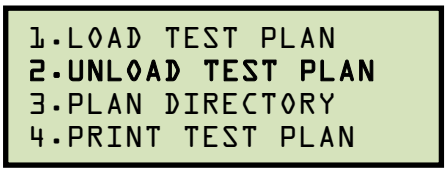
Press the **[4]** key (*NEXT*).

c. The following screen will be displayed:



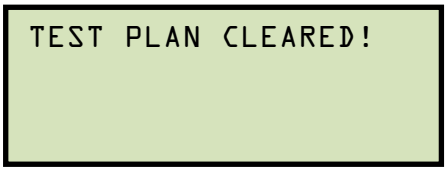
Press the **[4]** key (*TEST PLANS*).

d. The following screen will be displayed:



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

e. The test plan will be unloaded from the working memory, and the following screen will be displayed:



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

3.8.3. Printing or Viewing the Test Plan Directory

Follow the steps below to print a directory of the test plans stored in the unit's Flash EEPROM (ATRT-03 and ATRT-03A only) or to view the test plan directory on the LCD screen (ATRT-03B):

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

```
1.TEST XFMR 08/23/10
2.SETUP     08:25:15
3.CALCULATOR
4.DIAG   5.QUICK TST
```

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

b. The following screen will be displayed:

```
1.ENTER XFMR ID
2.REVIEW RECORD
3.RESTORE RECORD
4.NEXT PAGE
```

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

c. The following screen will be displayed:

```
1.COMPUTER CONTROL
2.SET TIME
3.SET TEST VOLTAGE
4.TEST PLANS
```

Press the **[4]** key (*TEST PLANS*).

d. The following screen will be displayed:

```
1.LOAD TEST PLAN
2.UNLOAD TEST PLAN
3.PLAN DIRECTORY
4.PRINT TEST PLAN
```

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

If using an ATRT-03 or ATRT-03A, the test plan directory will be printed on the built-in thermal printer and you will be returned to the "START-UP" menu.

If using an ATRT-03B, continue to step e.

e. The following screen will be displayed:

```
TEST PLAN DIRECTORY

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

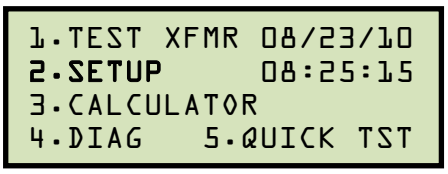
Press either the **[PAPER ∧ Contrast]** or **[PAPER ∨ Contrast]** key to scroll forward or reverse through the test plan directory. The test plan header will be displayed:

Press the **[STOP]** key when you are done browsing the test plan directory. You will be returned to the "START-UP" menu.

3.8.4. Printing a Test Plan (ATRT-03 and ATRT-03A Only)

Follow the steps below to print a test plan from the internal Flash EEPROM (ATRT-03 and ATRT-03A only):

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

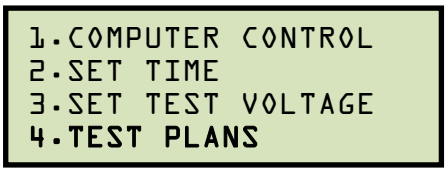


Press the **[2]** key (*SETUP*).

b. The following screen will be displayed:

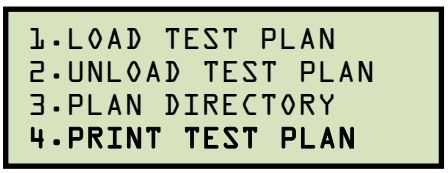
Press the **[4]** key (*NEXT PAGE*).

c. The following screen will be displayed:



Press the **[4]** key (*TEST PLANS*).

d. The following screen will be displayed:



Press the **[4]** key (*PRINT TEST PLAN*).

e. The following screen will be displayed:

```
  PRINT TEST PLAN

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

1. *ENTER PLAN NUMBER*

   Press the **[1]** key (*ENTER PLAN NUMBER*) if you know the test plan number that you would like to print**.** The following screen will be displayed:

```
  PRINT TEST PLAN
   NUMBER:
```

   Type the test plan number using the alpha-numeric keypad and then press the **[ENTER]** key. The test plan will be printed on the built-in thermal printer and you will be returned to the "START-UP" menu. Please see Figure 23 for a sample test plan printout.

2. *SCROLL TO SELECT*

   Press the **[2]** key (*SCROLL TO SELECT*) to select a test plan by scrolling through the test plan directory. The following screen will be displayed:

```
TEST PLAN DIRECTORY

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

   Press either the **[PAPER ∧ Contrast]** or **[PAPER ∨ Contrast]** key to scroll forward or reverse through the test plan directory. The test plan header will be displayed:

```
1    Y-DELTA TAPS:20
Siemens
```

   Continue to press the **[PAPER ∧ Contrast]** or **[PAPER ∨ Contrast]** key until you have located the test plan you would like to print, and then press the **[ENTER]** key. The selected test plan will be printed and you will be returned to the "START-UP" menu. Please see Figure 23 for a sample test plan printout.

```
                TEST PLAN NUMBER 8

TYPE:  SINGLE PHASE XFORMER
       VOLTAGE REGULATOR

TEST VOLTAGE = 40 V

MFR:              Westinghouse
MODEL:            2000288
KVA RATING:       10KVA
COMMENTS:         Voltage Reg Test

MAX DEVIATION:  0.50%

NUMBER OF TAPS:  9

TAP:  RAISE 4
    H VOLTAGE:  007,200 V
    X VOLTAGE:  007,380 V

TAP:  RAISE 3
    H VOLTAGE:  007,200 V
    X VOLTAGE:  007,335 V

TAP:  RAISE 2
    H VOLTAGE:  007,200 V
    X VOLTAGE:  007,290 V

TAP:  RAISE 1
    H VOLTAGE:  007,200 V
    X VOLTAGE:  007,245 V

TAP:  NEUTRAL
    H VOLTAGE:  007,200 V
    X VOLTAGE:  007,200 V

TAP:  LOWER 1
    H VOLTAGE:  007,200 V
    X VOLTAGE:  007,155 V

TAP:  LOWER 2
    H VOLTAGE:  007,200 V
    X VOLTAGE:  007,110 V

TAP:  LOWER 3
    H VOLTAGE:  007,200 V
    X VOLTAGE:  007,065 V

TAP:  LOWER 4
    H VOLTAGE:  007,200 V
    X VOLTAGE:  007,020 V
```


Figure 23. Sample Test Plan Printout

4.0 DIAGNOSTICS, VERIFICATION, AND TROUBLESHOOTING

4.1 Performing an H and X Cable Diagnostic Test

Use the steps below to perform a diagnostic test on the H and X cables:

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

```
1.TEST XFMR 08/23/10
2.SETUP     08:25:15
3.CALCULATOR
4.DIAG   5.QUICK TST
```

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

b. The following screen will be displayed:

```
1.CABLE TEST
2.VERIFICATION TEST
3.AUTO-DETECT XFMR
```

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

c. The following screen will be displayed:

```
     CABLE TEST
CONNECT:H0-X0, H1-X1
        H2-X2, H3-X3
THEN "ENTER" KEY...
```

Connect the H and X cables per the on-screen instructions and press the **[ENTER]** key.

d. The following screen will be displayed while the cables are being tested:

```
     CABLE TEST
```

The screen will be updated with the status of each test as shown:

```
     CABLE TEST
H0-X0, H1-X1: OK
H0-X0, H2-X2: OK
H0-X0, H3-X3: OK
```

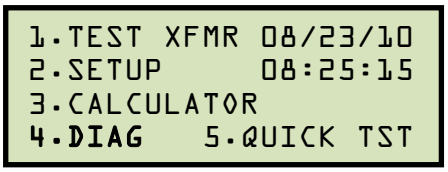
NOTE "NOT OK" will be displayed for a failed diagnostic test.

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

4.2 Performing a Verification Test

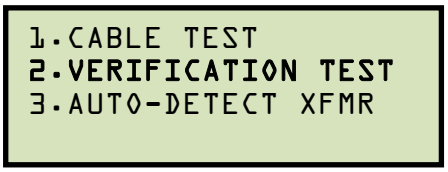
Use the steps below to perform a verification test on the ATRT-03's electronics:

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



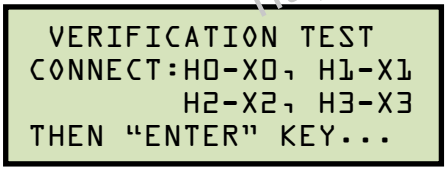
Press the **[4]** key (*DIAG*).

b. The following screen will be displayed:



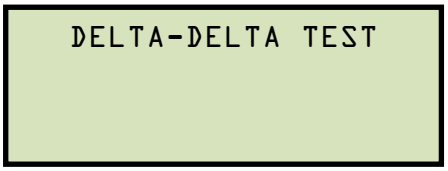
Press the **[2]** key (*VERIFICATION TEST*).

c. The following screen will be displayed:

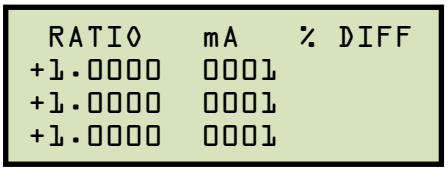


Connect the H and X cables per the on-screen instructions and then press the **[ENTER]** key.

d. The ATRT-03 will start performing a DELTA-DELTA test. The following screen will be displayed momentarily:



The screen will then be updated with the test results for each phase:



Press any key to continue. The unit will then proceed to perform a Y to Y test. The following screen will be displayed momentarily:

```
     Y TO Y TEST
```

The screen will then be updated with the test results for each phase:

```
 RATIO    mA    % DIFF
+1.0000  0001
+1.0000  0001
+1.0000  0001
```

NOTE The ratio reading should be 1.0000 ±0.1% for all tests.

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

APPENDIX A – TRANSFORMER VECTOR GROUP CODES

Utility power transformers manufactured in accordance with IEC specifications have a Rating Plate attached in a visible location. This plate contains a list of the transformer's configuration and operating specifications. One such rating is the winding configuration and phase-displacement code. This code follows a convention that comprises letter and number sets that denote three-phase winding configurations (i.e., Wye, delta, or zig-zag). Letter symbols for the different windings are noted in descending order of their rated voltages. That is, symbols denoting higher voltage ratings will be in upper-case letters and symbols denoting lower or intermediate voltage ratings will be in lower-case letters. If the neutral point of either a wye or zig-zag winding is brought out, the indication will be an N (high voltage) or n (lower voltage). The end numeral is a 300 multiplier that indicates phase lag between windings.

Accordingly, the following standard practice applies:

Wye (or star) = Y (high voltage) or y (low voltage)

Delta = D (high voltage) or d (low voltage)

Zig-zag = Z (high voltage) or z (low voltage)

For example, **Dyn11** decodes as follows:

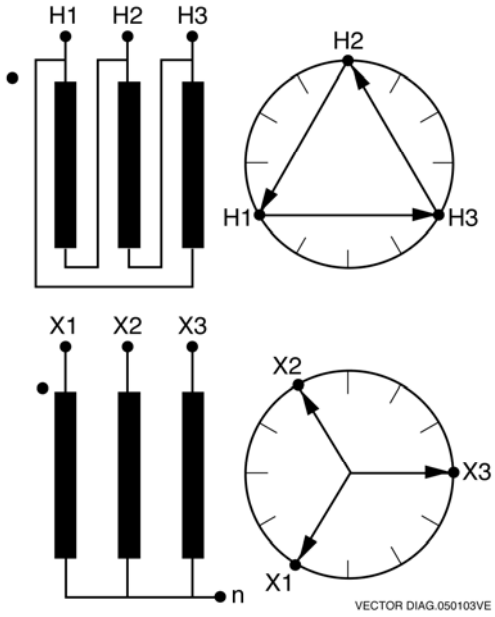
D indicates that the high-voltage windings are connected in a Delta configuration

(Since delta windings do not have a neutral point, the N never appears after a D).

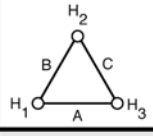
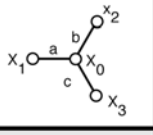
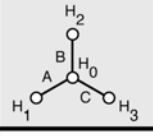
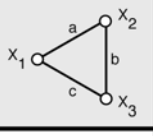
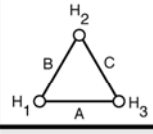
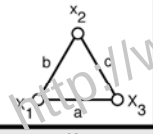
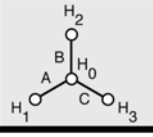
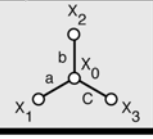
y indicates that the lower voltage winding is in a wye (or star) configuration.

n indicates that the lower voltage windings have the neutral point brought out.

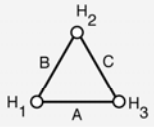
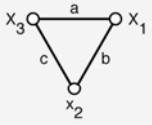
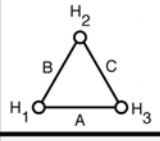
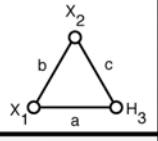
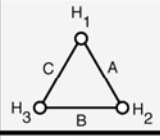
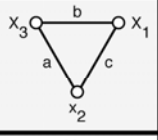
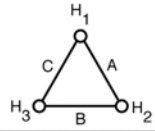
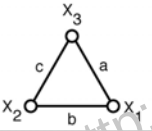
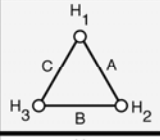
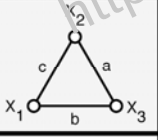
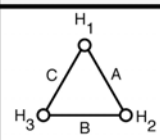
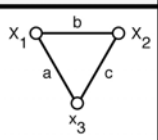
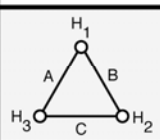
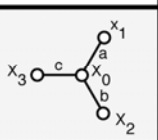
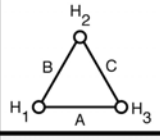
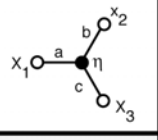
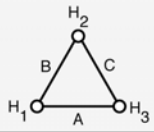
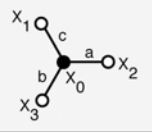
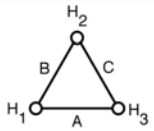
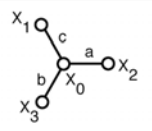
11 indicates a phase-displacement lag of 330 degrees between the Wye and the Delta winding.



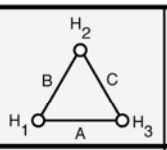
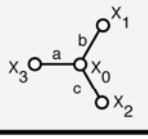
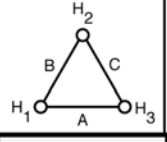
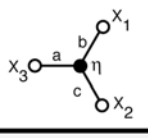
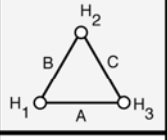
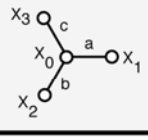
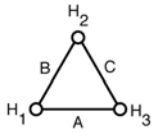
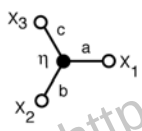
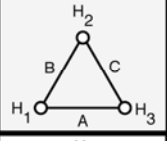
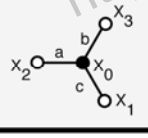
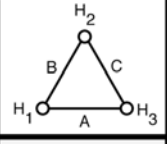
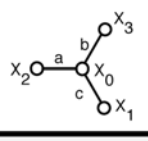
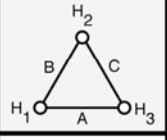
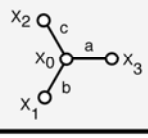
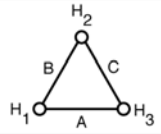
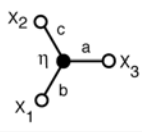
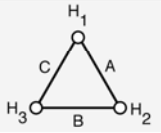
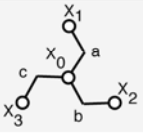
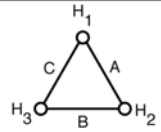
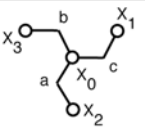
APPENDIX B – Common ANSI Transformer Descriptions

STD TEST NO.	TRANSFORMER CONFIGURATION		PHASE	WINDING TESTED		TURNS RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)		HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
1			1 Ø	$H_1 - H_2$	$X_1 - X_2$	$\frac{V_H}{V_x}$	1ph0	SNG – PHS
2			A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_1 - X_0$ $X_2 - X_0$ $X_3 - X_0$	$\frac{V_H \cdot \sqrt{3}}{V_x}$	Dyn1	d t – Y
3			A B C	$H_1 - H_0$ $H_2 - H_0$ $H_3 - H_0$	$X_1 - X_2$ $X_2 - X_3$ $X_3 - X_1$	$\frac{V_H}{V_x \cdot \sqrt{3}}$	YNd1	y – d t
4			A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_1 - X_3$ $X_2 - X_1$ $X_3 - X_2$	$\frac{V_H}{V_x}$	Dd0	d t – d t
5			A B C	$H_1 - H_0$ $H_2 - H_0$ $H_3 - H_0$	$X_1 - X_0$ $X_2 - X_0$ $X_3 - X_0$	$\frac{V_H}{V_x}$	YNyn0	y – y

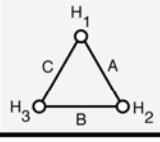
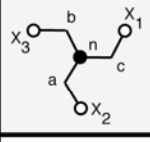
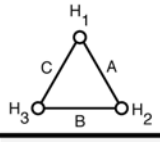
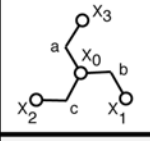
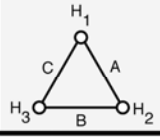
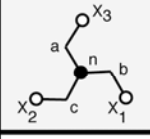
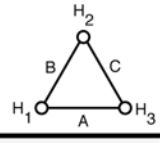
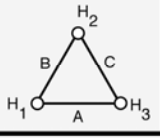
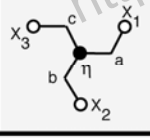
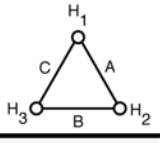
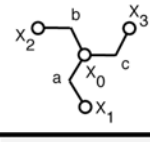
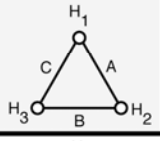
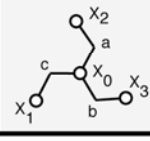
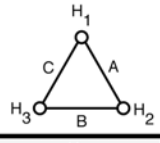
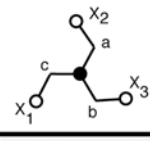
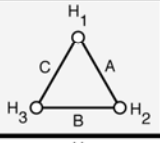
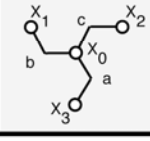
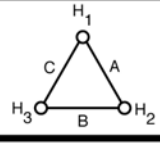
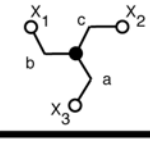
VANGUARD.050207V1

SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
1			—	A	$H_1 - H_3$	$X_3 - X_1$	$\frac{V_H}{V_x}$	Dd6	
				B	$H_2 - H_1$	$X_1 - X_2$			
				C	$H_3 - H_2$	$X_2 - X_3$			
37			—	A	$H_1 - H_3$	$X_1 - X_3$	$\frac{V_H}{V_x}$	Dd0	
				B	$H_2 - H_1$	$X_2 - X_1$			
				C	$H_3 - H_2$	$X_3 - X_2$			
38			—	A	$H_1 - H_2$	$X_3 - X_2$	$\frac{V_H}{V_x}$	Dd2	
				B	$H_2 - H_3$	$X_1 - X_3$			
				C	$H_3 - H_1$	$X_2 - X_1$			
39			—	A	$H_1 - H_2$	$X_3 - X_1$	$\frac{V_H}{V_x}$	Dd4	
				B	$H_2 - H_3$	$X_1 - X_2$			
				C	$H_3 - H_1$	$X_2 - X_3$			
40			—	A	$H_1 - H_2$	$X_2 - X_3$	$\frac{V_H}{V_x}$	Dd8	
				B	$H_2 - H_3$	$X_3 - X_1$			
				C	$H_3 - H_1$	$X_1 - X_2$			
41			—	A	$H_1 - H_2$	$X_1 - X_3$	$\frac{V_H}{V_x}$	Dd10	
				B	$H_2 - H_3$	$X_2 - X_1$			
				C	$H_3 - H_1$	$X_3 - X_2$			
42			—	A	$H_1 - H_3$	$X_1 - X_0$	$\frac{V_H \cdot \sqrt{3}}{V_x}$	Dyn1	
				B	$H_2 - H_1$	$X_2 - X_0$			
				C	$H_3 - H_2$	$X_3 - X_0$			
2			$H_3 - H_2$ $H_1 - H_3$ $H_2 - H_1$	A	$H_1 - H_3$	$X_1 - X_3$	$\frac{V_H \cdot \sqrt{3}}{V_x}$	Dy1	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	$H_2 - H_1$	$X_2 - X_1$			
				C	$H_3 - H_2$	$X_3 - X_2$			
61			$H_3 - H_2$ $H_1 - H_3$ $H_2 - H_1$	A	$H_1 - H_3$	$X_1 - X_2$	$\frac{V_H \cdot \sqrt{3}}{V_x}$	Dy3	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	$H_2 - H_1$	$X_2 - X_3$			
				C	$H_3 - H_2$	$X_3 - X_1$			
62			—	A	$H_1 - H_3$	$X_0 - X_2$	$\frac{V_H \cdot \sqrt{3}}{V_x}$	Dyn3	
				B	$H_2 - H_1$	$X_0 - X_3$			
				C	$H_3 - H_2$	$X_0 - X_1$			

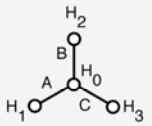
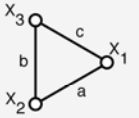
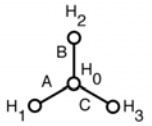
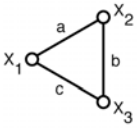
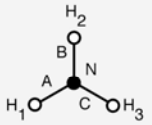
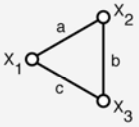
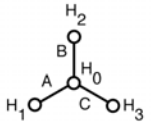
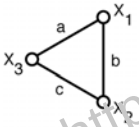
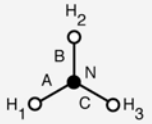
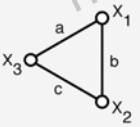
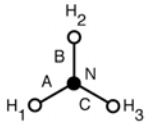
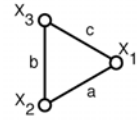
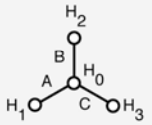
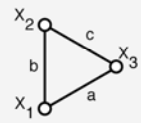
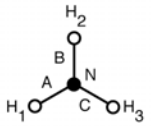
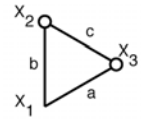
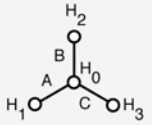
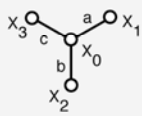
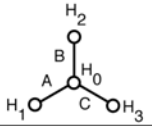
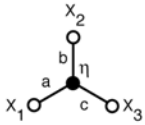
VANGUARD.050108V1

SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
3			—	A	$H_1 - H_3$	$X_3 - X_0$	$\frac{V_H \bullet \sqrt{3}}{V_x}$	Dyn5	
				B	$H_2 - H_1$	$X_1 - X_0$			
				C	$H_3 - H_2$	$X_2 - X_0$			
4			$H_3 - H_2$	A	$H_1 - H_3$	$X_3 - X_2$	$\frac{V_H \bullet \sqrt{3}}{V_x}$	Dy5	NO ACCESSIBLE NEUTRAL ON WYE WINDING
			$H_1 - H_3$	B	$H_2 - H_1$	$X_1 - X_3$			
			$H_2 - H_1$	C	$H_3 - H_2$	$X_2 - X_1$			
5			—	A	$H_1 - H_3$	$X_0 - X_1$	$\frac{V_H \bullet \sqrt{3}}{V_x}$	Dyn7	
				B	$H_2 - H_1$	$X_0 - X_2$			
				C	$H_3 - H_2$	$X_0 - X_3$			
6			$H_3 - H_2$	A	$H_1 - H_3$	$X_3 - X_1$	$\frac{V_H \bullet \sqrt{3}}{V_x}$	Dy7	NO ACCESSIBLE NEUTRAL ON WYE WINDING
			$H_1 - H_3$	B	$H_2 - H_1$	$X_1 - X_2$			
			$H_2 - H_1$	C	$H_3 - H_2$	$X_2 - X_3$			
63			$H_3 - H_2$	A	$H_1 - H_3$	$X_2 - X_1$	$\frac{V_H \bullet \sqrt{3}}{V_x}$	Dy9	NO ACCESSIBLE NEUTRAL ON WYE WINDING
			$H_1 - H_3$	B	$H_2 - H_1$	$X_3 - X_2$			
			$H_2 - H_1$	C	$H_3 - H_2$	$X_1 - X_3$			
64			—	A	$H_1 - H_3$	$X_2 - X_0$	$\frac{V_H \bullet \sqrt{3}}{V_x}$	Dyn9	
				B	$H_2 - H_1$	$X_3 - X_0$			
				C	$H_3 - H_2$	$X_1 - X_0$			
7			—	A	$H_1 - H_3$	$X_0 - X_3$	$\frac{V_H \bullet \sqrt{3}}{V_x}$	Dyn11	
				B	$H_2 - H_1$	$X_0 - X_1$			
				C	$H_3 - H_2$	$X_0 - X_2$			
8			$H_3 - H_2$	A	$H_1 - H_3$	$X_2 - X_3$	$\frac{V_H \bullet \sqrt{3}}{V_x}$	Dy11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
			$H_1 - H_3$	B	$H_2 - H_1$	$X_3 - X_1$			
			$H_2 - H_1$	C	$H_3 - H_2$	$X_1 - X_2$			
45			$H_2 - H_3$	A	$H_1 - H_2$	$X_1 - X_0$	$\frac{3}{2} \bullet \frac{V_H}{V_x}$	Dzn0	
			$H_3 - H_1$	B	$H_2 - H_3$	$X_2 - X_0$			
			$H_1 - H_2$	C	$H_3 - H_1$	$X_3 - X_0$			
46			$H_2 - H_3$	A	$H_1 - H_2$	$X_0 - X_2$	$\frac{3}{2} \bullet \frac{V_H}{V_x}$	Dzn2	
			$H_3 - H_1$	B	$H_2 - H_3$	$X_0 - X_3$			
			$H_1 - H_2$	C	$H_3 - H_1$	$X_0 - X_1$			

VANGUARD.050108V2

SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	WINDING TESTED			CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)		PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
47			—	A	$H_1 - H_2$	$X_3 - X_2$	$\frac{V_H}{V_x}$	Dz2	NO ACCESSIBLE NEUTRAL
				B	$H_2 - H_3$	$X_1 - X_3$			
				C	$H_3 - H_1$	$X_2 - X_1$			
48			$H_2 - H_3$	A	$H_1 - H_2$	$X_3 - X_0$	$\frac{3}{2} \bullet \frac{V_H}{V_x}$	Dzn4	
			$H_3 - H_1$	B	$H_2 - H_3$	$X_1 - X_0$			
			$H_1 - H_2$	C	$H_3 - H_1$	$X_2 - X_0$			
49			—	A	$H_1 - H_2$	$X_3 - X_1$	$\frac{V_H}{V_x}$	Dz4	NO ACCESSIBLE NEUTRAL
				B	$H_2 - H_3$	$X_1 - X_2$			
				C	$H_3 - H_1$	$X_2 - X_3$			
9			—	A	$H_1 - H_3$	$X_1 - X_3$	$\frac{V_H}{V_x}$	Dz0	NO ACCESSIBLE NEUTRAL
				B	$H_2 - H_1$	$X_2 - X_1$			
				C	$H_3 - H_2$	$X_3 - X_2$			
10			—	A	$H_1 - H_3$	$X_3 - X_1$	$\frac{V_H}{V_x}$	Dz6	NO ACCESSIBLE NEUTRAL
				B	$H_2 - H_1$	$X_1 - X_2$			
				C	$H_3 - H_2$	$X_2 - X_3$			
50			$H_2 - H_3$	A	$H_1 - H_2$	$X_0 - X_1$	$\frac{3}{2} \bullet \frac{V_H}{V_x}$	Dzn6	
			$H_3 - H_1$	B	$H_2 - H_3$	$X_0 - X_2$			
			$H_1 - H_2$	C	$H_3 - H_1$	$X_0 - X_3$			
51			$H_2 - H_3$	A	$H_1 - H_2$	$X_2 - X_0$	$\frac{3}{2} \bullet \frac{V_H}{V_x}$	Dzn8	
			$H_3 - H_1$	B	$H_2 - H_3$	$X_3 - X_0$			
			$H_1 - H_2$	C	$H_3 - H_1$	$X_1 - X_0$			
52			—	A	$H_1 - H_2$	$X_2 - X_3$	$\frac{V_H}{V_x}$	Dz8	NO ACCESSIBLE NEUTRAL
				B	$H_2 - H_3$	$X_3 - X_1$			
				C	$H_3 - H_1$	$X_1 - X_2$			
53			$H_2 - H_3$	A	$H_1 - H_2$	$X_0 - X_3$	$\frac{3}{2} \bullet \frac{V_H}{V_x}$	Dzn10	
			$H_3 - H_1$	B	$H_2 - H_3$	$X_0 - X_1$			
			$H_1 - H_2$	C	$H_3 - H_1$	$X_0 - X_2$			
54			—	A	$H_1 - H_2$	$X_1 - X_3$	$\frac{V_H}{V_x}$	Dz10	NO ACCESSIBLE NEUTRAL
				B	$H_2 - H_3$	$X_2 - X_1$			
				C	$H_3 - H_1$	$X_3 - X_2$			

VANGUARD.050108V3

SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	WINDING TESTED			CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)		PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
11			—	A	$H_1 - H_0$	$X_2 - X_1$	$\frac{V_H}{V_X \bullet \sqrt{3}}$	YNd7	
				B	$H_2 - H_0$	$X_3 - X_2$			
				C	$H_3 - H_0$	$X_1 - X_3$			
44			—	A	$H_1 - H_0$	$X_1 - X_2$	$\frac{V_H}{V_X \bullet \sqrt{3}}$	YNd1	
				B	$H_2 - H_0$	$X_2 - X_3$			
				C	$H_3 - H_0$	$X_3 - X_1$			
12			$H_3 - H_2$	A	$H_1 - H_3$	$X_1 - X_2$	$\frac{V_H}{V_X} \bullet \frac{\sqrt{3}}{2}$	Yd1	NO ACCESSIBLE NEUTRAL ON WYE WINDING
			$H_1 - H_3$	B	$H_2 - H_1$	$X_2 - X_3$			
			$H_2 - H_1$	C	$H_3 - H_2$	$X_3 - X_1$			
13			—	A	$H_1 - H_0$	$X_3 - X_2$	$\frac{V_H}{V_X \bullet \sqrt{3}}$	YNd5	
				B	$H_2 - H_0$	$X_1 - X_2$			
				C	$H_3 - H_0$	$X_2 - X_3$			
14			$H_3 - H_2$	A	$H_1 - H_3$	$X_3 - X_1$	$\frac{V_H}{V_X} \bullet \frac{\sqrt{3}}{2}$	Yd5	NO ACCESSIBLE NEUTRAL ON WYE WINDING
			$H_1 - H_3$	B	$H_2 - H_1$	$X_1 - X_2$			
			$H_2 - H_1$	C	$H_3 - H_2$	$X_2 - X_3$			
15			$H_3 - H_2$	A	$H_1 - H_3$	$X_2 - X_1$	$\frac{V_H}{V_X} \bullet \frac{\sqrt{3}}{2}$	Yd7	NO ACCESSIBLE NEUTRAL ON WYE WINDING
			$H_1 - H_3$	B	$H_2 - H_1$	$X_3 - X_2$			
			$H_2 - H_1$	C	$H_3 - H_2$	$X_1 - X_3$			
16			—	A	$H_1 - H_0$	$X_1 - X_3$	$\frac{V_H}{V_X \bullet \sqrt{3}}$	YNd11	
				B	$H_2 - H_0$	$X_2 - X_1$			
				C	$H_3 - H_0$	$X_3 - X_2$			
17			$H_3 - H_2$	A	$H_1 - H_3$	$X_1 - X_3$	$\frac{V_H}{V_X} \bullet \frac{\sqrt{3}}{2}$	Yd11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
			$H_1 - H_3$	B	$H_2 - H_1$	$X_2 - X_1$			
			$H_2 - H_1$	C	$H_3 - H_2$	$X_3 - X_2$			
18			—	A	$H_1 - H_0$	$X_0 - X_1$	$\frac{V_H}{V_X}$	YNyn6	
				B	$H_2 - H_0$	$X_0 - X_2$			
				C	$H_3 - H_0$	$X_0 - X_3$			
19			$H_2 - H_0$	A	$H_1 - H_0$	$X_1 - X_2$	$\frac{V_H}{V_X}$	YNy0	NO ACCESSIBLE NEUTRAL ON LOW VOLTAGE WINDING
			$H_3 - H_0$	B	$H_2 - H_0$	$X_2 - X_3$			
			$H_1 - H_0$	C	$H_3 - H_0$	$X_3 - X_1$			

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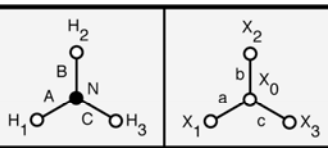
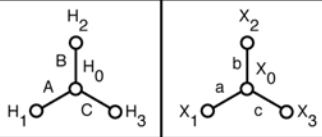
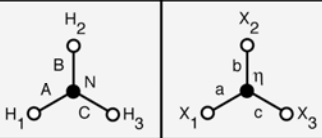
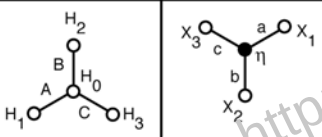
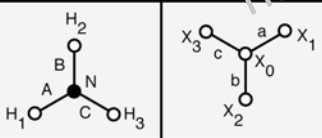
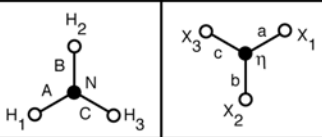
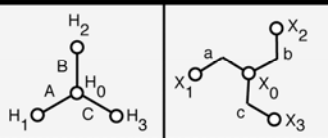
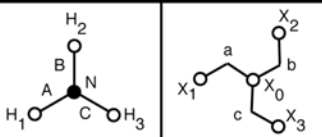
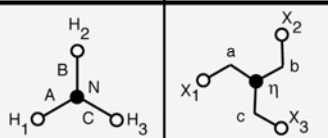
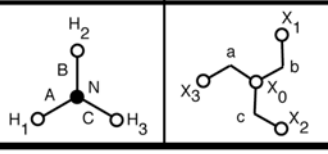
SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	WINDING TESTED			CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)		PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
20			X_3-X_0 X_1-X_0 X_2-X_0	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_1-X_0 X_2-X_0 X_3-X_0	$\frac{V_H}{V_x}$	Yyn0	NO ACCESSIBLE NEUTRAL ON HIGH VOLTAGE WINDING
43			—	A B C	H_1-H_0 H_2-H_0 H_3-H_0	X_1-X_0 X_2-X_0 X_3-X_0	$\frac{V_H}{V_L}$	YNyn0	
21			—	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_1-X_3 X_2-X_1 X_3-X_2	$\frac{V_H}{V_x}$	Yy0	NO ACCESSIBLE NEUTRAL
22			H_2-H_0 H_3-H_0 H_1-H_0	A B C	H_1-H_0 H_2-H_0 H_3-H_0	X_2-X_1 X_3-X_2 X_1-X_3	$\frac{V_H}{V_x}$	YNy6	NO ACCESSIBLE NEUTRAL ON LOW VOLTAGE WINDING
23			X_3-X_0 X_1-X_0 X_2-X_0	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_0-X_1 X_0-X_2 X_0-X_3	$\frac{V_H}{V_x}$	Yyn6	NO ACCESSIBLE NEUTRAL ON HIGH VOLTAGE WINDING
24			—	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_3-X_1 X_1-X_2 X_2-X_3	$\frac{V_H}{V_x}$	Yy6	NO ACCESSIBLE NEUTRAL
65			—	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_1-X_0 X_2-X_0 X_3-X_0	$\frac{V_H \bullet \sqrt{3}}{V_x}$	YNzn1	
25			—	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_1-X_0 X_2-X_0 X_3-X_0	$\frac{V_H \bullet \sqrt{3}}{V_x}$	Yzn1	NO ACCESSIBLE NEUTRAL ON WYE WINDING
26			H_3-H_2 H_1-H_3 H_2-H_1	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_1-X_2 X_2-X_3 X_3-X_1	$\frac{V_H}{V_x} \bullet \frac{\sqrt{3}}{2}$	Yz1	NO ACCESSIBLE NEUTRAL
27			—	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_3-X_0 X_1-X_0 X_2-X_0	$\frac{V_H \bullet \sqrt{3}}{V_x}$	Yzn5	NO ACCESSIBLE NEUTRAL ON WYE WINDING

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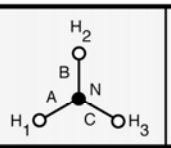
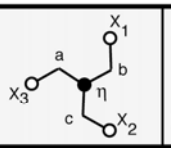
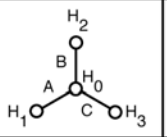
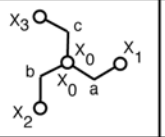
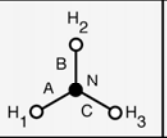
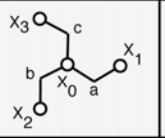
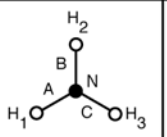
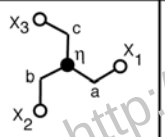
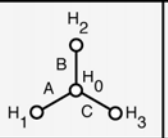
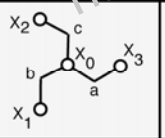
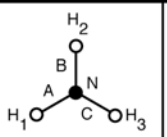
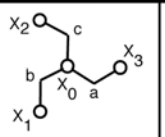
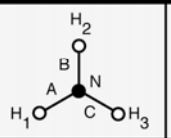
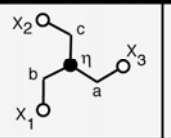
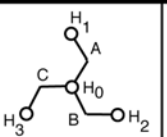
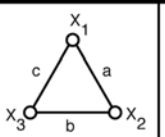
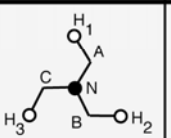
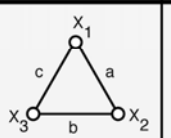
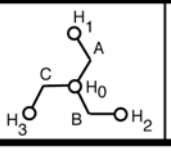
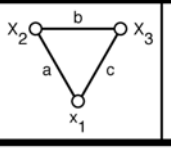
SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	WINDING TESTED			CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)		PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
28			H_3-H_2 H_1-H_3 H_2-H_1	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_3-X_1 X_1-X_2 X_2-X_3	$\frac{V_H}{V_x}\bullet\frac{\sqrt{3}}{2}$	Yz5	NO ACCESSIBLE NEUTRAL
66			—	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_0-X_1 X_0-X_2 X_0-X_3	$\frac{V_H}{V_x}\bullet\sqrt{3}$	YNzn7	
29			—	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_0-X_1 X_0-X_2 X_0-X_3	$\frac{V_H\bullet\sqrt{3}}{V_x}$	Yzn7	NO ACCESSIBLE NEUTRAL ON WYE WINDING
30			H_3-H_2 H_1-H_3 H_2-H_1	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_2-X_1 X_3-X_2 X_1-X_3	$\frac{V_H}{V_x}\bullet\frac{\sqrt{3}}{2}$	Yz7	NO ACCESSIBLE NEUTRAL
67			—	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_0-X_3 X_0-X_1 X_0-X_2	$\frac{V_H\bullet\sqrt{3}}{V_x}$	YNzn11	
31			—	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_0-X_3 X_0-X_1 X_0-X_2	$\frac{V_H\bullet\sqrt{3}}{V_x}$	Yzn11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
32			H_3-H_2 H_1-H_3 H_2-H_1	A B C	H_1-H_3 H_2-H_1 H_3-H_2	X_1-X_3 X_2-X_1 X_3-X_2	$\frac{V_H}{V_x}\bullet\frac{\sqrt{3}}{2}$	Yz11	NO ACCESSIBLE NEUTRAL
55			X_2-X_3 X_3-X_1 X_1-X_2	A B C	H_1-H_0 H_2-H_0 H_3-H_0	X_1-X_2 X_2-X_3 X_3-X_1	$\frac{2}{3}\bullet\frac{V_H}{V_x}$	ZNd0	
56			—	A B C	H_1-H_2 H_2-H_3 H_3-H_1	X_1-X_2 X_2-X_3 X_3-X_1	$\frac{V_H}{V_x}$	Zd0	NO ACCESSIBLE NEUTRAL ON HIGH VOLTAGE
57			X_2-X_3 X_3-X_1 X_1-X_2	A B C	H_1-H_0 H_2-H_0 H_3-H_0	X_2-X_1 X_3-X_2 X_1-X_3	$\frac{2}{3}\bullet\frac{V_H}{V_x}$	ZNd6	

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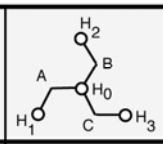
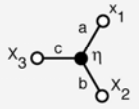
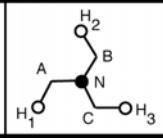
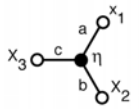
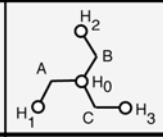
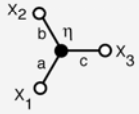
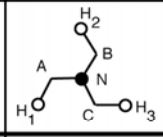
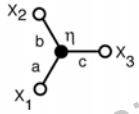
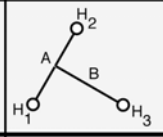
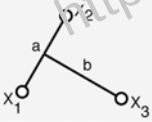
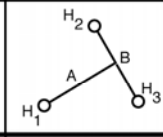
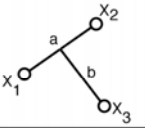
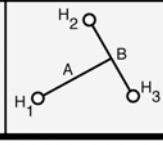
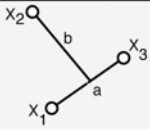
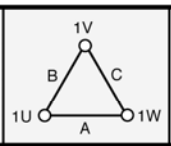
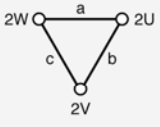
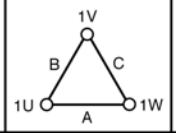
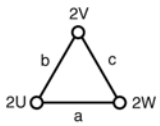
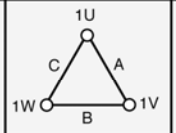
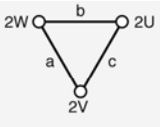
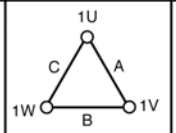
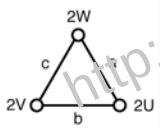
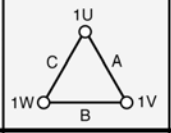
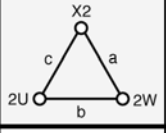
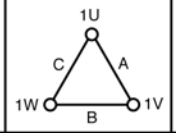
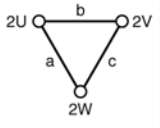
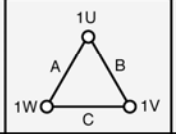
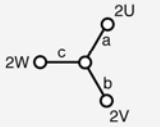
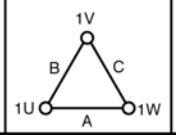
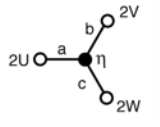
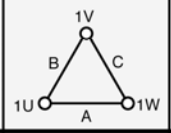
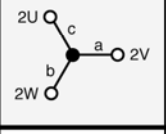
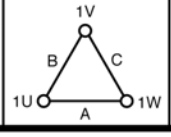
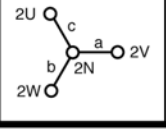
SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
33			—	A B C	$H_1 - H_0$ $H_2 - H_0$ $H_3 - H_0$	$X_3 - X_1$ $X_1 - X_2$ $X_2 - X_3$	$\frac{V_H}{V_X \bullet \sqrt{3}}$	ZNy5	NO ACCESSIBLE NEUTRAL ON WYE WINDING
34			$H_3 - H_2$ $H_1 - H_3$ $H_2 - H_1$	A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_3 - X_1$ $X_1 - X_2$ $X_2 - X_3$	$\frac{V_H}{V_X} \bullet \frac{\sqrt{3}}{2}$	Zy5	NO ACCESSIBLE NEUTRAL
35			—	A B C	$H_1 - H_0$ $H_2 - H_0$ $H_3 - H_0$	$X_1 - X_3$ $X_2 - X_1$ $X_3 - X_2$	$\frac{V_H}{V_X \bullet \sqrt{3}}$	ZNy11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
36			$H_3 - H_2$ $H_1 - H_3$ $H_2 - H_1$	A B C	$H_1 - H_3$ $H_2 - H_1$ $H_3 - H_2$	$X_1 - X_3$ $X_2 - X_1$ $X_3 - X_2$	$\frac{V_H}{V_X} \bullet \frac{\sqrt{3}}{2}$	Zy11	NO ACCESSIBLE NEUTRAL
58			 $H_1 - H_2$ $X_1 - X_2$	A B	$H_1 - H_2$ $H_1 - H_3$	$X_1 - X_2$ $X_1 - X_3$	$\frac{V_H}{V_X}$	T-T 0	
59			$H_2 - H_3$ $X_1 - X_2$	A B	$H_1 - H_3$ $H_2 - H_3$	$X_1 - X_2$ $X_1 - X_3$	$\frac{V_H}{V_X} \bullet \frac{\sqrt{3}}{2}$ $\frac{V_H}{V_X} \bullet \frac{2}{\sqrt{3}}$	T-T 30 Lag	
60			$H_2 - H_3$ $X_1 - X_3$	A B	$H_1 - H_3$ $H_2 - H_3$	$X_1 - X_3$ $X_2 - X_1$	$\frac{V_H}{V_X} \bullet \frac{\sqrt{3}}{2}$ $\frac{V_X}{V_H} \bullet \frac{2}{\sqrt{3}}$	T-T 30 Lead	

VANGUARD.050108V7

APPENDIX C – CEI/IEC 60076-1 Transformer Descriptions

SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
1			—	A	1U – 1W	2W – 2U	$\frac{U1}{U2}$	Dd6	
				B	1V – 1U	2U – 2V			
				C	1W – 1V	2V – 2W			
37			—	A	1U – 1W	2U – 2W	$\frac{U1}{U2}$	Dd0	
				B	1V – 1U	2V – 2U			
				C	1W – 1V	2W – 2V			
38			—	A	1U – 1V	2W – 2V	$\frac{U1}{U2}$	Dd2	
				B	1V – 1W	2U – 2W			
				C	1W – 1U	2V – 2U			
39			—	A	1U – 1W	2W – 2U	$\frac{U1}{U2}$	Dd4	
				B	1V – 1U	2U – 2V			
				C	1W – 1U	2V – 2W			
40			—	A	1U – 1V	2V – 2W	$\frac{U1}{U2}$	Dd8	
				B	1V – 1W	2W – 2U			
				C	1W – 1U	2U – 2V			
41			—	A	1U – 1V	2U – 2W	$\frac{U1}{U2}$	Dd10	
				B	1V – 1W	2V – 2U			
				C	1W – 1U	2W – 2V			
42			—	A	1U – 1W	2U – 2N	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dyn1	
				B	1V – 1U	2V – 2N			
				C	1W – 1V	2W – 2N			
2			1W – 1V 1U – 1W 1V – 1U	A	1U – 1W	2U – 2V	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dy1	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1U	2V – 2W			
				C	1W – 1V	2W – 2U			
61			1W – 1V 1U – 1W 1V – 1U	A	1U – 1W	2U – 2V	$\frac{V_{U1} \bullet \sqrt{3}}{U2}$	Dy3	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1U	2V – 2W			
				C	1W – 1V	2W – 2U			
62			—	A	1U – 1W	2N – 2V	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dyn3	
				B	1V – 1U	2N – 2W			
				C	1W – 1V	2N – 2U			

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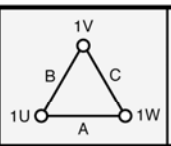
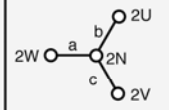
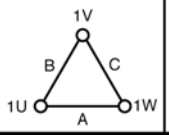
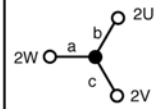
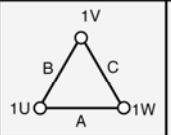
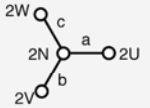
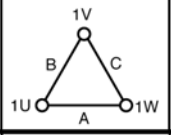
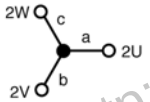
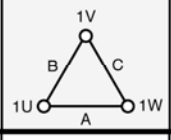
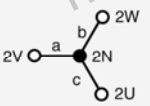
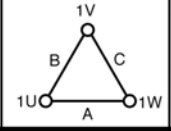
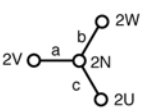
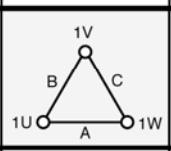
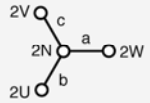
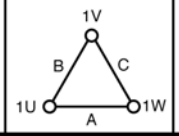
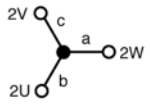
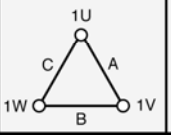
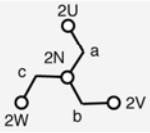
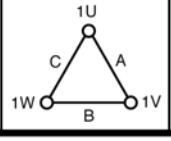
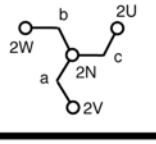
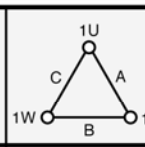
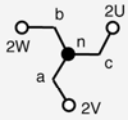
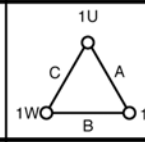
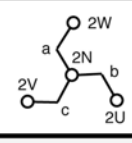
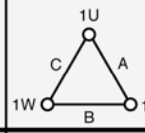
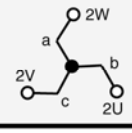
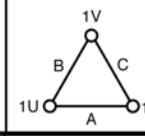
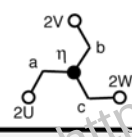
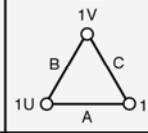
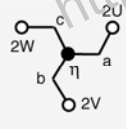
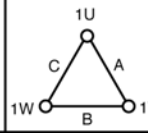
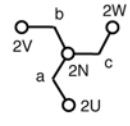
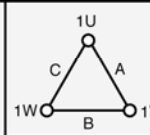
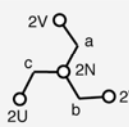
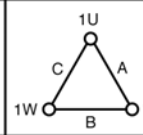
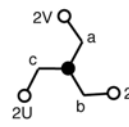
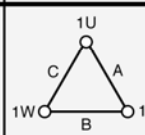
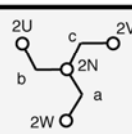
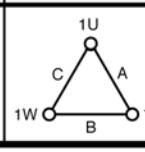
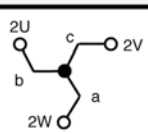
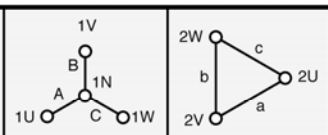
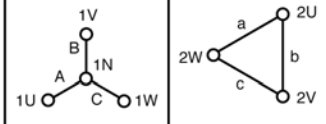
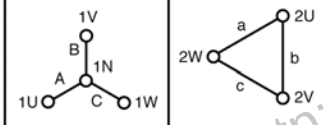
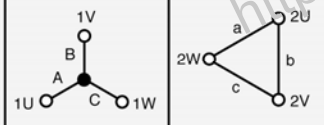
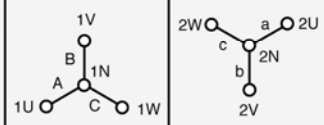
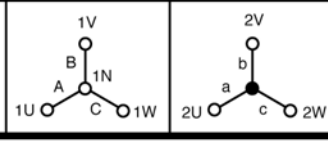
SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
3			—	A	1U– 1W	2W – 2N	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dyn5	
				B	1V – 1U	2U – 2N			
				C	1W – 1V	2V – 2N			
4			1W – 1V 1U –1W 1V – 1U	A	1U– 1W	2W – 2V	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dy5	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1U	2U – 2W			
				C	1W – 1V	2V – 2U			
5			—	A	1U – 1W	2N – 2U	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dyn7	
				B	1V – 1U	2N – 2V			
				C	1W – 1V	2N– 2W			
6			1W –1V 1U –1W 1V –1U	A	1U – 1W	2W – 2U	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dy7	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1U	2U – 2V			
				C	1W – 1V	2V – 2W			
63			1W –1V 1U–1W 1V–1U	A	1U– 1W	2V – 2U	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dy9	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1U	2W – 2V			
				C	1W – 1V	2U – 2W			
64			—	A	1U– 1W	2V – 2N	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dyn9	
				B	1V – 1U	2W – 2N			
				C	1W – 1V	2U – 2N			
7			—	A	1U – 1W	2N – 2W	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dyn11	
				B	1V – 1U	2N– 2U			
				C	1W – 1V	2N – 2V			
8			1W– 1V 1U –1W 1V–1U	A	1U – 1W	2V – 2W	$\frac{U1 \bullet \sqrt{3}}{U2}$	Dy11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1U	2W – 2U			
				C	1W – 1V	2U – 2V			
45			1V –1W 1W–1U 1U–1V	A	1U – 1V	2U – 2N	$\frac{3}{2} \bullet \frac{U1}{U2}$	Dzn0	
				B	1V – 1W	2V – 2N			
				C	1W – 1U	2W – 2N			
46			1V –1W 1W–1U 1U–1V	A	1U– 1V	2N – 2V	$\frac{3}{2} \bullet \frac{U1}{U2}$	Dzn2	
				B	1V – 1W	2N – 2W			
				C	1W – 1U	2N – 2U			

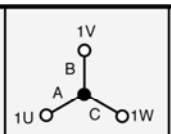
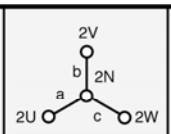
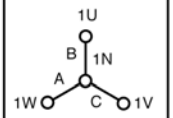
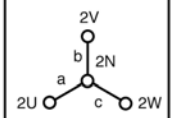
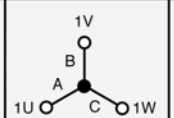
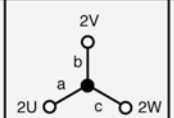
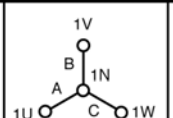
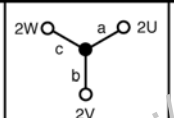
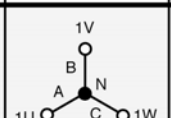
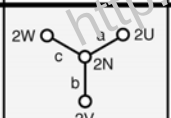
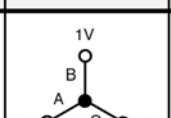
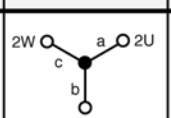
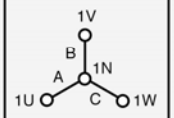
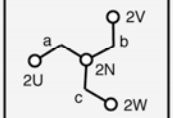
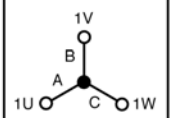
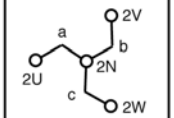
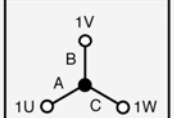
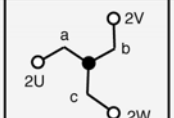
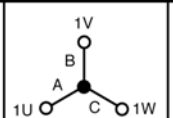
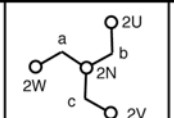
CEI/IEC.050108C2

SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	WINDING TESTED			CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)		PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
47			—	A	1U – 1V	2W – 2V	$\frac{U1}{U2}$	Dz2	NO ACCESSIBLE NEUTRAL
				B	1V – 1W	2U – 2W			
				C	1W – 1U	2V – 2U			
48			1V–1W 1W–1U 1U–1V	A	1U – 1V	2W – 2N	$\frac{3}{2}\bullet\frac{U1}{U2}$	Dzn4	
				B	1V – 1W	2U – 2N			
				C	1W – 1U	2V – 2N			
49			—	A	1U – 1V	2W – 2U	$\frac{U1}{U2}$	Dz4	NO ACCESSIBLE NEUTRAL
				B	1V – 1W	2U – 2V			
				C	1W – 1U	2V – 2W			
9			—	A	1U – 1W	2U – 2W	$\frac{U1}{U2}$	Dz0	NO ACCESSIBLE NEUTRAL
				B	1V – 1U	2V – 2U			
				C	1W – 1V	2W – 2V			
10			—	A	1U – 1W	2W – 2U	$\frac{U1}{U2}$	Dz6	NO ACCESSIBLE NEUTRAL
				B	1V – 1U	2U – 2V			
				C	1W – 1V	2V – 2W			
50			1V–1W 1W–1 U 1U–1V	A	1U – 1V	2N – 2U	$\frac{3}{2}\bullet\frac{U1}{U2}$	Dzn6	
				B	1V – 1W	2N – 2V			
				C	1W – 1U	2N – 2W			
51			1V–1W 1W–1U 1U–1V	A	1U – 1V	2V – 2N	$\frac{3}{2}\bullet\frac{U1}{U2}$	Dzn8	
				B	1V – 1W	2W – 2N			
				C	1W – 1U	2U – 2N			
52			—	A	1U– 1V	2V – 2W	$\frac{U1}{U2}$	Dz8	NO ACCESSIBLE NEUTRAL
				B	1V – 1W	2W – 2U			
				C	1W – 1U	2U – 2V			
53			1V–1W 1W–1U 1U–1V	A	1U – 1V	2N – 2W	$\frac{3}{2}\bullet\frac{U1}{U2}$	Dzn10	
				B	1V – 1W	2N – 2U			
				C	1W – 1U	2N – 2V			
54			—	A	1U – 1V	2U – 2W	$\frac{U1}{U2}$	Dz10	NO ACCESSIBLE NEUTRAL
				B	1V – 1W	2V– 2U			
				C	1W –1U	2W – 2V			

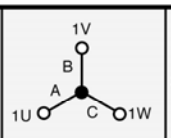
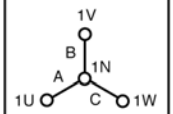
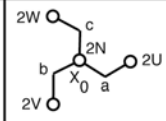
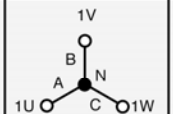
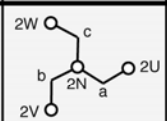
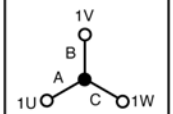
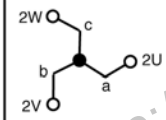
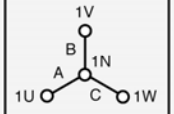
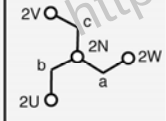
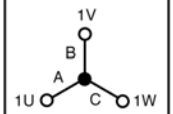
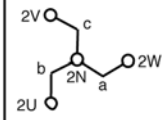
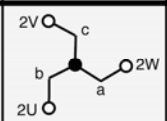
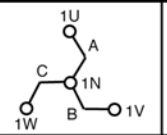
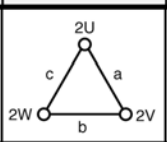
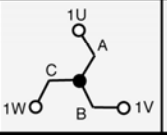
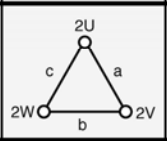
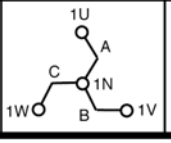
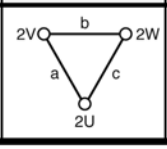
CEI/IEC.050108C3

SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
11			—	A	1U – 1N	2V – 2U	$\frac{U1}{U2 \bullet \sqrt{3}}$	YNd7	
				B	1V – 1N	2W – 2V			
				C	1W – 1N	2U – 2W			
44			—	A	1U – 1N	2U – 2V	$\frac{U1}{U2 \bullet \sqrt{3}}$	YNd1	
				B	1V – 1N	2V – 2W			
				C	1W – 1N	2W – 2U			
12			1W–1V 1U–1W 1V–1U	A	1U – 1W	2U – 2V	$\frac{U1}{U2} \bullet \frac{\sqrt{3}}{2}$	Yd1	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1U	2V – 2W			
				C	1W – 1V	2W – 2U			
13			—	A	1U – 1N	2W – 2U	$\frac{U1}{U2 \bullet \sqrt{3}}$	YNd5	
				B	1V – 1N	2U – 2V			
				C	1W – 1N	2V – 2W			
14			1W–1V 1U–1W 1V–1U	A	1U – 1W	2W – 2U	$\frac{U1}{U2} \bullet \frac{\sqrt{3}}{2}$	Yd5	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1U	2U – 2V			
				C	1W – 1V	2V – 2W			
15			1W–1V 1U–1W 1V–1U	A	1U – 1W	2V – 2U	$\frac{U1}{U2} \bullet \frac{\sqrt{3}}{2}$	Yd7	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1U	2W – 2V			
				C	1W – 1V	2U – 2W			
16			—	A	1U– 1N	2U – 2W	$\frac{U1}{U2 \bullet \sqrt{3}}$	YNd11	
				B	1V – 1N	2V– 2U			
				C	1W – 1N	2W – 2V			
17			1W–1V 1U–1W 1V–1U	A	1U– 1W	2U – 2W	$\frac{U1}{U2} \bullet \frac{\sqrt{3}}{2}$	Yd11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1U	2V – 2U			
				C	1W – 1V	2W – 2V			
18			—	A	1U – 1N	2N – 2U	$\frac{U1}{U2}$	YNyn6	
				B	1V – 1N	2N – 2V			
				C	1W – 1N	2N – 2W			
19			1V–1N 1W–1N 1U–1N	A	1U – 1N	2U – 2V	$\frac{U1}{U2}$	YNy0	NO ACCESSIBLE NEUTRAL ON LOW VOLTAGE WINDING
				B	1V – 1N	2V – 2W			
				C	1W – 1N	2W – 2U			

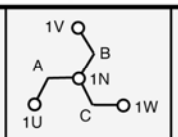
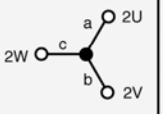
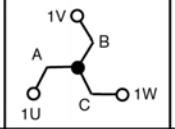
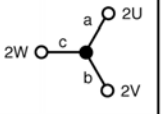
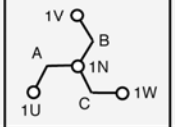
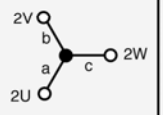
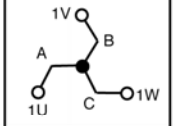
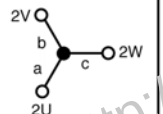
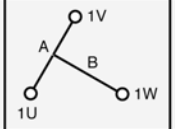
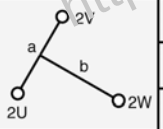
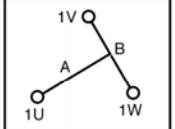
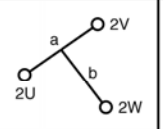
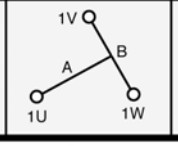
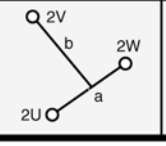
CEI/IEC.050108C4

SPEC TEST NO.	TRANSFORMER CONFIGURATION: HIGH-VOLTAGE WINDING (H)	TRANSFORMER CONFIGURATION: LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	WINDING TESTED: HIGH VOLTAGE WINDING	WINDING TESTED: LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
20			2W–2N 2U–2N 2V–2N	A B C	1U – 1W 1V – 1U 1W – 1V	2U – 2N 2V– 2N 2W – 2N	$\frac{U1}{U2}$	Yyn0	NO ACCESSIBLE NEUTRAL ON HIGH VOLTAGE WINDING
43			—	A B C	1U – 1N 1V – 1N 1W – 1N	2U – 2W 2V – 2N 2W – 2N	$\frac{U1}{U2}$	YNyn0	
21			—	A B C	1U – 1W 1V – 1U 1W – 1V	2U – 2W 2V – 2U 2W – 2V	$\frac{U1}{U2}$	Yy0	NO ACCESSIBLE NEUTRAL
22			1V–1N 1W–1N 1U–1N	A B C	1U – 1N 1V – 1N 1W – 1N	2V – 2U 2W – 2V 2U – 2W	$\frac{U1}{U2}$	YNy6	NO ACCESSIBLE NEUTRAL ON LOW VOLTAGE WINDING
23			2W–2N 2U–2N 2V–2N	A B C	1U – 1W 1V – 1U 1W – 1V	2N – 2U 2N – 2V 2N – 2W	$\frac{U1}{U2}$	Yyn6	NO ACCESSIBLE NEUTRAL ON HIGH VOLTAGE WINDING
24			—	A B C	1U – 1W 1V – 1U 1W – 1V	2W – 2U 2U – 2V 2V – 2W	$\frac{U1}{U2}$	Yy6	NO ACCESSIBLE NEUTRAL
65			—	A B C	1U – 1W 1V – 1U 1W – 1V	2U – 2N 2V – 2N 2W – 2N	$\frac{V_H \bullet \sqrt{3}}{V_X}$	YNzn1	
25			—	A B C	1U – 1W 1V – 1U 1W – 1V	2U – 2N 2V – 2N 2W – 2N	$\frac{U1 \bullet \sqrt{3}}{U2}$	Yzn1	NO ACCESSIBLE NEUTRAL ON WYE WINDING
26			1W–1V 1U–1W 1V–1U	A B C	1U – 1W 1V– 1U 1W – 1V	2U – 2V 2V – 2W 2W – 2U	$\frac{U1}{U2} \bullet \frac{\sqrt{3}}{2}$	Yz1	NO ACCESSIBLE NEUTRAL
27			—	A B C	1U – 1W 1V – 1U 1W – 1V	2W – 2N 2U – 2N 2V – 2N	$\frac{U1 \bullet \sqrt{3}}{U2}$	Yzn5	NO ACCESSIBLE NEUTRAL ON WYE WINDING

CEI/IEC.050108C5

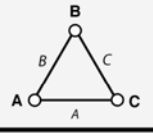
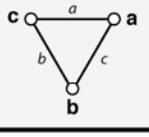
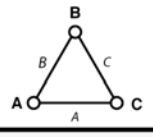
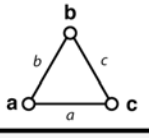
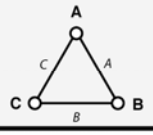
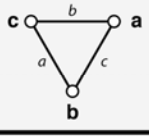
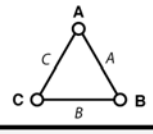
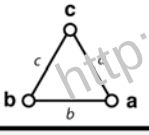
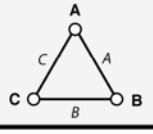
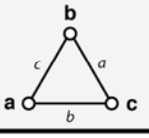
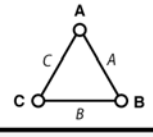
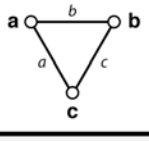
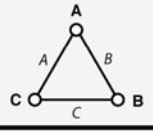
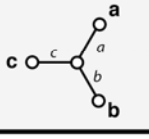
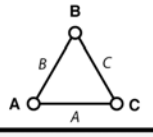
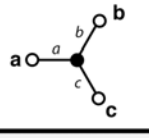
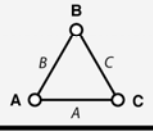
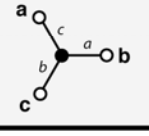
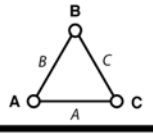
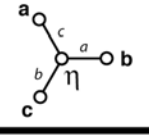
SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
28			1W–1V 1U–1W 1V–1U	A B C	1U – 1W 1V – 1U 1W – 1V	2W – 2U 2U – 2V 2V – 2W	$\frac{U1}{U2}\bullet\frac{\sqrt{3}}{2}$	Yz5	NO ACCESSIBLE NEUTRAL
66			—	A B C	1U – 1W 1V – 1U 1W – 1V	2N – 2U 2N – 2V 2N – 2W	$\frac{V_H}{V_X}\bullet\frac{\sqrt{3}}{}$	YNzn7	
29			—	A B C	1U – 1W 1V – 1U 1W – 1V	2N – 2U 2N – 2V 2N – 2W	$\frac{U1}{U2}\bullet\frac{\sqrt{3}}{}$	Yzn7	NO ACCESSIBLE NEUTRAL ON WYE WINDING
30			1W–1V 1U–1W 1V–1U	A B C	1U – 1W 1V – 1U 1W – 1V	2V – 2U 2W – 2V 2U – 2W	$\frac{U1}{U2}\bullet\frac{\sqrt{3}}{2}$	Yz7	NO ACCESSIBLE NEUTRAL
67			—	A B C	1U – 1W 1V – 1U 1W – 1V	2N – 2W 2N – 2U 2N – 2V	$\frac{V_H}{V_X}\bullet\frac{\sqrt{3}}{}$	YNzn11	
31			—	A B C	1U – 1W 1V – 1U 1W – 1V	2N – 2W 2N – 2U 2N – 2V	$\frac{U1}{U2}\bullet\frac{\sqrt{3}}{}$	Yzn11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
32			1W–1V 1U–1W 1V–1U	A B C	1U – 1W 1V – 1U 1W – 1V	2U – 2W 2V – 2U 2W – 2V	$\frac{U1}{U2}\bullet\frac{\sqrt{3}}{2}$	Yz11	NO ACCESSIBLE NEUTRAL
55			1V–1W 1W–1U 1U–1V	A B C	1U – 1N 1V – 1N 1W – 1N	2U– 2V 2V – 2W 2W – 2U	$\frac{2}{3}\bullet\frac{U1}{U2}$	ZNd0	
56			—	A B C	1U – 1V 1V – 1W 1W – 1U	2U – 2V 2V – 2W 2W – 2U	$\frac{U1}{U2}$	Zd0	NO ACCESSIBLE NEUTRAL ON HIGH VOLTAGE
57			1V–1W 1W–1U 1U–1V	A B C	1U – 1N 1V – 1N 1W – 1N	2V – 2U 2W – 2V 2U – 2W	$\frac{2}{3}\bullet\frac{U1}{U2}$	ZNd6	

CEI/IEC.050108C6

SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
33			—	A	1U – 1N	2W – 2U	$\frac{U1}{U2 \cdot \sqrt{3}}$	ZNy5	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1N	2U – 2V			
				C	1W – 1N	2V – 2W			
34			1W–1V 1U–1W 1V–1U	A	1U – 1W	2W – 2U	$\frac{U1}{U2} \cdot \frac{\sqrt{3}}{2}$	Zy5	NO ACCESSIBLE NEUTRAL
				B	1V – 1U	2U – 2V			
				C	1W – 1V	2V – 2W			
35			—	A	1U – 1N	2U – 2W	$\frac{U1}{U2 \cdot \sqrt{3}}$	ZNy11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	1V – 1N	2V – 2U			
				C	1W – 1N	2W – 2V			
36			1W–1V 1U–1W 1V–1U	A	1U – 1W	2U – 2W	$\frac{U1}{U2} \cdot \frac{\sqrt{3}}{2}$	Zy11	NO ACCESSIBLE NEUTRAL
				B	1V – 1U	2V – 2U			
				C	1W – 1V	2W – 2V			
58			1U–1V 2U–2V	A	1U – 1V	2U – 2V	$\frac{U1}{U2}$	T-T 0	
				B	1U – 1W	2U – 2W			
59			1V–1W 2U–2V	A	1U – 1W	2U – 2V	$\frac{U1}{U2} \cdot \frac{\sqrt{3}}{2}$	T-T 30 Lag	
				B	1V – 1W	2U – 2W	$\frac{U1}{U2} \cdot \frac{2}{\sqrt{3}}$		
60			1V–1W 2U–2W	A	1U – 1W	2U – 2W	$\frac{U1}{U2} \cdot \frac{\sqrt{3}}{2}$	T-T 30 Lead	
				B	1V – 1W	2V – 2U	$\frac{U1}{U2} \cdot \frac{2}{\sqrt{3}}$		

CEI/IEC.050108C7

APPENDIX D – Australian Std.2374 Transformer Descriptions

SPEC TEST NO.	TRANSFORMER CONFIGURATION: HIGH-VOLTAGE WINDING (H)	TRANSFORMER CONFIGURATION: LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	WINDING TESTED: HIGH VOLTAGE WINDING	WINDING TESTED: LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
1			—	A B C	A – C B – A C – B	c – a a – b b – c	HV / LV	Dd6	
37			—	A B C	A – C B – A C – B	a – c b – a c – b	HV / LV	Dd0	
38			—	A B C	A – B B – C C – A	c – b a – c b – a	HV / LV	Dd2	
39			—	A B C	A – B B – C C – A	c – a a – b b – c	HV / LV	Dd4	
40			—	A B C	A – B B – C C – A	b – c c – a a – b	HV / LV	Dd8	
41			—	A B C	A – B B – C C – A	a – c b – a c – b	HV / LV	Dd10	
42			—	A B C	A – C B – A C – B	a – η b – η c – η	HV • √3 / LV	Dyn1	
2			C – B A – C B – A	A B C	A – C B – A C – B	a – c b – a c – b	HV • √3 / LV	Dy1	NO ACCESSIBLE NEUTRAL ON WYE WINDING
61			C – B A – C B – A	A B C	A – C B – A C – B	a – b b – c c – a	V_H • √3 / V_X	Dy3	NO ACCESSIBLE NEUTRAL ON WYE WINDING
62			—	A B C	A – C B – A C – B	η – b η – c η – a	HV • √3 / LV	Dyn3	

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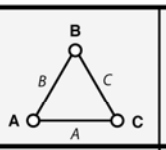
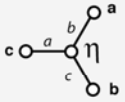
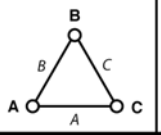
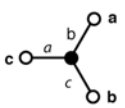
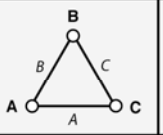
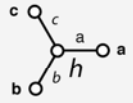
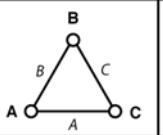
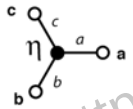
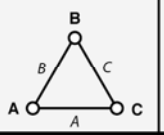
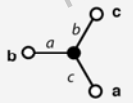
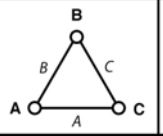
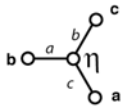
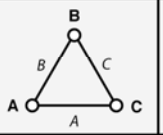
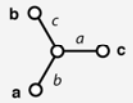
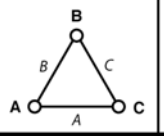
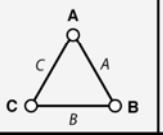
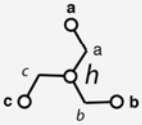
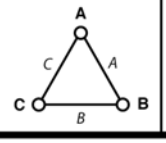
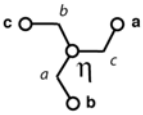
SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	WINDING TESTED			CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)		PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
3			—	A	A – C	c – η	$\frac{HV}{LV} \cdot \sqrt{3}$	Dyn5	
				B	B – A	a – η			
				C	C – B	b – η			
4			C – B	A	A – C	c – b	$\frac{HV}{LV} \cdot \sqrt{3}$	Dy5	NO ACCESSIBLE NEUTRAL ON WYE WINDING
			A – C	B	B – A	a – c			
			B – A	C	C – B	b – a			
5			—	A	A – C	η – a	$\frac{HV}{LV} \cdot \sqrt{3}$	Dyn7	
				B	B – A	η – b			
				C	C – B	η – c			
6			C – B	A	A – C	c – a	$\frac{HV}{LV} \cdot \sqrt{3}$	Dy7	NO ACCESSIBLE NEUTRAL ON WYE WINDING
			A – C	B	B – A	a – b			
			B – A	C	C – B	b – c			
63			C – B	A	B – C	b – a	$\frac{HV}{LV} \cdot \sqrt{3}$	Dy9	NO ACCESSIBLE NEUTRAL ON WYE WINDING
			A – C	B	B – A	c – b			
			B – A	C	C – B	a – c			
64			—	A	A – C	b – η	$\frac{HV}{LV} \cdot \sqrt{3}$	Dyn9	
				B	B – A	c – η			
				C	C – B	a – η			
7			—	A	A – C	η – c	$\frac{HV}{LV} \cdot \sqrt{3}$	Dyn11	
				B	B – A	η – a			
				C	C – B	η – b			
8			C – B	A	A – C	b – c	$\frac{HV}{LV} \cdot \sqrt{3}$	Dy11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
			A – C	B	B – A	c – a			
			B – A	C	C – B	a – b			
45			B – C	A	A – B	a – η	$\frac{3}{2} \cdot \frac{HV}{LV}$	Dzn0	
			C – A	B	B – C	b – η			
			A – B	C	C – A	c – η			
46			B – C	C	A – B	η – b	$\frac{3}{2} \cdot \frac{HV}{LV}$	Dzn2	
			C – A	A	B – C	η – c			
			A – B	B	C – A	η – a			

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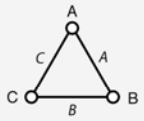
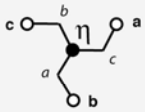
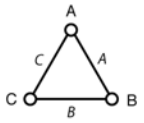
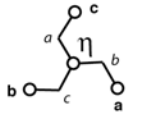
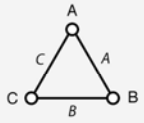
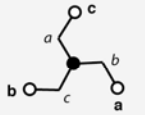
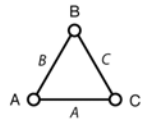
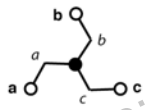
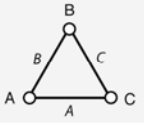
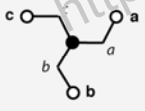
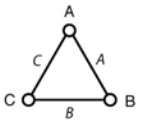
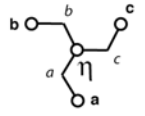
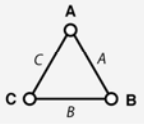
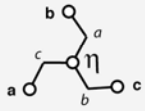
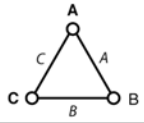
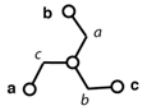
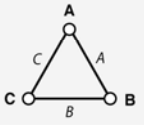
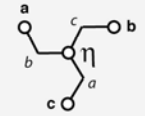
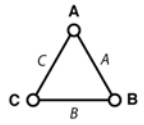
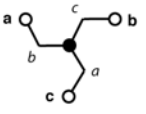
SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	WINDING TESTED			CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)		PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
47			—	A B C	A – B B – C C – A	c – b a – c b – a	$\frac{HV}{LV}$	Dz2	NO ACCESSIBLE NEUTRAL
48			B – C C – A A – B	A B C	A – B B – C C – A	c – η a – η b – η	$\frac{3}{2} \cdot \frac{HV}{LV}$	Dzn4	
49			—	A B C	A – B B – C C – A	c – a a – b b – c	$\frac{HV}{LV}$	Dz4	NO ACCESSIBLE NEUTRAL
9			—	A B C	A – C B – A C – B	a – c b – a c – b	$\frac{HV}{LV}$	Dz0	NO ACCESSIBLE NEUTRAL
10			—	A B C	A – C B – A C – B	c – a a – b b – c	$\frac{HV}{LV}$	Dz6	NO ACCESSIBLE NEUTRAL
50			B – C C – A A – B	A B C	A – B B – C C – A	η – a η – b η – c	$\frac{3}{2} \cdot \frac{HV}{LV}$	Dzn6	
51			B – C C – A A – B	A B C	A – B B – C C – A	b – η c – η a – η	$\frac{3}{2} \cdot \frac{HV}{LV}$	Dzn8	
52			—	A B C	A – B B – C C – A	b – c c – a a – b	$\frac{HV}{LV}$	Dz8	NO ACCESSIBLE NEUTRAL
53			B – C C – A A – B	A B C	A – B B – C C – A	η – c η – a η – b	$\frac{3}{2} \cdot \frac{HV}{LV}$	Dzn10	
54			—	A B C	A – B B – C C – A	a – c b – a c – b	$\frac{HV}{LV}$	Dz10	NO ACCESSIBLE NEUTRAL

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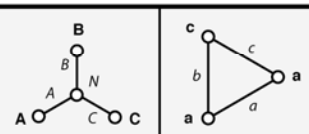
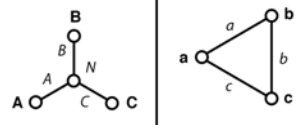
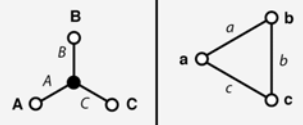
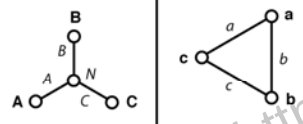
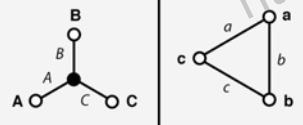
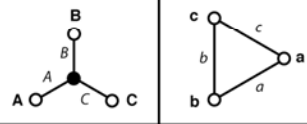
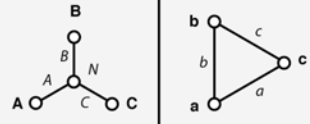
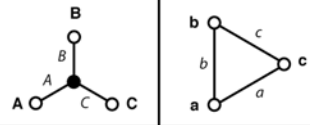
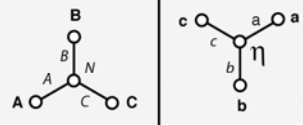
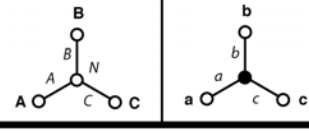
SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
11			—	A	A – N	b – a	$\frac{HV}{LV \bullet \sqrt{3}}$	YNd7	
				B	B – N	c – b			
				C	C – N	a – c			
44			—	A	A – N	a – b	$\frac{HV}{LV \bullet \sqrt{3}}$	YNd1	
				B	B – N	b – c			
				C	C – N	c – a			
12			C – B A – C B – A	A	A – C	a – b	$\frac{HV}{LV} \bullet \frac{\sqrt{3}}{2}$	Yd1	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	B – A	b – c			
				C	C – B	c – a			
13			—	A	A – N	c – a	$\frac{HV}{LV \bullet \sqrt{3}}$	YNd5	
				B	B – N	a – b			
				C	C – N	b – c			
14			C – B A – C B – A	A	A – C	c – a	$\frac{HV}{LV} \bullet \frac{\sqrt{3}}{2}$	Yd5	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	B – A	a – b			
				C	C – B	b – c			
15			C – B A – C B – A	A	A – C	b – a	$\frac{HV}{LV} \bullet \frac{\sqrt{3}}{2}$	Yd7	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	B – A	c – b			
				C	C – B	a – c			
16			—	A	A– N	a – c	$\frac{HV}{LV \bullet \sqrt{3}}$	YNd11	
				B	B – N	b – a			
				C	C – N	c – b			
17			C – B A – C B – A	A	A – C	a – c	$\frac{HV}{LV} \bullet \frac{\sqrt{3}}{2}$	Yd11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
				B	B – A	b – a			
				C	C – B	c – b			
18			—	A	A – N	η – a	$\frac{HV}{LV}$	YNyn6	
				B	B – N	η – b			
				C	C – N	η – c			
19			B – N C – N A – N	A	A – N	a – b	$\frac{HV}{LV}$	YNy0	NO ACCESSIBLE NEUTRAL ON LOW VOLTAGE WINDING
				B	B – N	b – c			
				C	C – N	c – a			

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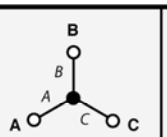
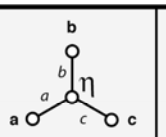
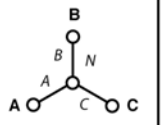
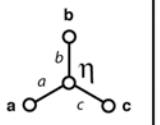
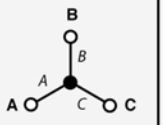
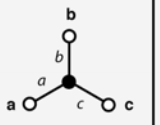
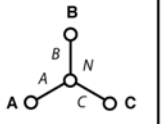
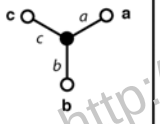
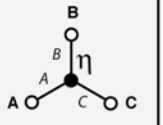
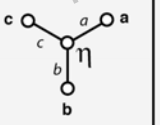
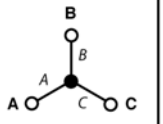
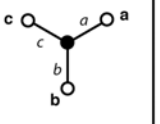
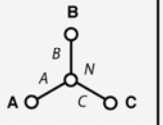
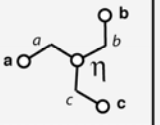
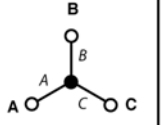
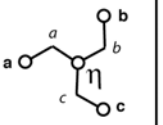
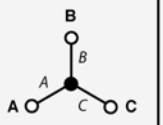
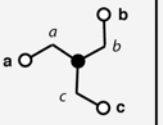
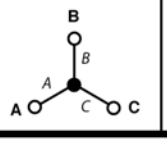
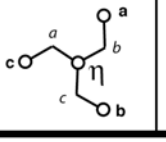
SPEC TEST NO.	TRANSFORMER CONFIGURATION: HIGH-VOLTAGE WINDING (H)	TRANSFORMER CONFIGURATION: LOW-VOLTAGE WINDING (X)	EXT. JUMPER	PHASE	WINDING TESTED: HIGH VOLTAGE WINDING	WINDING TESTED: LOW VOLTAGE WINDING	CAL. TURN RATIO	VECTOR GROUP	NOTES
20			c – h a – h b – h	A B C	A – C B – C C – B	a – η b – η c – η	HV / LV	Yyn0	NO ACCESSIBLE NEUTRAL ON HIGH VOLTAGE WINDING
43			—	A B C	A – N B – N C – N	a – η b – η c – η	HV / LV	YNyn0	
21			—	A B C	A – C B – A C – B	a – c b – a c – b	HV / LV	Yy0	NO ACCESSIBLE NEUTRAL
22			B – N C – N A – N	A B C	A – N B – N C – N	b – a c – b a – c	HV / LV	YNy6	NO ACCESSIBLE NEUTRAL ON LOW VOLTAGE WINDING
23			c – h a – h b – h	A B C	A – C B – A C – B	η – a η – b η – c	HV / LV	Yyn6	NO ACCESSIBLE NEUTRAL ON HIGH VOLTAGE WINDING
24			—	A B C	A – C B – A C – B	c – a a – b b – c	HV / LV	Yy6	NO ACCESSIBLE NEUTRAL
65			—	A B C	A – C B – A C – B	a – η b – η c – η	$\frac{V_H \cdot \sqrt{3}}{V_X}$	YNzn1	
25			—	A B C	A – C B – A C – B	a – η b – η c – η	$\frac{V_H \cdot \sqrt{3}}{LV}$	Yzn1	NO ACCESSIBLE NEUTRAL ON WYE WINDING
26			C – B A – C B – A	A B C	A – C B – A C – B	a – b b – c c – a	$\frac{HV}{LV} \cdot \frac{\sqrt{3}}{2}$	Yz1	NO ACCESSIBLE NEUTRAL
27			—	A B C	A – C B – A C – B	c – η a – η b – η	$\frac{HV \cdot \sqrt{3}}{LV}$	Yzn5	NO ACCESSIBLE NEUTRAL ON WYE WINDING

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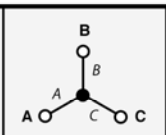
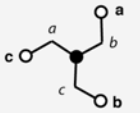
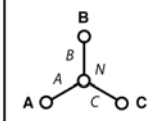
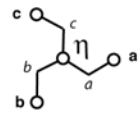
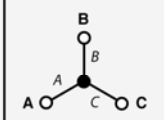
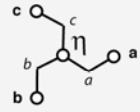
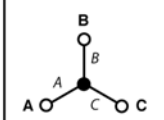
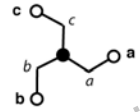
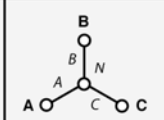
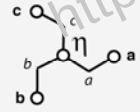
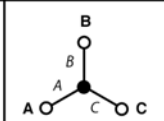
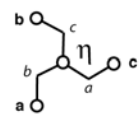
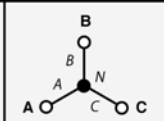
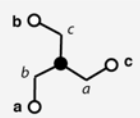
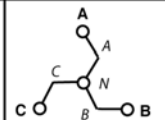
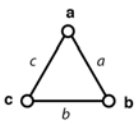
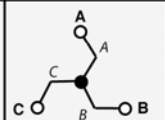
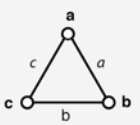
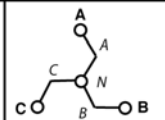
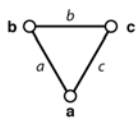
SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
28			C – B A – C B – A	*A* *B* *C*	A – C B – A C – B	c – a a – b b – c	$\frac{HV}{LV} \bullet \frac{\sqrt{3}}{2}$	Yz5	NO ACCESSIBLE NEUTRAL
66			—	*A* *B* *C*	A – C B – A C – B	η – a η – b η – c	$\frac{V_H}{V_X} \bullet \frac{\sqrt{3}}{}$	YNzn7	
29			—	*A* *B* *C*	A – C B – A C – B	η – a η – b η – c	$\frac{HV \bullet \sqrt{3}}{LV}$	Yzn7	NO ACCESSIBLE NEUTRAL ON WYE WINDING
30			C – B A – C B – A	*A* *B* *C*	A – C B – A C – B	b – a c – b a – c	$\frac{HV}{LV} \bullet \frac{\sqrt{3}}{2}$	Yz7	NO ACCESSIBLE NEUTRAL
67			—	*A* *B* *C*	A – C B – A C – B	η – c η – a η – b	$\frac{V_H \bullet \sqrt{3}}{V_X}$	Yzn11	
31			—	*A* *B* *C*	A – C B – A C – B	η – c η – a η – b	$\frac{HV \bullet \sqrt{3}}{LV}$	Yz11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
32			C – B A – C B – A	*A* *B* *C*	A – C B – A C – B	a – c b – a c – b	$\frac{HV}{LV} \bullet \frac{\sqrt{3}}{2}$	Yz11	NO ACCESSIBLE NEUTRAL
55			b – c c – a a – b	*A* *B* *C*	A – N B – N C – N	a – b b – c c – a	$\frac{2}{3} \bullet \frac{HV}{LV}$	ZNd0	
56			—	*A* *B* *C*	A – B B – C C – A	a – b b – c c – a	$\frac{HV}{LV}$	Zd0	NO ACCESSIBLE NEUTRAL ON HIGH VOLTAGE
57			b – c c – a a – b	*A* *B* *C*	A – N B – N C – N	b – a c – b a – c	$\frac{HV}{LV}$	ZNd6	

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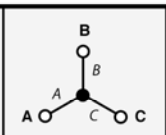
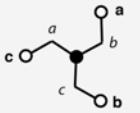
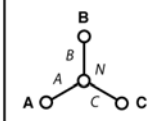
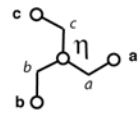
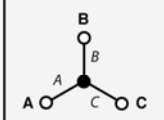
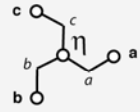
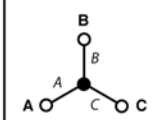
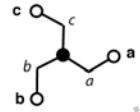
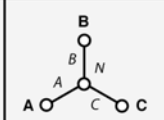
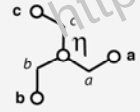
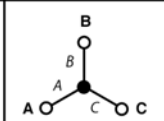
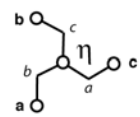
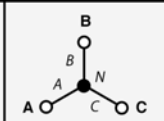
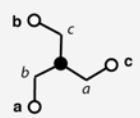
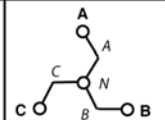
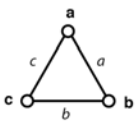
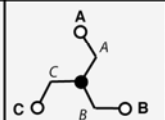
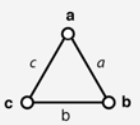
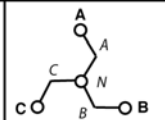
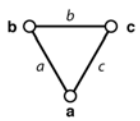
SPEC TEST NO.	TRANSFORMER CONFIGURATION		EXT. JUMPER	PHASE	WINDING TESTED		CAL. TURN RATIO	VECTOR GROUP	NOTES
	HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)			HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING			
28			C – B A – C B – A	*A* *B* *C*	A – C B – A C – B	c – a a – b b – c	$\frac{HV}{LV} \bullet \frac{\sqrt{3}}{2}$	Yz5	NO ACCESSIBLE NEUTRAL
66			—	*A* *B* *C*	A – C B – A C – B	η – a η – b η – c	$\frac{V_H}{V_X} \bullet \frac{\sqrt{3}}{}$	YNzn7	
29			—	*A* *B* *C*	A – C B – A C – B	η – a η – b η – c	$\frac{HV \bullet \sqrt{3}}{LV}$	Yzn7	NO ACCESSIBLE NEUTRAL ON WYE WINDING
30			C – B A – C B – A	*A* *B* *C*	A – C B – A C – B	b – a c – b a – c	$\frac{HV}{LV} \bullet \frac{\sqrt{3}}{2}$	Yz7	NO ACCESSIBLE NEUTRAL
67			—	*A* *B* *C*	A – C B – A C – B	η – c η – a η – b	$\frac{V_H \bullet \sqrt{3}}{V_X}$	Yzn11	
31			—	*A* *B* *C*	A – C B – A C – B	η – c η – a η – b	$\frac{HV \bullet \sqrt{3}}{LV}$	Yz11	NO ACCESSIBLE NEUTRAL ON WYE WINDING
32			C – B A – C B – A	*A* *B* *C*	A – C B – A C – B	a – c b – a c – b	$\frac{HV}{LV} \bullet \frac{\sqrt{3}}{2}$	Yz11	NO ACCESSIBLE NEUTRAL
55			b – c c – a a – b	*A* *B* *C*	A – N B – N C – N	a – b b – c c – a	$\frac{2}{3} \bullet \frac{HV}{LV}$	ZNd0	
56			—	*A* *B* *C*	A – B B – C C – A	a – b b – c c – a	$\frac{HV}{LV}$	Zd0	NO ACCESSIBLE NEUTRAL ON HIGH VOLTAGE
57			b – c c – a a – b	*A* *B* *C*	A – N B – N C – N	b – a c – b a – c	$\frac{HV}{LV}$	ZNd6	

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